JFII JLO FITNESS INSTITUTE OF INDIA

ESSENTIAL OF LEVEL 3 SPORTS INSTRUCTOR

ANATOMY
SPORT
HEART
INJURY
ARTERY
AEROBIC
ENERGY
ROTATOR CUFF
MUSCLE

Registered to Certify in Sports Fitness Education and Skilled Development Program

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ANATOMY

OBJECTIVE OF THIS LESSON

At the end of this lesson you will be able to:

→ Define human anatomy and determine the anatomical position
→ Describe the composition of a human body – **muscles**, **bones**, **organs** and **tissues**
→ Define anatomical terminology based on the position of parts and movement of parts
→ Describe the musculoskeletal system and differentiate movements based on the types of muscles

ABOUT ANATOMY

Anatomy, derived from a Greek word *anatémnein*, refers to the study of structures by cutting open a plant, animal or any living being.

ANATOMICAL POSITION

Refers to the standing, sitting or lying down positions. Typically, a body at equilibrium with eyes, palms and toes facing forward is said to be in its anatomical position.

154.75

Figure 1 Anatomical Position

COMPOSITION OF THE HUMAN BODY

The human body is made up of **muscles**, **bones**, **organs**, and **other tissues**.

Muscles are connective tissues and responsible for movement because of their flexibility to contract or extend.

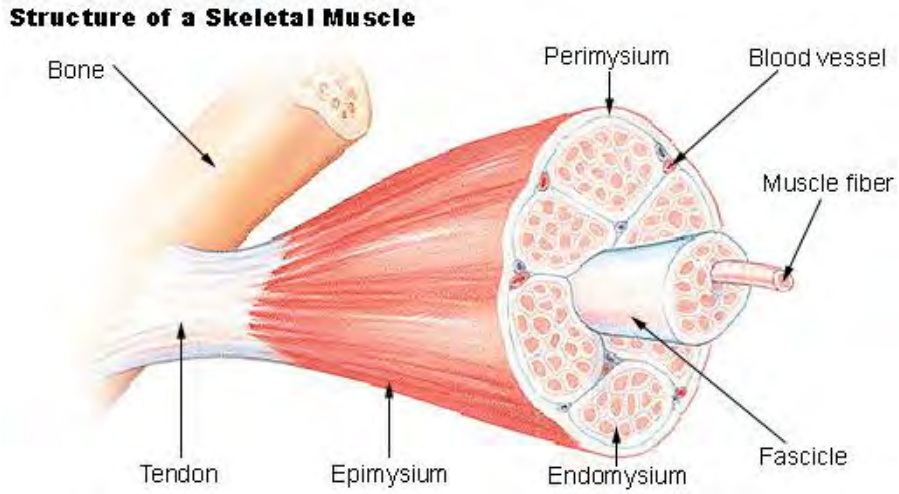


Figure 2 Structure of a Skeletal Muscle

Bones are hard connective tissues that form the skeletal structure of the body and muscles are attached to these bones through tendons or ligaments.

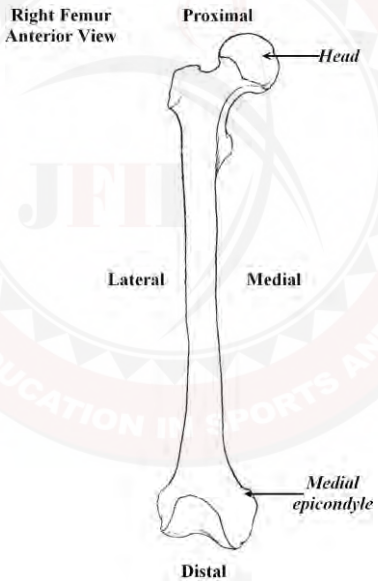


Figure 3 Anterior View of the Right Femur

Organs are tissues which perform various bodily functions such as pumping blood (heart), breathing (lungs), metabolism (liver), digestion (intestines), etc. These types of tissues are located inside the thorax (rib cage), and abdomen.

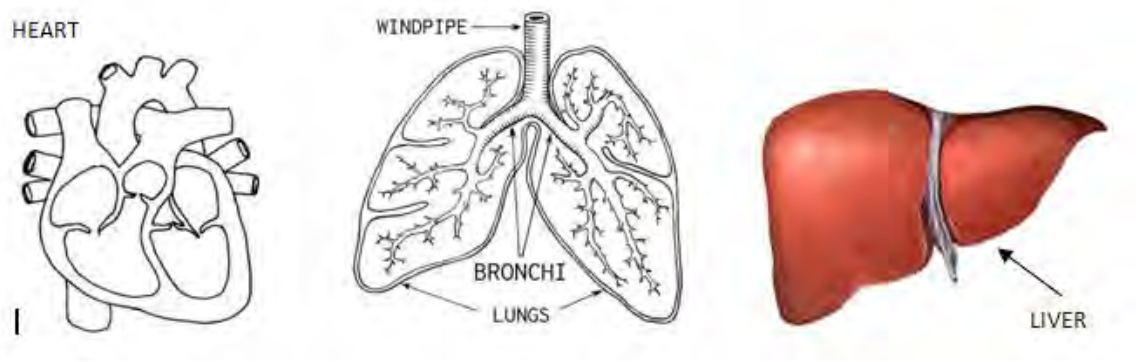


Figure 4 Organs

Other Tissues include ligaments and skin which imparts proper shape to the body, and also protects from external trauma.

Figure 5 Ligaments

The structures, which are present around joints, are called *ligaments*.

ANATOMICAL TERMINOLOGY

Anatomical terms refer to the position of structures or body parts as whole.

Terminology based on position of parts

- **Superior** - upper portion of the body part
- **Inferior** - lower portion of the body part
- **Medial** - middle portion of the body part (refers to central part)
- **Lateral** - outer portion of the body part (refers to outer part)
- **Anterior** - front portion of the body part
- **Posterior** - back portion of the body part

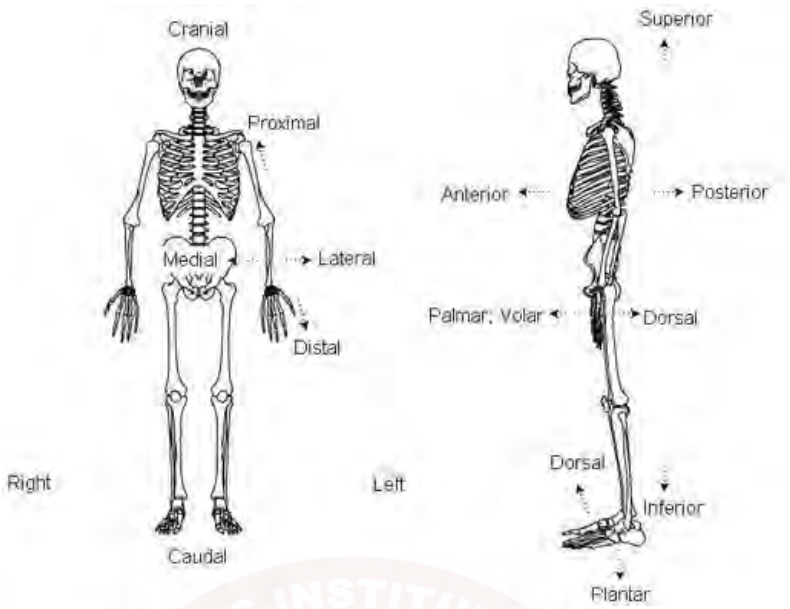


Figure 6 Position of Parts

Terminology based on movements of the parts

- **Flexion** - when origin and insertion of muscle moves **closer** to each other in Saggital plane with **concentric contraction**.
- **Extension** - when origin and insertion of muscle moves **away** from each other in Saggital plane with **eccentric contraction**.
- **Abduction** - when a part moves away from the mid line in frontal plane
- **Adduction** - when a part moves closer to mid line in frontal plane

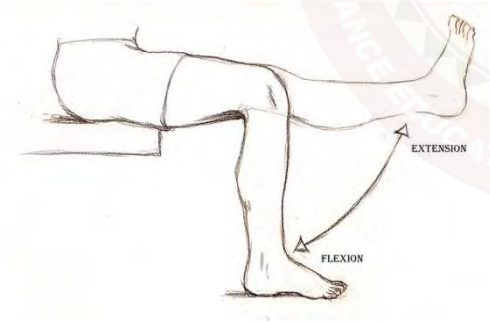


Figure 7 Flexion and Extension

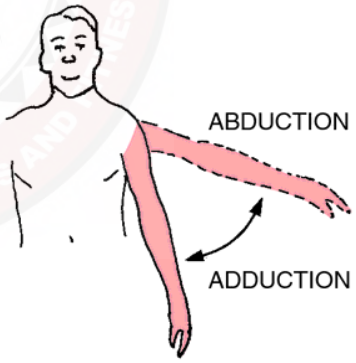


Figure 8 Abduction/adduction

- **Medial/internal rotation** - when a part rotates towards the midline on its fixed axis of rotation.
- **Lateral/external rotation** - when a part rotates away from the midline on its fixed axis of rotation
- **Circumduction** - combination of **all the above movement** (only occurs in ball and socket type of joint)

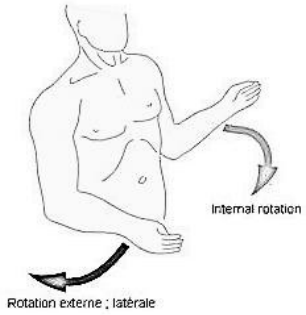


Figure 9 Rotation

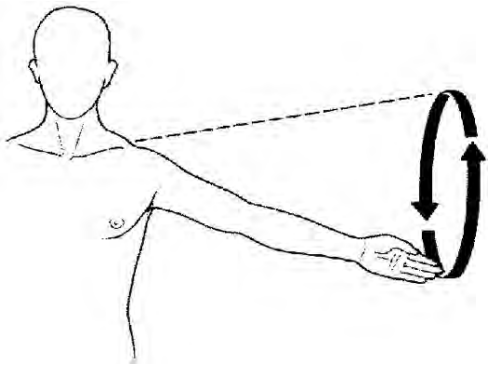


Figure 10 *Circumduction*

MUSCULO-SKELETAL SYSTEM

Skeletal System

Bone is one of the hardest structures of the body with a certain degree of toughness and elasticity. Pinkish-white externally, and deep red from within, on examining a section of any bone, you can observe that it is composed of two kinds of tissue:

1. **Compact Tissue -** dense in texture, like ivory.
2. **Cancellous Tissue** - comprised of slender fibers and lamella that form a reticular structure.

Muscular System

Muscles are connected with bones, cartilages, ligaments, and skin, either directly, or through the intervention of fibrous structures called **tendons** or **aponeurosis**. Muscles vary extremely in their form. In the limbs, they are of considerable length, especially the more superficial ones; they surround the bones, and ensure protection of various joints. In the trunk, they are broad, flattened, and expanded, and assist in forming the walls of the trunk cavities. Hence the terms **long, broad, short,** etc., are used to describe a muscle. Also, the term **origin** implies that it is more of a fixed or central attachment; and the term **insertion** refers to the movable point on which the force of the muscle is applied.

Muscle tissue is a soft tissue and there are three types of muscle tissue recognized in vertebrates:

- **Skeletal muscle** or "voluntary muscle" - Anchored by tendons (or by aponeuroses in few places) to bone and is used to effect skeletal movement such as locomotion and in maintaining posture. An average adult male is made up of 42% of skeletal muscle and an average adult female is made up of 36% (as a percentage of body mass).
- **Smooth muscle** or "involuntary muscle" is found within the walls of organs and structures such as the esophagus, stomach, intestines, bronchi, uterus, etc. Unlike skeletal muscle, smooth muscle is not under conscious control.
- **Cardiac muscle** is also an "involuntary muscle" but is more akin in structure to skeletal muscle, and is found only in the heart.

ASSESSMENT

1. Define Anatomy.
2. Describe the Anatomical Position.
3. Describe the composition of a human body.
4. Where are organs located? Describe the location.
5. How is anatomical terminology classified? Give examples of each type.
6. Describe the two types of skeletal tissues.
7. What are voluntary and involuntary muscles? Give an example for each.

Student Notes

KINESIOLOGY

OBJECTIVE OF THE LESSON

At the end of this lesson you will be able to:

→ Describe Kinesiology and its significance to a personal trainer
→ Identify the various planes of movement and map these with various body parts
→ Classify the types of muscle contractions and comprehend the associated movements
→ Differentiate between the types of grips & movements and determine how to perform/train exercises involving grips
→ Recognize the types of muscle fibers, their relationship to metabolism, their endurance and other attributes
→ Recognize biomechanical implementations and train muscles of various body parts

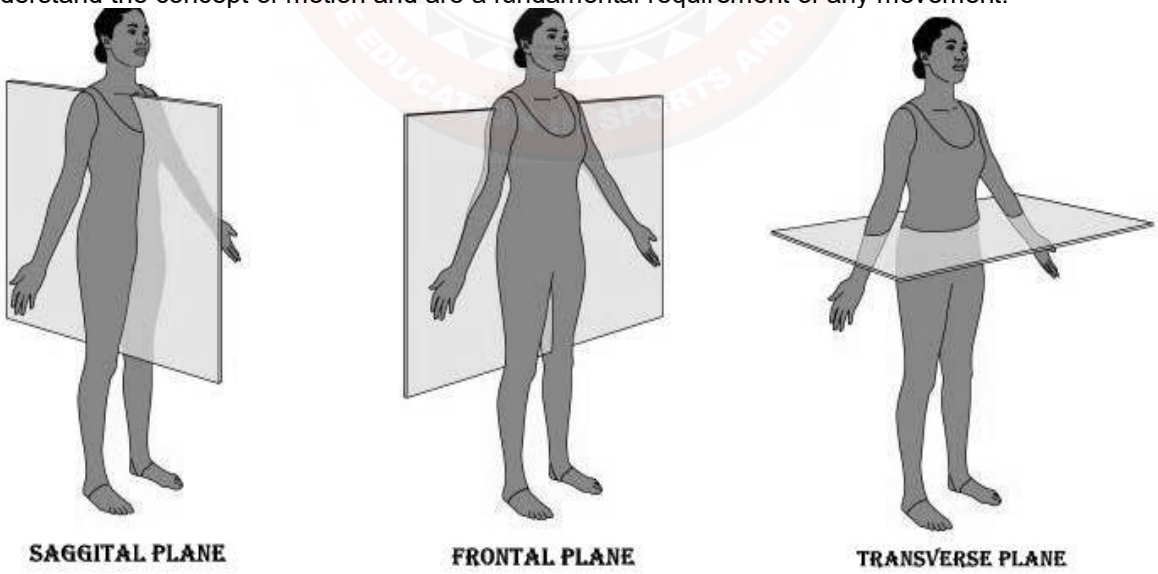
INTRODUCTION TO KINESIOLOGY

Kinesiology refers to the study of human and animal movement, performance, and function by applying the sciences of biomechanics, anatomy, physiology, psychology, and neuroscience. It is also known as Human Kinetics, where *kinesio* refers to movements with respect to mechanical principles, and *logy* means study.

As a personal trainer, you should have a basic understanding about movement to prescribe work outs to a client. This lesson will help you to understand various types of movements as concepts of **biomechanics**.

PLANES OF MOVEMENT

Planes in context of the human anatomy are imaginary surfaces, which when positioned in a specific direction across the human body, cut the body into two symmetrical or equal halves. They help us understand the concept of motion and are a fundamental requirement of any movement.



The planes of movement are broadly classified into three types:

- **Sagittal/Lateral plane** - This plane divides the body into two lateral halves or right and left half.

- **Frontal/Coronal Plane** - This plane divides the body into anterior (front) and posterior (back) halves.
- **Transverse/Horizontal plane** - This plane divides the body into superior and inferior halves.

Movements and their planes

Every movement in the body will be across one of these planes.

Human Body Part	Movements	Planes
Scapular Motion	Protraction	Transverse plane
	Retraction	
Shoulder Joint	Flexion	Sagittal Plane
	Extension	
	Abduction	Frontal Plane
	Adduction	
	Internal Rotation	Transverse Plane
	External Rotation	
Elbow Joint	Flexion	Sagittal Plane
	Extension	
Wrist Joint	Flexion (Dorsi flexion)	Sagittal Plane
	Extension (Palmar Flexion)	
Spine		
Cervical Spine	Flexion	Sagittal Plane
	Extension	
	Side flexion	Frontal Plane
Thoracic Spine	Rotation	Transverse Plane
Lumbar Spine	Flexion	Sagittal Plane
	Extension	
	Side flexion	Frontal Plane
Hip Joint	Flexion	Sagittal Plane
	Extension	
	Abduction	Frontal Plane
	Adduction	
	Internal Rotation	Transverse Plane
Knee Joint	Flexion	Sagittal Plane
	Extension	
Ankle Joint	Flexion	Sagittal Plane
	Extension	

***Note: Circumduction** is not added in the above list, as it is a combination of all actions and planes.*

MUSCLE CONTRACTIONS

Muscle contractions in voluntary muscles, (excluding reflexes) occur as a result of conscious effort originating in the brain. The brain sends signals, in the form of electric current (through the nervous system to the muscles) which is responsible for movement of that muscle.

The following are the various types of muscle contractions:

Isotonic Contractions:

Isotonic contractions are those that cause the muscle to change length as it contracts and causes movement of a body part. There are two types of Isotonic contractions:

1. **Concentric**
   Concentric contractions are those that cause the muscle to shorten as it contracts. An example is bending the elbow from a straight to fully flexed position, causing a concentric contraction of the biceps Brachii muscle. Concentric contractions are the most common type of muscle contraction and occur frequently in daily activities, basically against gravity movement.

2. **Eccentric**
   Eccentric contractions are the opposite of concentric and occur when the muscle lengthens as it contracts. This is less common and usually involves the control or deceleration of a movement being initiated by the eccentric muscles' agonist, towards gravity movement.

Isometric Contractions

Isometric contractions occur when there is no change in the length of the contracting muscle. This occurs when carrying an object in front of you as the weight of the object is pulling your arms down but your muscles are contracting to hold the object at the same level. Another example is when you grip something, such as a tennis racket. There is no movement in the joints of the hand, but the muscles are contracting to provide a force sufficient enough to keep a steady hold on the racket.

Isokinetic Contractions

Isokinetic contractions are similar to isotonic in that the muscle changes length during the contraction. However, Isokinetic contractions produce movements of a constant speed. To measure this, a special piece of equipment known as an *Isokinetic Dynamometer* is required. Examples of using Isokinetic contractions in day-to-day and sporting activities are rare. The best is breast stroke in swimming, where the water provides a constant, even resistance to the movement of adduction.

TYPES OF GRIPS IN EXERCISES

Grips can be broadly categorized as true grips and false grips. In exercises, only true grips can be used. True grips are further classified into five different types and are divided according to the movement in the forearm.

Grip	Illustration
Supine grip	

Prone grip	
Natural Hang grip (Neutral grip)	
Mid Prone grip (Hammer grip)	
Dead Grip	

TYPES OF MOVEMENTS

Types of movements are broadly classified into two:

Involvement of extremities

1. Unilateral
2. Bilateral
3. Isolateral

Involvement of joints

1. Isolation
2. Compound
3. Power

TYPES OF MUSCLE FIBRES

The muscle fibres are broadly classified into two i.e. Type I and Type II. There are two principal ways to categorize muscle fibers: the **type of myosin** (fast or slow) present, and the degree of **oxidative phosphorylation** that the fiber undergoes. Skeletal muscle can thus be broken down into two broad categories: **Type I and Type II**. Type I fibers appear red due to the presence of the oxygen binding protein **myoglobin**. These fibers are suited for endurance and are slow to fatigue because they use oxidative metabolism to generate ATP. Type II fibers are white due to the absence of myoglobin and a reliance on **glycolytic enzymes**. These fibers are efficient for short bursts of speed and power and use both oxidative metabolism and anaerobic metabolism depending on the particular sub-type.

These two muscle fibres types are further divided into 4 subgroups; Type I, Type IIa, Type IIx and Type IIb.

Variables	Type I	Type IIa	Type IIx	Type IIb
Contraction time	Slow	Moderately fast	Fast	Very Fast
Resistance to fatigue	High	Medium	Intermediate	Low
Activity Used for	Aerobic	Long-term anaerobic	Short term anaerobic	Short term anaerobic
Maximum duration of use	Hours	< 30 minutes	< 5 Minutes	< 1 Minute
Power produced	Low	Medium	High	Very High
Oxidative capacity	High	High	Intermediate	Low
Glycolytic capacity	Low	High	High	High
Note	Consume lactic acid	Produce lactic acid and Creatine phosphate	Consume Creatine phosphate	Consume Creatine phosphate

BIOMECHANICAL IMPLEMENTATION

Biomechanics is the study of the mechanical laws relating to the movement or structure of living organisms. Biomechanics plays an important role in understanding the particular movement.

In relation to muscle work

1. **Agonist:** Agonist is the muscle that actually executes the movement, and it refers to a particular group of muscles. Example: for elbow flexion (biceps curls) the agonist muscle is the Biceps group which includes Biceps Brachii and Brachialis.
2. **Antagonist:** Antagonist is the muscle that opposes the agonist muscles to perform agonistic activity. Example:-for elbow flexion, when biceps group does agonistic activity, the triceps opposes that movement, so triceps is antagonist to biceps.
3. **Prime-Movers:** Prime Movers is a main muscle (only particular muscle) which does exclusive movement of that joint or also called as first movers of movement. Example: Elbow flexion (Biceps Curls), Brachialis is a prime mover of that action.
4. **Synergist:** Synergist are basically referred as helping muscle. In any activity where two or more joints are involved, this synergist muscle helps prime movers or agonist to complete movement. Example: For squats, the prime mover is quadriceps, but synergist (Helping muscle) is Gluteus muscle (Buttock muscle) which helps body to get up from the squat position.

ASSESSMENT

1. What is kinesiology?
2. What are the various types of movements?
3. What are the different types of muscle contractions?
4. List the types of grips.
5. What are the various planes of movements?

6. Describe the types of muscle fibers.
7. Explain with examples the biomechanical implementations of various types of muscle movements.

Student Notes

PHYSICAL EXERCISE

OBJECTIVE OF THE LESSON

At the end of this lesson, you will be able to:

→ Define physical exercise and specify its benefits

→ Define the principles of physical exercise and recognize the various parameters that govern exercise pattern to achieve the desired benefits

INTRODUCTION TO PHYSICAL EXERCISE

Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness. It is performed for various reasons including strengthening muscles and the cardiovascular system, honing athletic skills, weight loss or maintenance, as well as for the purpose of enjoyment.

PRINCIPLES OF PHYSICAL EXERCISE

Principles of exercises are set protocol or policies through which a person can achieve his/ her goal in an effective manner. These principles are broadly classified into two categories:

Basic Principles

1. **FITT**

   In developing an effective physical fitness program, you must adhere to basic exercise principles, regardless of your fitness level. FITT is an easy acronym to remember the exercise variables that you can manipulate to avoid boredom and to keep your body challenged:

   - **Frequency** - how often you exercise
   - **Intensity** - how hard you exercise
   - **Time** - how long you exercise
   - **Type** - the type of exercise you're doing (e.g., running, walking, etc.)

   Manipulating FITT to sustain the training effect:

   When you workout at sufficient intensity, time and frequency, the body will improve (also called the **Training Effect**) and you'll start to see changes in the weight, body fat percentage, cardio endurance and strength. When your body adjusts to your current FITT levels, it's time to manipulate one of more of them. For example, if you've been walking 3 times a week for 20 minutes and you've stopped seeing improvement, you could change your program by implementing one or more of the following ideas:
   Frequency- Add one more day of walking.
   Intensity- Add short bursts of jogging, speed walking or hill training.
   Time- Add 10-15 minutes to your usual workout time.
   Type- Do a different activity such as cycling, swimming or aerobics.

2. **ADAPTATION**

   Adaptation means that the body can adjust to any overload as long as it is done in small increments. The amount of progress the body can make depends on adequate rest, consistency of workouts, adequate nutrition, and genetic makeup. For example: If exercises lasting less than 10 seconds (ATP-CP energy system) are repeated with a full recovery (approximately 3 to 5 minutes) then an adaptation in which stores of ATP and CP in the muscles are increased. This means more energy is available more rapidly and increases the maximum peak power output. If overloads are experienced for periods of up to 60 seconds, with a full recovery, it is found that

glycogen stores are enhanced. The most noticeable effect of weight training with heavy loads on fast twitch muscle fibers is larger and stronger muscles (hypertrophy).

3. OVERLOAD

Overload means that a training program causes the body to adapt only when the demands are greater than what the body is accustomed to doing. This does not mean that the overload is greater than your maximum; rather overload is generally greater than 75% of your maximal effort.

A muscle will only strengthen when forced to operate beyond its customary intensity. The load must be progressively increased in order to further adaptive responses as training develops, and the training stimulus is gradually raised. Overload can be progressed by:

- increasing the resistance e.g. adding 5kg to the barbell
- increasing the number of repetitions with a particular weight
- increasing the number of sets of the exercise (work)
- increasing the intensity- more work in the same time, i.e. reducing the recovery periods

4. SPECIFICITY

Specificity of training is the principle that your body will adapt to whatever exercises you perform. This means that if you only perform bench presses, your body will not adapt to sit-ups. The amount and nature of the mobility training required by each athlete will vary according to the individual athlete's event requirements and his/her individual range of movement for each joint action. It may be necessary to measure the range of movement for particular joint actions to determine the present range and future improvement.

Specificity is an important principle in strength training, where the exercise must be specific to the type of strength required, and is therefore related to the particular demands of the event. The coach should have knowledge of the predominant types of muscular activity associated with his/her particular event, the movement pattern involved and the type of strength required. Although specificity is important, it is necessary in every schedule to include exercises of a general nature (e.g. power clean, squat). These exercises may not relate too closely to the movement of any athletic event but they do give a balanced development and provide a strong base upon which highly specific exercise can be built.

5. PROGRESSION

The intensity and duration of exercise must gradually increase to improve the level of fitness. The principle of progression states that as the body adapts to the exercise program you must gradually increase the overload to continue to adapt. It is critical that all progressions are gradual and small in nature to prevent over loading the body's ability to recover.

6. OVER-TRAINING

Over-training addresses the body's need for adequate rest and nutrition following exercise to recuperate before the next exercise session. If recuperation is not adequate, over-training will occur. Signs of over training include: increased injury rate, increased resting hear rate, muscle soreness that does not subside after 48 hours, apathy, insomnia, loss of appetite, lack of adaptation to exercise, and loss of strength. **Over-training must be avoided.**

7. DE-TRAINING (REVERSIBILITY)

This principle is very much important to athletes. **Improved** ranges of movement can be achieved and maintained by regular use of mobility exercises. If an athlete ceases mobility training, his/her ranges of movement will decline over time to those maintained by his/her other physical activities. When training ceases the training effect will also stop. It gradually reduces at approximately one third of the rate of acquisition. Athletes must ensure that they continue strength training throughout the competitive period, although at a much reduced volume, or newly acquired strength will be lost.

Advanced Principles

Advanced principles are implemented for body builders and these principles require continuous supervision and knowledge.

1. **PRE EXHAUST**
   Pre-exhaust, as the name implies, is pre-fatiguing or pre-tiring a certain muscle of a body part (e.g., chest, legs, deltoids) using an isolation or "single-joint" exercise first and then finishing with one or two compound or "multiple-joint" movement(s). Utilizing two single-joint exercises followed by a multiple-joint movement is typically referred to as a "double-pre-exhaust".

   Pre-exhaust training is an excellent technique by forcing your muscles to work twice as hard on compound movements ensuring muscular fatigue first before neurological fatigue sets in. Secondly, because single-joint movements are used first and bio-mechanically great exercises for joint stability, it can be used to limit the force on the joints and tendons when doing multiple-joint movements. And thirdly, pre-exhaust can be used during training plateaus, training through an injury or for a change in training mode to maintain interest. It is typically used to offset the body's ability to adapt to a certain exercise stimulus.

2. **REVERSE PYRAMIDS**
   The traditional reverse pyramid training involves decreasing the weight each set while increasing the number of reps being done. It is exactly opposite to pyramids also refers to drop sets.

3. **FORCED REPS**
   Forced reps are manually assisted reps aimed at prolonging the time under tension of a particular set. In other words, having a training partner give you just enough help to complete a movement makes the muscles contract for a longer period of time.

4. **PARTIAL REPS**
   A partial rep is defined as only using half the exercise-specific range of motion for a particular exercise. The key though is to always use the strongest portion of the rep. Doing a workout that utilizes partial reps has a number of benefits. Firstly, it will kick-start muscle growth and hit your body from a new angle. It will also burn more calories to strip body fat from your muscles, giving you better definition and also increase your strength endurance.

   You can use partial reps to help you do more reps on a set so you can extend the set helping you increase the intensity of a set to help you build more muscle so for example:
   - Let's say you're supposed to do 5 reps with 135 pounds on the standing military press but after you've done 5 FULL reps by pushing the weight all the way up & bringing the weight all the way down.
   - You would continue to about 5-to-10 more partial reps where you only bring the weight ½ way down before you push it back up to help you increase the intensity of the set by doing more work.

ASSESSMENT

1. What is a physical exercise and why is it required?
2. What are the two types of principles of exercise?
3. What are the four FITT variables? Define them.
4. What is specificity?
5. What is de-training?
6. Why is pre exhaust important?
7. What are pyramid and reverse pyramid principles?
8. Describe forced and partial repetitions.

Student Notes

STRETCHING

OBJECTIVES OF THIS LESSON

At the end of this lesson you will be able to:

→ Determine the principles of stretching such as when to stretch
→ Appreciate the benefits of stretching
→ Classify various types of stretching

INTRODUCTION TO STRETCHING

Stretching aims to minimize pain and the stiffness of muscles and tissues. Stretching helps increases flexibility and therefore prevents soft tissue injuries.

TYPES OF STRETCHING

Out of these seven stretching exercises, some exercises should only be done under proper supervision.

Ballistic Stretching

Ballistic stretching uses the momentum of a moving body or a limb in an attempt to force it beyond its normal range of motion. This is called stretching, or "warming up", by bouncing into (or out of) a stretched position, using the stretched muscles as a spring, which pulls you out of the stretched position. (For example, bouncing, bending down repeatedly to touch your toes.) This type of stretching is not considered useful and can lead to injury. It does not allow your muscles to adjust to, and relax in, the stretched position. It may instead cause them to tighten up by repeatedly activating the stretch reflex

Figure 11Side abdominal stretch

Dynamic Stretching

Dynamic stretching involves moving parts of your body and gradually increasing reach, speed of movement, or both. Dynamic stretching consists of controlled leg and arm swings that take you to the limits of your range of motion. In dynamic stretches, there are no bounces or "jerky" movements. An example of dynamic stretching would be slow, controlled leg swings, arm swings, or torso twists.

Figure 12 Dynamic stretching

Active Stretching

Active stretching is also referred to as *static-active stretching.* An active stretch is one where you assume a position and then hold it there with no assistance other than using the strength of your agonist muscles. Active stretching increases active flexibility and strengthens the agonistic muscles. Active stretches are usually quite difficult to hold and maintain for more than 10 seconds and rarely need to be held any longer than 15 seconds.

Figure 13 Active stretching

Passive Stretching

Passive stretching is also referred to as *relaxed stretching*, and as *static-passive stretching*. A passive stretch is one where you assume a position and hold it with some other part of your body, or with the assistance of a partner or some other apparatus. For example, bringing your leg up high and then holding it there with your hand.

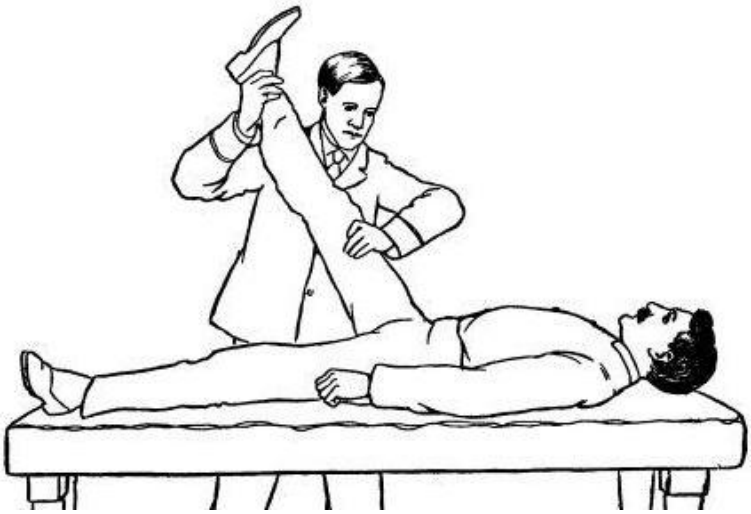


Figure 14 Passive stretching

Static Stretching

Static stretching involves holding a position. That is, you stretch to the farthest point and hold the stretch. In this stretching the client himself does the stretching and holds the stretched part in position for a longer period of time.

Figure 15 Static Stretching

Isometric Stretching

Isometric stretching is a type of static stretching (meaning it does not use motion), which involves the resistance of muscle groups through isometric contractions (tensing) of the stretched muscles. The use of isometric stretching is one of the fastest ways to develop increased static-passive flexibility and is much more effective than either passive stretching or active stretching alone. Isometric stretches also help to develop strength in the "tensed" muscles (which helps to develop static-active flexibility), and seems to decrease the amount of pain usually associated with stretching.

Figure 16 Isometric stretching

PNF Stretching

PNF stretching is currently the fastest and most effective way known to increase static-passive flexibility. PNF is an acronym for *proprioceptive neuromuscular facilitation*. It is not really a type of stretching but is a technique of combining passive stretching and isometric stretching (in order to achieve maximum static flexibility.

There are three methods in PNF stretching:

1. **The Hold Relax Technique**
   This technique is also called the *contract-relax*. After assuming an initial passive stretch, the muscle being stretched is isometrically contracted for 7-15 seconds, after which the muscle is briefly relaxed for 2-3 seconds, and then immediately subjected to a passive stretch which stretches the muscle even further than the initial passive stretch. This final passive stretch is held for 10-15 seconds. The muscle is then relaxed for 20 seconds before performing another PNF technique.

2. **The Contract Relax Technique**
   It involves performing two isometric contractions: first of the agonists, then, of the antagonists. The first part is similar to the hold-relax where, after assuming an initial passive stretch, the stretched muscle is isometrically contracted for 7-15 seconds. Then the muscle is relaxed while its antagonist immediately performs an isometric contraction that is held for 7-15 seconds. The muscles are then relaxed for 20 seconds before performing another PNF technique.

3. **The Hold Relax Swing**
   This technique (and a similar technique called the *hold-relax-bounce*) actually involves the use of dynamic or ballistic stretches in conjunction with static and isometric stretches. It is very risky, and is successfully used performed only by the most advanced of athletes and dancers that have managed to achieve a high level of control over their muscle stretch reflex. It is similar to the hold-relax technique except that a dynamic or ballistic stretch is employed in place of the final passive stretch.

ASSESSMENT

1. When is a good time to stretch?
2. How does stretching prevent soft tissue injury?
3. What are the various types of stretching?
4. What is the key difference between ballistic stretching and dynamic stretching?
5. What muscles are exercised during active stretching?
6. Elaborate on isometric testing as a technique for relaxing tensed muscles.

7. Which is the most effective way to increase static-passive flexibility? Elaborate on this technique and its three methods.

Student Notes

WEIGHT TRAINING

OBJECTIVES OF THE LESSON

At the end of this lesson you will be able to:

→ Describe weight training
→ Identify the benefits of weight training on various parts of the body such as legs, back, chest

INTRODUCTION TO WEIGHT TRAINING

Weight training is a common type of strength training for developing the strength and size of skeletal muscles. It uses the weight force of gravity (in the form of weighted bars, dumbbells or weight stacks) to oppose the force generated by muscle through concentric or eccentric contraction. Weight training uses a variety of specialized equipment to target specific muscle groups and types of movement.

BENEFITS OF WEIGHT TRAINING

The different muscle groups that benefit from training are: Arms, Chest, Shoulder, Back, and Legs.

LEGS

Aerobic leg workouts especially promote cardiovascular health. During exercise, large leg muscles pump blood that carries oxygen and nutrients throughout the body. This not only promotes heart fitness but also brain function since a healthy circulatory system is crucial for overall health. Performing regular aerobic exercise boosts blood flow, metabolism and immunity. It therefore helps defend against a variety of serious circulatory-related health problems, such as heart-attack, stroke and vascular dementia.

The legs (including the buttocks) include the largest muscle groups in your body. If you want to help build more muscle tissue to boost the metabolism, the bigger muscle groups need to be worked on first and foremost.

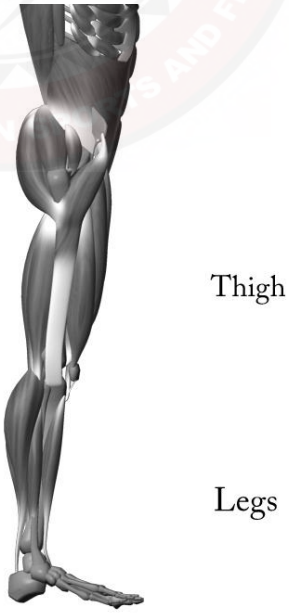


Figure 17 Legs

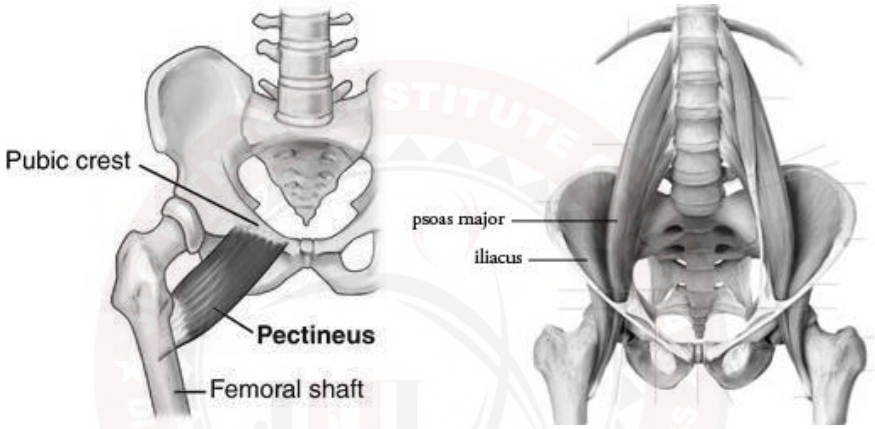
Let's consider according to region the various parts of the leg:

UPPER 1/3RD OF THIGH

The upper 1/3rd portion of the thigh is further divided into **Anterior**, **Lateral** and **Posterior**.

1. Anterior region of upper 1/3rd of thigh:

Muscle	Origin	Insertion	Action	Plane of movement
Iliopsoas	Iliac fossa, transverse processes of lumbar vertebrae	Lesser trochanter of the femur	Hip Flexion	Sagittal
Pectineus	Superior ramus of pubis	Linea aspera of femur	Hip Flexion	Sagittal

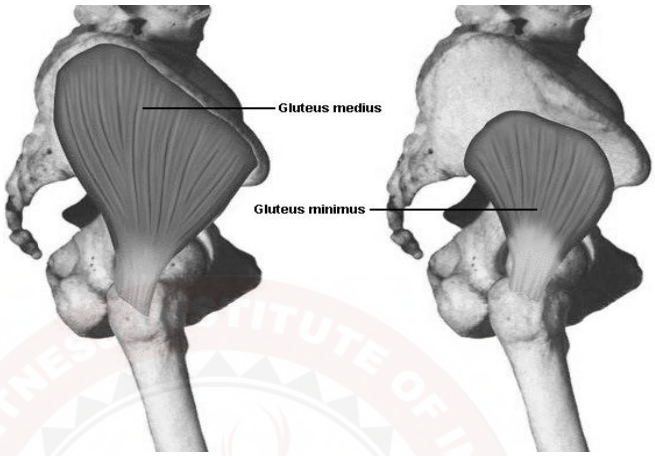


Lesson exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					

2. Lateral region of Upper 1/3rd of Thigh:-

Muscle	Origin	Insertion	Action	Plane of movement
Gluteus Medius	Lateral ilium	Greater trochanter of the femur	Abducts Hip	Frontal
Gluteus Minimus	External surface of ilium	Greater trochanter of femur	Abducts Hip	Frontal

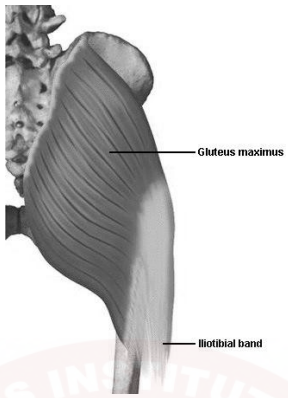


Lesson exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					

3. Posterior Region of Upper 1/3rd of Thigh:-

Muscle	Origin	Insertion	Action	Plane of movement
Gluteus Maximux	Lateral ilium	Greater trochanter of the femur	Abducts Hip	Frontal



Lesson exercise

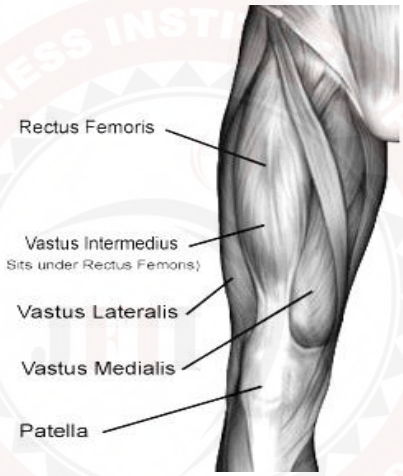
SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					

LOWER 2/3^{RDS} OF THIGH

The lower 2/3rd portion of the thigh is further divided into anterior and posterior compartments.

1. Anterior region of lower 2/3^{rds} of Thigh:-

Main Muscle	Individual Muscle	Origin	Insertion	Action	Plane of movement
Quadriceps	Vastus Medialis	Shaft of the femur	via quadriceps tendon into patella, then ligamentum patellae onto tibial tuberosity of the tibia	Extension of Knee	Sagittal plane
	Vastus Intermedialis	Linea aspera			
	Vastus Lateralis	Greater trochanter of the femur			
	Rectus Femoris	Anterior inferior iliacspine			



Lesson exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					

2. Posterior region of lower 2/3rd of Thigh

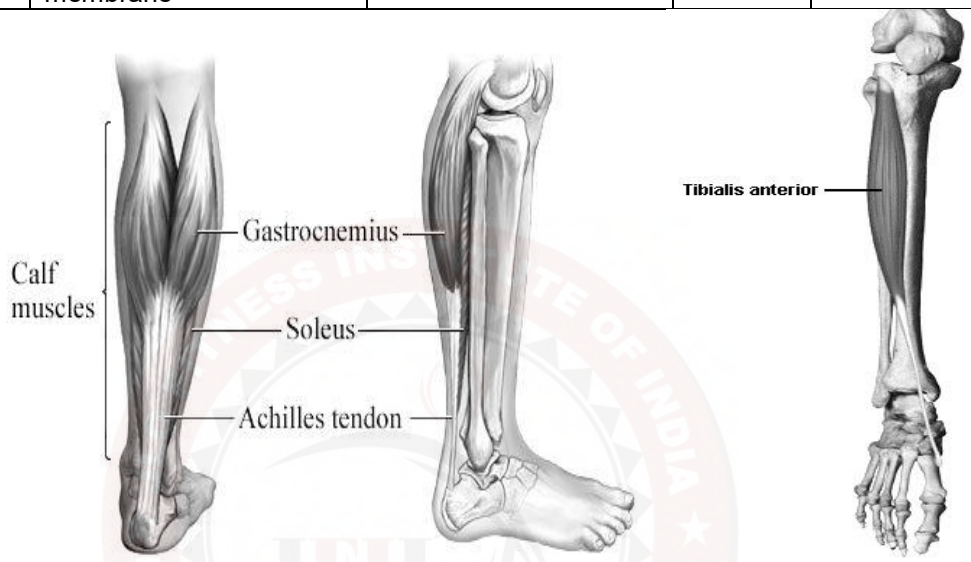
Main Muscle	Individual Muscle	Origin	Insertion	Action	Plane of movement
Hamstrings	Semimembranosis	ischial tuberosity	medial condyle of t ibia	Flexion of Knee, Synergist for Hip extension	Sagittal Plane
	Semitendinosis	ischial tuberosity	medial tibia		
	Biceps Femoris	Long Head :-Ischial tuberosity Short Head :-Linea aspera	head of fibula, lateral condyle of tibia		
	Adductor Magnus	inferior ramus of pubis and ischium, ischial tuberosity	lineas aspera of femur		

Lesson exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					

3. Leg (Below knee)

Muscle	Origin	Insertion	Action	Plane of movement
Tibialis Anterior	Lateral condyle of tibia	Cuneiform and base of 1st metatarsal	Dorsi Flexion	Sagittal Plane
Gastrocnemius	Lateral and medial condyle of the femur	Calcaneus	Plantar Flexion	
Soleus	Proximal tibia, proximal fibula, interosseous membrane	Calcaneus		



Lesson exercise

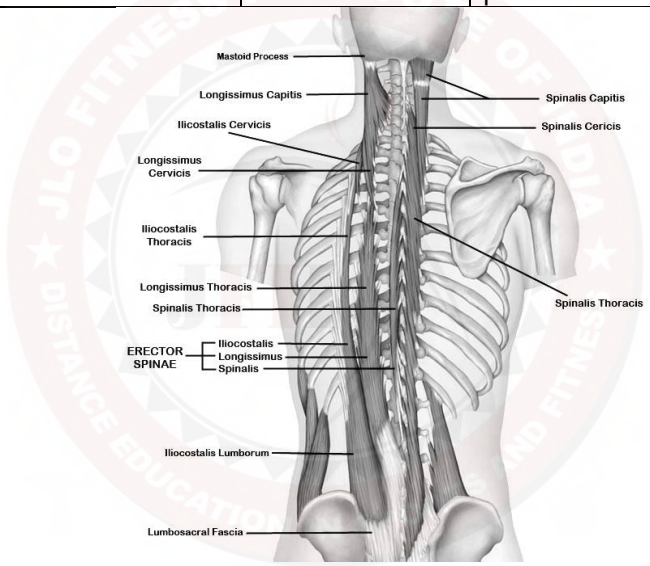
SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					

BACK

Without a doubt, the back is one of the hardest body parts to train, next to the legs. The back muscles give stability to the back and the entire body. It consists of a main postural muscle which helps in maintaining the posture in various activities. Back workout is also important for fat loss, next to legs.

The back is comprised of three main muscles:

Muscle	Origin	Insertion	Action	Plane of movement
Latissimus Dorsi	Lumbodorsal fascia via thoracic and lumbar vertebrae, sacrum, ilium	Intertubercular groove of the humerus	Extends, adducts, and medially rotates arm	Transverso-frontal plane
Trapezius	Occipital bone, cervicala nd thoracic vertebrae	Lateral 1/3 of clavicleand scapular spine andacromion	Elevates, depresses, rotates, adducts scapula	Frontal and Transverse plane
Errector Spinae	Sacrum, Ribs, Vertebrae, Ligamentum Nuchae	Vertebrae, Ribs, Skull	Extension of Spine, Main postural muscle	Sagittal plane



Lesson exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					

CHEST

Chest is a part which works throughout the day, for example: be it while working on computer or playing video games. As per anatomy the chest has two muscles that are Pectoralis Major and Pectoralis Minor.

Muscle	Origin	Insertion	Action	Plane of movement
Pectoralis Minor	Ribs 3-5	coracoid process of the scapula	Depresses and pulls scapula anteriorly	Transverse frontal plane
Pectoralis Major	Sternum, clavicle, andribs	Greater tubercle and along inter tubercular groove of the humerus	Flexes, medially rotates, and adducts arm, Horizontal Adduction	Moves in all three planes.

Figure 18 Pectoralis Minor

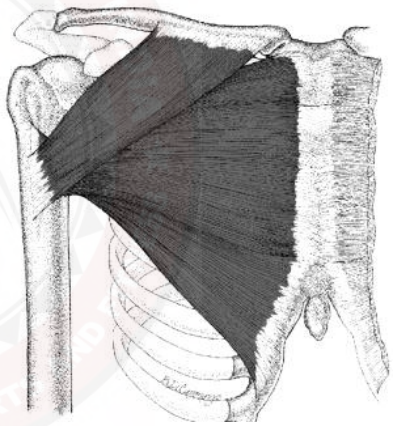


Figure 19 Pectoralis Major

Lesson exercise

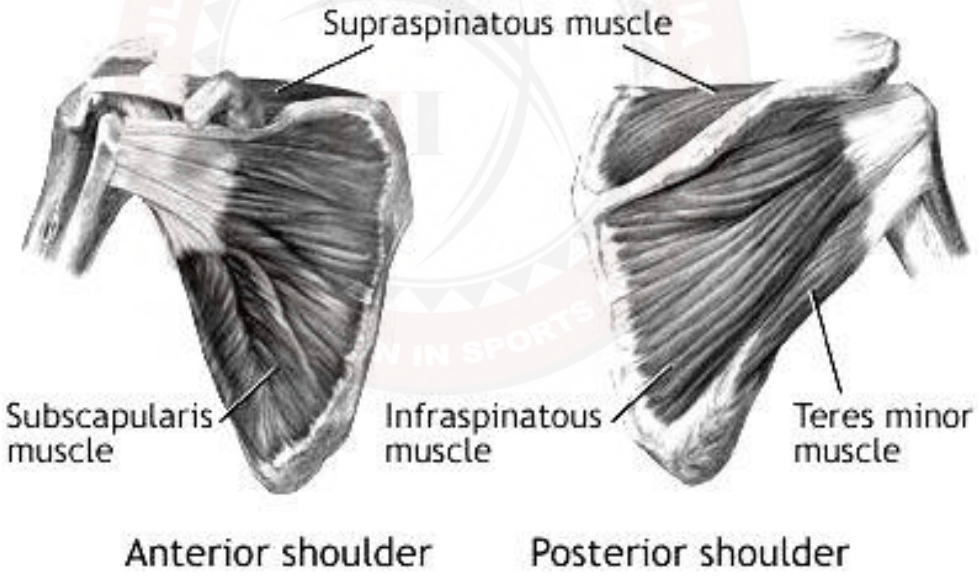
SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					

SHOULDER

The shoulder is made up of three bones: **Clavical**, **Scapula** and **Humerus**. All three bones are attached to each other and are covered by capsular ligaments. The shoulder joint is a mobile joint but, stability is compromised. Due to lack of stability the shoulder is more prone to injuries. A small injury to shoulder joint can lead to larger dysfunction, and hence exercises should be done either under supervision or properly. The muscles are:

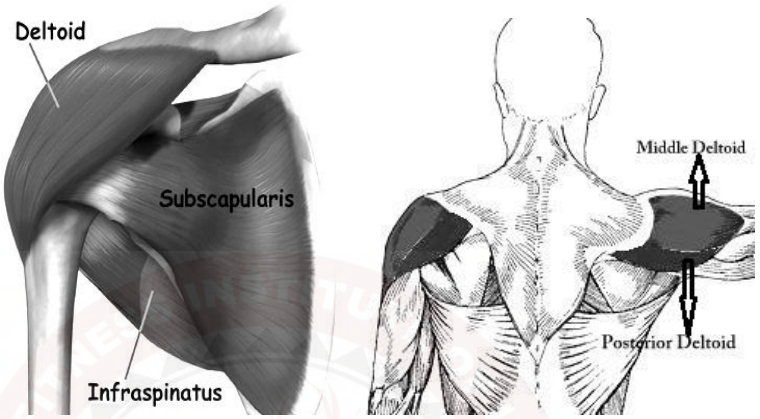
1. ROTATOR CUFF MUSCLES

Muscle	Origin	Insertion	Action	Plane of movement
Supra Spinatus	Supra Spinous Fossa	Greater tubercle of the Hhumerus	Abduction (0^0-30^0)	Frontal
Infra Spinatus	Infra Spinous Fossa	Greater tubercle of the humerusHumerus	External Rotation	Transverse
Teres Minor	Lateral border of Scapula	Greater tubercle of the Hhumerus	External Rotation	Transverse
Sub Scapularis	Sub Scapular Fossa	Lesser Tubercle tubercle of the Humerus	Internal Rotation	Transverse



2. DELTOID MUSCLES

Muscle	Origin	Insertion	Action	Plane of movement
Anterior Deltoid	Clavicle	Deltoid Tuberosity of Humerus	Flexion	Sagittal
Middle Deltoid	Acromion Process		Abduction	Frontal
Posterior Deltoid	Spine of Scapula		Extension	Sagittal



Lesson Exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
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9.					

ARMS

The arm is the part of the upper limb between the shoulder and the elbow joints. The bone in the arm is referred to as the *humerus* bone. Muscles attached to this bone as known simply as the *arm muscles.* There are three types of arm muscles: **Biceps Brachii**, **Brachialis** & **Brachioradialis**, and **Triceps**.

1. BICEPS BRACHII

Muscle	Origin	Insertion	Action	Plane of movement
Long Head	Supra glenoid tubercle	Biceps Tubercle of Radius	Flexion of elbow	Sagittal
Short Head	Corocoid Process		Supination of forearm	Frontal

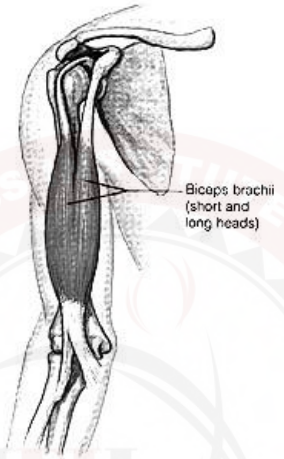


Figure 20 Biceps Brachii

2. BRACHIALIS & BRACHIORADIALIS

Muscle	Origin	Insertion	Action	Plane of movement
Brachialis	Anterior of Humerus	Coronoid Process of Ulna	Flexion of Elbow	Sagittal
Brachioradialis	Lateral epicondyle of humerus	Radial Styloid Process	Flexion of Elbow in MID PRONE POSITION	Sagittal

Figure 21 Brachioradialis

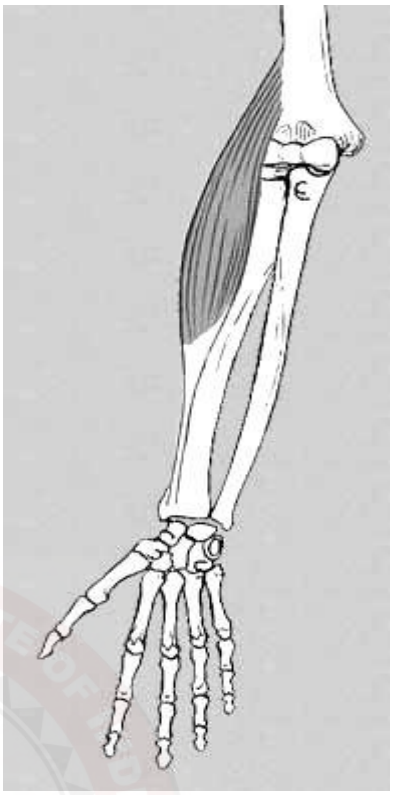


Figure 22 Brachialis

Lesson Exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

TRICEPS

Muscle	Origin	Insertion	Action	Plane of movement
Long Head	Infra Glenoid Tubercle	Olecranon Process of Ulna	Extension of Elbow	Sagittal
Lateral Head	Posterolateral Surface of Humerus			
Medial Head	PosteroMedial Surface of Humerus			

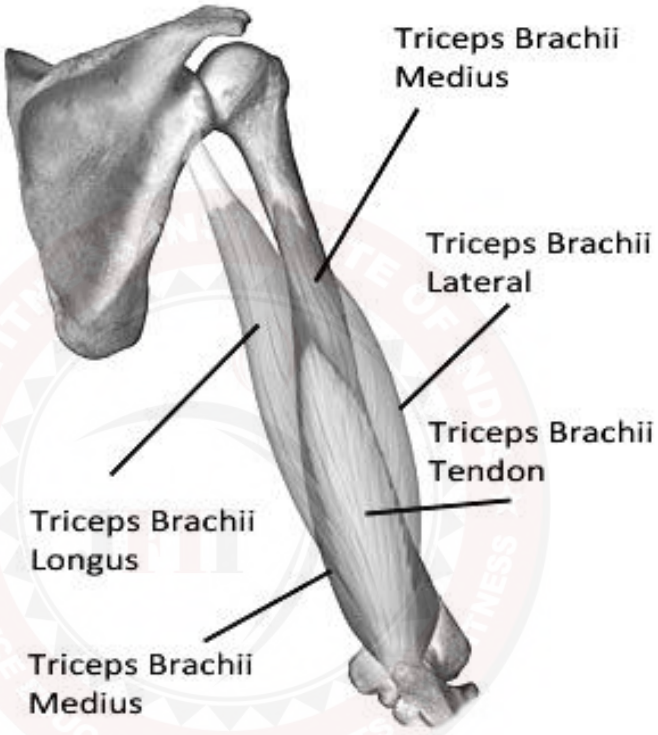


Figure 23 Triceps

Lesson Exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					

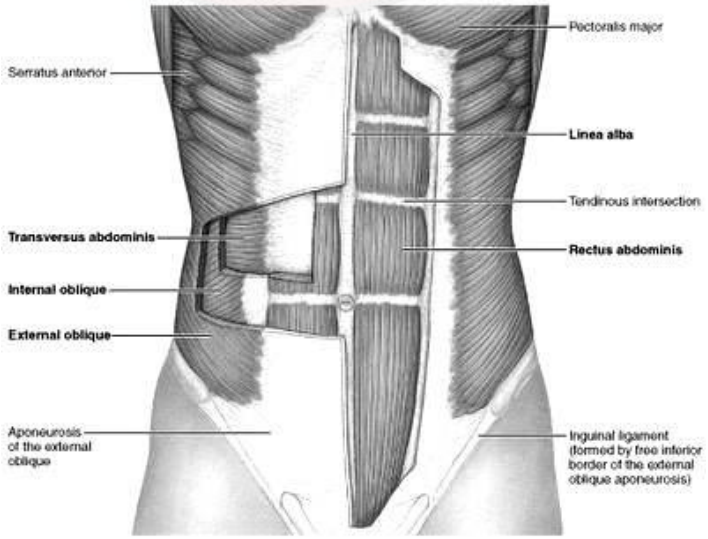
ABS

The abs or the abdomen is situated between the thorax and pelvis. The abdomen is a covering and encompasses of lot of vital organs such as the digestive tract, stomach, spleen, and kidneys. If the abdominal muscles are weak due to an enlarged abdomen or pregnancy, the person can have a mechanical back pain. This pain can be treated by exercises for abdominal muscles. While conducting abdominal exercises, the trainer should ensure that clients performing such exercise are not to hold their breath. Holding the breath while performing abs exercises can lead to a sudden increase in intra-abdominal pressure and result in a hernia (expulsion or misalignment of abdominal content).

This is one of the main components in CORE training, and hence one of the major group of muscles to train for posture.

Muscle	Origin	Insertion	Action	Plane of movement
Rectus Abdominus	Pubic crest and Pubic Symphysis	ribs and xiphoidprocess	flexes vertebral column, compresses abdominal contents	Sagittal
Internal Oblique	lumbodorsal fascia,iliac crest	linea alba, aponeurosis of internal abdominal oblique	assists inflexion and rotation of vertebral column	Sagittal and Transverse plane
External Oblique	lower eight ribs	linea alba, aponeurosis of the external abdominal oblique		
Transverses Abdominus **	lateral third of the inguinal ligament, iliac crest, lower six ribs, lumbodorsal fascia	Muscle ends anteriorly in a broad aponeurosis	Main Postural Muscle and also rotates trunk	Transverse plane

** Main component in core muscles.



Lesson Exercise

SR NO.	Exercise Name	Prime Movers	Synergist	Supported/ Unsupported	Analysis of Movement
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

ASSESSMENT

1. What is weight training?
2. List the different types of muscle groups involved in weight training.
3. Identify the various parts of the legs and their sub-divisions.
4. Which are the three muscles of the back?
5. Differentiate between Pectoralis Minor and Pectoralis Major.
6. Which are the three bones and muscles of the shoulder?
7. What is the risk associated with poor execution of abdominal exercises?

Student Notes

SCHEDULING OF EXERCISES

OBJECTIVES OF THIS LESSON

At the end of this lesson, you will be able to:

→ Outline the basic rules for succeeding in sustaining an effective exercise program
→ Formulate an effective exercise schedule program for people at the beginner and intermediate levels of exercise maturity

RULES FOR EXERCISE SUCCESS

More than half of the people starting an exercise program will drop out after a few months. Assisting your clients with the following rules of exercise success will ensure long-term commitment towards their exercise program.

1. Develop a ‗health' and ‗fitness' evaluation list highlighting the dos and don'ts. Examples of dos include regular exercise, avoidance of stress, good posture, etc. Examples of don'ts include no smoking, no substance abuse, no excessive alcohol consumption, etc.
2. Work with the client to set realistic long and short-term fitness and physique goals. Write them down and encourage the client to solicit support from friends or family. Encourage the client to reward his or herself on achievements of goals.
3. Encourage the client to find a workout companion with similar fitness goals and pick exercises that the client enjoys.
4. Encourage the client to schedule exercises three to five days per week and choose a "special" time of the day. Remind the client to be selfish about preserving that time for their body and general well-being.
5. Train the client to indentify signs of physical stress in the body and ensure they progress slowly in the beginning. Most injuries in fitness come from doing too much, too soon, too fast, and too hard. Don't allow vigorous exercise if you the client is sick.
6. Don't let early awkwardness or uneven skill development discourage the client.
7. Ensure that the client wears comfortable exercise clothing and proper shoes.
8. Ensure that the client plans exercise at least two hours after a big meal or at least an hour before.
9. Watch out for and train the client to spot the signs of overexertion: breathlessness, dizziness, tightness or pain in the chest, loss of muscle control, and nausea. If any of these symptoms are experience by the trainee, exercise must be stopped immediately and a physician consulted.

RULES OF MAKING AN EFFECTIVE SCHEDULE

Beginner exercise schedule(2 day split)		
BODY PART: UPPER BODY		
EXERCISE	***SETS(volume)***	***REPS(intensity)***
For Back		
back extensions	2 to 3	15 to 20
seated rows	2 to 3	15 to 20
lat pull downs	2 to 3	15 to 20
rear delt fly	2 to 3	15 to 20
For chest		
seated chest press (high mid low)	1 set of each level	15 to 20
seated chest fly (high mid low)	1 set of each level	15 to 20
For shoulders		
seated overhead press	2 to 3	15 to 20
cable front raise	2 to 3	15 to 20
cable lateral raise	2 to 3	15 to 20
cable internal rotations	2 to 3	15 to 20
cable external rotations	2 to 3	15 to 20
For biceps group		
barbell arm curls	2 to 3	15 to 20
dumbbell hammer curls	2 to 3	15 to 20
cable reverse curls	2 to 3	15 to 20
For triceps		
cable push downs	2 to 3	15 to 20
BODY PART: LEGS		
EXERCISE	***SETS***	***REPS***
For quadriceps group		
Squats(depending upon the level of your client it could be: Body weight squats/ball wall squats/barbell grasp squats)		
Leg press (seated / incline)-- Foot position High/Mid/Low	2 to 3	15 to 20
Leg extensions	2 to 3	15 to 20
For Soleus		
Seated calf raise	2 to 3	15 to 20
For gastrocnemius		
Standing calf raise	2 to 3	15 to 20
For hamstring group (Biceps femoris,Semitendinosus,semimembranosus)		
Leg curls (seated / prone)	2 to 3	15 to 20

Intermediate exercise schedule (3 Day Split)		
Body Part combinations are-- chest shoulders triceps / back biceps / core muscles and abdominals / legs		
BODY PART : LEGS		
EXERCISE	***SETS(Volume)***	***REPS(Intensity)***
For quadriceps group		
Barbell Squats	2 to 3	12 to 15
Barbell Forward lunges	2 to 3	12 to 15
Leg Press (Foot Position : High/ mid/Low)	1 set fo each	12 to 15
Leg extensions	2 to 3	12 to 15
For soleus		
Seated Calf Raise	2 to 3	12 to 15
For gastrocnemius		
Standing Calf Raise	2 to 3	12 to 15
For hamstring group (Biceps Femoris,semitendinosus,semimembranosus)		
Leg curls (Seated / Prone)	2 to 3	12 to 15
For Gluteal Group		
Stiff leg Dead lift	2 to 3	12 to 15
BODY PART: CHEST SHOULDER TRICEPS(PUSHING MUSCLE GROUP)		
EXERCISE	***SETS(volume)***	***REPS(intensity)***
For chest		
Decline Barbell Chest Press	2 to 3	8 to 12
Flat barbell chest press	2 to 3	8 to 12
Incline barbell chest press	2 to 3	12 to 15
Bent Over cable cross over fly (high mid low -- positions)	2 to 3	12 to 15
For shoulders		
Barbell overhead press	2 to 3	12 to 15
Cable front raises	2 to 3	12 to 15
Cable / Machine Lateral raises	2 to 3	12 to 15
For triceps		
Decline Close Grip Bench press	2 to 3	12 to 15
Cable Triceps push downs	2 to 3	12 to 15
Cable/ Dumbbell triceps kick backs	2 to 3	12 to 15
BODY PART: BACK BICEPS (PULLING MUSCLE GROUP)		
EXERCISE	***SETS(volume)***	***REPS(intensity)***
For Erector spinae		
Conventional deadlifts	2 to 3	12 to 15
For latissimus dorsi		
One arm dumbbell rows	2 to 3	12 to 15
Seated rows(unilateral / Bilateral ; Supine grip / neutral grip	2 to 3	12 to 15

Lat Pull downs(Prone / Supine)	2 to 3	12 to 15
For Trapezius (upper and middle)		
Barbell shrugs	2 to 3	12 to 15
Barbell bent over shrugs	2 to 3	12 to 15
For Rear Deltoid	2 to 3	
Bent over lateral raise	2 to 3	12 to 15
For Biceps Brachii		
Dumbbell arm curls	2 to 3	12 to 15
For Brachioradialis		
Dumbbell hammer curls	2 to 3	12 to 15
For Brachialis		
Cable Reverse Curls	2 to 3	12 to 15

Advance exercise schedule (4 Day split)		
EXERCISE	***SETS(volume)***	***REPS(intensity)***
Body part combinations : Legs , Back , Chest & biceps , shoulders & triceps		
BODY PART: LEGS		
For Quadriceps Femoris		
Barbell squats	2 to 3	8 to 12
Dynamic Forward lunges	2 to 3	8 to 12
Leg press (Unilateral / bilateral)	2 to 3	8 to 12
For Soleus		
Seated (Bent knee) Calf raise	2 to 3	8 to 12
For Gastrocnemius		
Standing (straight Knee Calf Raise)	2 to 3	8 to 12
For Hamstring group (Biceps Femoris , Semimembranosus , semitendinosus)		
Leg curls (Seated / prone)	2 to 3	8 to 12
For the gluteal group		
Stiff leg deadlift	2 to 3	8 to 12
BODY PART : BACK		
For Erector spinae		
Conventional deadlifts	2 to 3	8 to 12
For latissimus Dorsi		
One arm dumbbell row	2 to 3	8 to 12
Seated rows	2 to 3	8 to 12
Lat pull downs	2 to 3	8 to 12

For Trapezius (upper)		
Dumbbell shrugs	2 to 3	8 to 12
For Trapezius (Middle)		
Bent Over / Prone bench Shrugs (Barbell / Dumbbell)	2 to 3	8 to 12
Cable trap depressions	2 to 3	8 to 12
For rear deltoid		
Bent over lateral raise	2 to 3	8 to 12
BODY PART: CHEST AND BICEPS		
For pectoralis major sternocostal head		
Decline dumbbell chest press	2 to 3	8 to 12
For pectoralis major middle portion		
Flat Dumbbell chest press	2 to 3	8 to 12
For pectoralis major clavicular head		
Incline dumbbell chest press	2 to 3	8 to 12
Cable upright chest flyes (Staggered Stance then progress to bilkateral stance)-- cam position - High /Mid/Low	2 to 3	8 to 12
For biceps brachii		
Incline bench supination curls	2 to 3	8 to 12
For brachioradialis		
Dumbbell hammer curls	2 to 3	8 to 12
For brachialis		
Cable reverse curls	2 to 3	8 to 12
BODY PART : SHOULDERS + TRICEPS		
For anterior deltoid		
Dumbbell Overhead press	2 to 3	8 to 12
Cable front raise	2 to 3	8 to 12
For lateral deltoid		
Cable lateral raise	2 to 3	8 to 12
Machine lateral raise	2 to 3	8 to 12
For triceps brachii		
Barbell close grip bench press	2 to 3	8 to 12
Cable triceps push downs	2 to 3	8 to 12
Dumbbell kickbacks	2 to 3	8 to 12

ASSESSMENT

1. List the rules for succeeding in sustaining an effective exercise program.
2. Give an example of an exercise schedule for beginners.

Student Notes

PERIODIZATION

OBJECTIVES OF THE LESSON

At the end of the less you will be able to:

→ Describe periodization and trace its origins
→ Classify the various types of stress response stages
→ Identify the different types of training cycles
→ Formulate an annual training plan and categorize it into phases

INTRODUCTION TO PERIODIZATION

Periodization is most widely used in resistance program design to avoid over-training and to systematically alternate high loads of training with decreased loading phases to improve components of muscular fitness (for example, strength, strength-speed, and strength-endurance).

The roots of periodization come from Hans Selye‘s model, known as the *General Adaptation Syndrome (GAS)*, describing biological responses to stress. Selye's work has been used by the athletic community since the 1950s (Fleck, 1999).

Russian physiologist Leo Metveyev and Romanian sport scientist Tudor Bompa expanded and further organized the periodization model. Bompa and Metveyev have been regarded as the fathers of modern periodization. Since the 1960s, other coaches and exercise physiologists have added to the original models, creating ―modified" periodization models. However, despite the differing terminology amongst scientist and practitioners, the scientific basis for periodization remains a common ground.

STRESS RESPONSE STAGES

The GAS describes three basic stages of response to stress:
1. **Alarm stage:** involving the initial shock of the stimulus on the system.
2. **Resistance stage:** involving the adaptation to the stimulus by the system.
3. **Exhaustion stage:** where repairs are inadequate, and a decrease in system function results.

The foundation of periodic training is to maintain one‘s body in the resistance stage without ever going into the exhaustion stage. By adhering to cyclic training the body is given adequate time to recover from significant stress before additional training is undertaken.

The response to a new stress is to first respond poorly and the response drops off. For example when the body is first exposed to sun, a sunburn might develop. During the resistance stage adaptation improves the response to a higher level, called ***super compensation***, than the previous equilibrium. The example would be that a suntan develops. The exhaustion stage is a continuation of the stimulus at too high a level and the increase gained from adaptation is now offset and all gains are lost. The example would be that wrinkles, spots, or even skin cancer develop.

The goal in sports periodization is to reduce the stress at the point where the resistance stage ends so the body has time to recover. In this way the exhaustion stage does not reduce the gains achieved, the body can recover and remain above the original equilibrium point. The next cycle of increased stimulus now improves the response further and the equilibrium point continues to rise after each cycle.

Selye (1957) labeled beneficial stresses as "**eustress**" and detrimental stresses as "**distress**". In athletics, when physical stress is at a healthy level (eustress), an athlete experiences muscular strength and growth, while excessive physical stress (distress) can lead to tissue damage, disease, and death.

TYPES OF TRAINING CYCLES

Training should be organized and planned in advance of a competition or performance. It should consider the athlete's potential, his/her performance in tests or competition, and calendar of competition. It has to be simple, suggestive, and above all flexible as its content can be modified to meet the athletes' rate of progress. This concept is considered as the theory of planning.

Periodic training systems typically divide time up into three types of cycles: ***microcycle***, ***mesocycle***, and ***macrocycle***.

The microcycle is generally up to 7 days. The mesocycle may be anywhere from 2 weeks to a few months, but is typically a month. There are longer cycles as well for the Olympian, being 4 or 8 years, and the career plan which is usually only considered for Olympians and professional athletes.

The Macrocycle

Macrocycle refers to an annual plan that works towards peaking for the goal competition of the year, usually lasting a year or two. There are three phases in the macrocycle:

1. Preparation
2. Competition
3. Transition

Phase	Description
Preparation Phase	The entire **preparation phase** should be around 2/3rd to 3/4th of the macrocycle. The preparation phase is further divided into general and specific preparation of which general preparation takes over half. An example of **general preparation** would be building an aerobic base for an endurance athlete such as running on a treadmill and learning any rules or regulations that would be required such as proper swimming stroke as not to be disqualified. An example of **specific preparation** would be to work on the proper form to be more efficient and to work more on the final format of the sport, which is to move from the treadmill to the pavement.
Competition Phase	The competition phase can be several competitions, but they lead up to the main competition with specific tests. Testing might include any of the following: performance level, new shoes or gear, a new race tactic might be employed, pre-race meals, ways to reduce anxiety before a race, or the length needed for the taper. When the pre-competitions are of a higher priority there is a definite taper stage while lower priority might simply be integrated in as training. The competitive phase ends with the taper and the competition.
Transition Phase	The transition phase is important for psychological reasons;, a year of training means a vacation is in order. A typical weekend warrior might take three months while a professional athlete might take as little as two weeks.

The Mesocycle

A mesocycle represents a phase of training lasting between 2 – 6 weeks or microcycles, but this can depend on the sporting discipline. During the preparatory phase, a mesocycle commonly consists of 4 – 6 micro-cycles, while during the competitive phase it will usually consist of 2 – 4 micro-cycles depending on the competition's calendar.

The goal of the planner is to fit the mesocycles into the overall plan timeline-wise to make each mesocycle end on one of the phases and then to determine the workload and type of work of each cycle based on where in the overall plan the given mesocycle falls. The goal in mind is to make sure the body peaks for the high priority competitions by improving each cycle along the way.

The Microcycle

A microcycle is typically a week because of the difficulty in developing a training plan that does not align itself with the weekly calendar. Each microcycle is planned based on where it is in the overall macrocycle.

PLANNING A TRAINING

The annual plan is important in that it directs and guides athletic training over a year. It is based on the concept of periodization and the principles of training. The objective of training is to reach a high level of performance (peak performance) and an athlete has to develop skills, bio motor abilities and psychological traits in a methodical manner.

Preparatory Phase

This phase consists of the general preparation and specific preparation. Usually the general preparation is the longest of the two phases and the specific preparation is the shortest.

Competitive Phase

This phase may contain a few main competitions each containing a pre-competitive and a main competition. Within the main competition, an uploading phase and a special preparatory phase may be included.

Transition Phase

This phase is used to facilitate psychological rest, relaxation and biological regeneration as well as to maintain an acceptable level of general physical preparation. This phase lasts between 3 – 4 weeks (maybe longer) but should not exceed 5 weeks under normal conditions and may be sports specific. It allows the body to fully regenerate so that it is prepared for the next discipline.

ASSESSMENT

1. What are the primary benefits of periodization?
2. What are the various types of stress and response stages?
3. What are the three types of cycles and their significance?
4. Outline the significance of each stage in the macrocycle.
5. How will you go about coming up with a long term training plan for a person? Explain briefly.

Student Notes

FUNCTIONAL TRAINING

OBJECTIVES OF THIS LESSON

At the end of this lesson you will be able to:

→ Explain the concept of functional training
→ Differentiate between functional training for stabilization and mobility along with their associated body parts
→ List the best practices in functional training
→ Determine the application of functional training to sports situations

INTRODUCTION TO FUNCTIONAL TRAINING

Over the past decade, there has been a shift toward making training more functional. The revolution began, as it often does, with physical therapists, and functional training was slowly adopted by coaches and personal trainers. One of the many signs that functional training would be the wave of the future was when the large manufacturers of strength-training machines began to introduce what they called —ground-based" machines and also to manufacture basic squat racks and weight benches. The public had spoken with their wallets, and the popularity of machines, particularly in the athletic training area, was on the decline. However, over the past few years, a controversy has begun to develop around functional training. A kind of functional paradox has risen. The gurus of functional training seem to deliver a clear message: **Functional training should be done standing and should be multi-joint.** Surprisingly, however, some coaches who have embraced functional training promote concepts that, in the initial analysis, appear nonfunctional. This use of apparently nonfunctional exercises by so called advocates of functional training caused some confusion in the field. This apparent contradiction is actually simple and can be resolved by differentiating between ***functional training for mobility*** and ***functional training for stabilization***.

STABILITY VS MOBILIZATION

Function varies from joint to joint. Exercises that promote the function of joints that require stabilization are different from exercises that promote the function of joints that strive for mobility.

Categorization of joints according to mobility and stability:

Joint	Function
Ankle	Mobility
Knee	Stability
Hip	Mobility
Lumbar spine	Stability
Thoracic spine	Mobility
Cervical spine	Stability

The primary function of certain muscles and muscle groups is stabilization. Functional training for those muscles involves training them to be better stabilizers, often by performing simple exercises through small ranges of motion. In many cases, in the effort to make everything functional, coaches and athletes ended up neglecting the important stabilizing functions of certain muscle groups.

For example, rotator cuff muscles are very important deep muscles to stabilize the shoulder joint, as the hip flexors are extremely important for hip stabilization anteriorly, as the *gluteus medius* and *minimus* are very important for lateral hip stabilization

The three key groups in need of stability training are:

1. The deep abdominals (*transversus abdominis* and *internal oblique*)
2. The hip abductors and rotators
3. The scapula stabilizers.

Many coaches began to label exercises for these areas as rehabilitative or "rehabilitative," but in fact, these exercises can form an integral part of functional training.

Function at the ankle, knee, and hip

Function at the ankle, knee, and hip is maximized when the hip displays great stability. For some athletes the development of stability at the hip may initially require isolated hip abduction work to properly "turn on," or activate, the muscle. Performance expert Mark Verstegen of Athletes' Performance Institute in Tempe, Arizona, refers to this concept as *isolation for innervation*. At certain times, certain muscle groups--notably the deep abdominals, hip abductors, and scapula stabilizers--need to be isolated to improve their function. For this reason, some single-joint, apparently nonfunctional exercises may in fact improve function of the entire lower extremity. This is one of the paradoxes of functional training. Thus what AIICP suggests is that no exercise is non functional. Every exercise can be placed in the continuum of functional training. For example a leg press apparently is less functional as compared to a squat but by itself leg press is a very functional multijoint exercise.

Function at the shoulder

Function at the shoulder joint is enhanced by improving the function of the scapula stabilizers. Although many athletes perform exercises for the rotator cuff, few exercise the scapula stabilizers. But a strong rotator cuff without strong scapula stabilizers is like trying to shoot a cannon from a canoe. At training facilities, it has been found that most athletes have adequate rotator cuff strength but insufficient strength or control of the scapula stabilizers. As a result, we should frequently employ exercises to work on the scapula stabilizers that might appear nonfunctional, but the development of these areas is critical to long-term health of the shoulder joint.

Function at the lower back

Physical therapists are again leading the way in the area of developing the stabilizers of the lower back. Improving abdominal strength to aid in the stabilization of the lower back is far from a new concept, but the specific methods are changing rapidly. Researchers in Australia have clearly established that two deep spinal stabilizing muscles, the *transversus abdominis* and *multifidus*, experience rapid atrophy after an episode of low-back pain. Without retraining these muscles, the recurrence of back pain is almost guaranteed. To improve the function of the lumbar spine, a certain degree of isolation is necessary, and this isolation involves simple, short-range contractions of the deep abdominal muscles.

The key to developing a truly functional training program is not to go too far in any particular direction. The majority of exercises should be done standing and should be multijoint, but at the same time, attention should be paid to development of the key stabilizer groups in the hips, torso, and posterior shoulder.

FUNCTIONAL TRAINING FOR SPORT

A second functional paradox revolves around multi-planar activity done in a sport-specific position. Advocates of this style of functional training espouse the use of loaded exercises (for example, dumb-bell, weight vest) with a flexed posture and foot positions that some Strength and Conditioning coaches would consider less than desirable. Although athletes find themselves in compromised positions in competitive situations, coaches need to evaluate how far they are willing to go in loading athletes in positions of spinal flexion. As an example, although a baseball player often squats down to field a ground ball with a flexed spine, weighted squatting movements with the spine in a flexed position may not be wise. At what point do you cross the line from safe training into unsafe training? Our position on this is simple. The argument that "this happens in sports all the time" is not

sufficient to take risks in the weight room. If we are training for strength (six reps or less), we never compromise back safety to make the body position of the exercise more specific. If we are training for endurance (10 reps or more), we may at times employ exercises in flexed postures while loaded with a weight vest or dumbbell. Physical therapist Mike Clark of the National Academy of Sports Medicine has proposed a guideline of not more than 10 percent of body weight for exercises done with a flexed spine or for forward-reaching actions. This is an excellent guide for most athletes but may be too heavy for larger athletes.

As you begin to explore the concept of functional training for sport, keep an open mind about how and why athletes move in your sport. Think of your training as a vehicle to improve performance, not just to improve strength. Many athletes have neglected strength training because they do not fully understand the performance-enhancing value of strength in sports such as baseball, tennis, or soccer. The key from the athlete‘s standpoint is for the training to make sense. The key from the coach‘s standpoint is to make the training make sense to the athlete. A training program built around actions that do not occur in sport simply does not make sense. The key is to design a training program that truly prepares athletes for their sports. This can be done only by using exercises that train the muscles the same way they are used in sport, in other words, functional training.

BEST PRACTICES IN FUNCTIONAL TRAINING

- Functional training exercise systems should incorporate such exercises that train strength, power, speed, endurance, flexibility, agility, balance and neuro muscular co-ordination.
- No exercise can be called non-functional. Every exercise should be considered as a continuum of Functionality.
- A physical instructor should always keep trying to make tailor made unique exercise programs for their clients taking into consideration their current fitness level, health condition, age, daily activities important in their lifestyle, to mention a few parameters.
- A physical trainer may begin with isolation exercises and gradually proceed to multi joint compound and power exercises that will make the client more and more functional as compared to the previous exercise sessions.
- The type of exercise movements that you can innovate specific to the needs of your client has limitless options, but one should always be careful that the exercise movements are based on the scientific principles of established facts like Anatomy Kinesiology and Biomechanics.

ASSESSMENT

1. What is functional training? Define.
2. How is functional training for stabilization different from functional training for mobility?
3. List the different body parts associated with stability and mobilization.
4. What parameters of the individual should be considered by the trainer for providing customized functional training?
5. Describe how functional training can be applied to sports.

Student Notes

POSTURE ANALYSIS AND ITS EXERCISE PRESCRIPTION

OBJECTIVE OF THIS LESSON

At the end of this lesson you will be able to:

→ Define posture
→ List the benefits of maintaining a good posture
→ Identify the correct postures in various states of rest and motion
→ Classify the different types of postures
→ Understand and perform exercises to correct postures

INTRODUCTION TO POSTURE

Posture is the position in which you hold your body upright against gravity while standing, sitting or lying down.

Good Posture

Good posture involves training your body to stand, walk, sit and lie in positions where the least strain is placed on supporting muscles and ligaments during movement or weight-bearing activities. Proper posture:

- Keeps bones and joints in the correct alignment so that muscles are being used properly.
- Helps decrease the abnormal wearing of joint surfaces that could result in arthritis.
- Decreases the stress on the ligaments holding the joints of the spine together.
- Prevents the spine from becoming fixed in abnormal positions.
- Prevents fatigue because muscles are being used more efficiently, allowing the body to use less energy.
- Prevents strain or overuse problems.
- Prevents backache and muscular pain.
- Contributes to a good appearance.

Bad Posture

Poor posture is the posture that results from certain muscles tightening up or shortening while others lengthen and become weak which often occurs as a result of one's daily activities. Bad posture can manifest as rounded and elevated shoulders and a pushed-forward head position. This position places stress on the spine between the top of the neck and skull and the base of the neck and upper shoulders. There is a reduction in the stability of the shoulder blades resulting in changes to the movement pattern of the upper extremities. Bad posture can also assume form with a forward tilting of the hips, an increase in the curve of the lumbar spine, and a protruding stomach. This position places stress over both the hip joints and lower back.

CAUSES OF BAD POSTURE

There is no one single identifiable cause of bad posture. But fundamentally the causes of bad posture can be dichotomized into either **Repetitive Stress** or **Postural faults**. Repetitive Stress comes in the form of repeated actions that cause tension in the fascia and muscles, which will in turn affect the alignment of the body. Postural faults arise from adopting a wrong posture or the lack of awareness of your body. Postural faults are ingrained from a young age can also result to in bad posture.

Repetitive stress

Repetitive activities such as sitting at your desk, using a computer, and carrying children often contribute to bad posture and alignment. Forward head posture and sway back are common results of this postural misalignment. Posture can be corrected by lengthening the tissues in your body, and thus correcting this bad posture. Tight tissues and muscles are also responsible for locking your body into bad posture.

An example of bad posture caused by sub-optimal body alignment is commonly seen in the relationship between the pelvis and the legs: Some people have developed a habit of storing tremendous amounts of tension in their hips, buttocks, and legs. This prevents their hip girdle from resting upon their leg bones in a way that provides maximum energy, range of motion, stability and stamina.

Postural Faults

Postural faults arise from adopting a wrong posture or the lack of awareness of your body. The diagrams below also illustrate the different postural habits and factors that can cause bad posture.

Knees

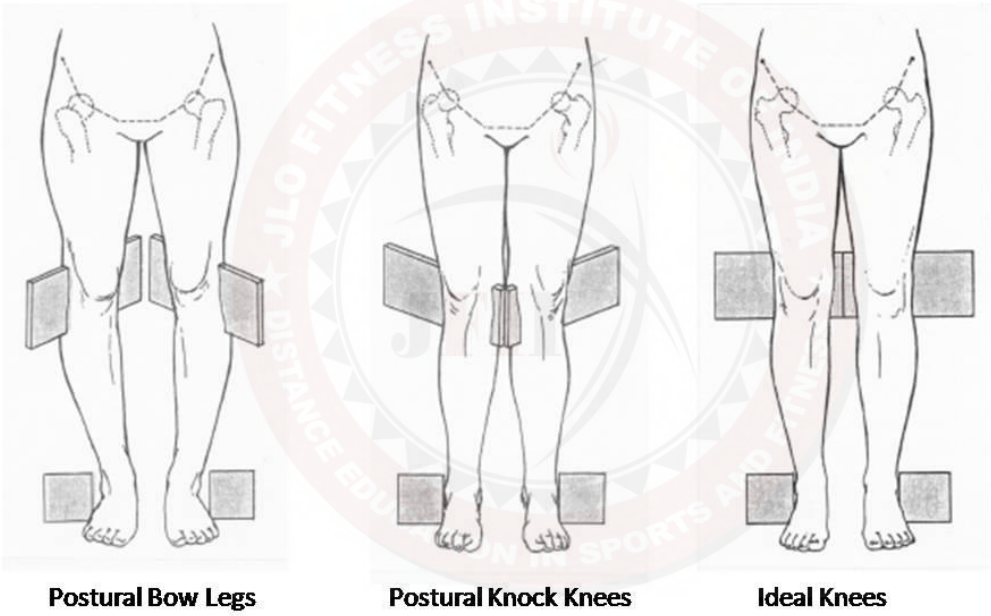


Figure 24 Postural Faults - Knees

Pelvis

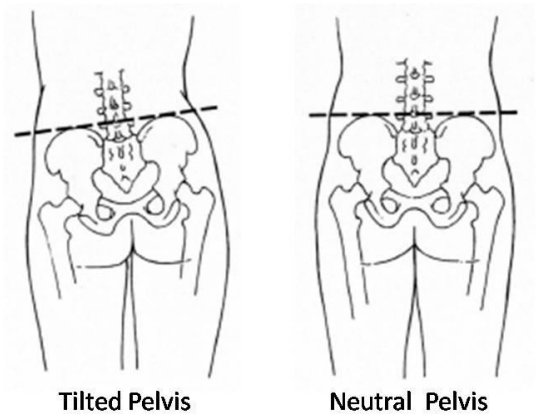


Figure 25 Postural Faults-Pelvis

In a lateral pelvic tilt the pelvis is not level from side to side, but the corner of one side of the pelvic is higher than the other. In standing, a lateral tilt is associated with the sideway bend of the lumbar spine and inward and compression of the hip joints.

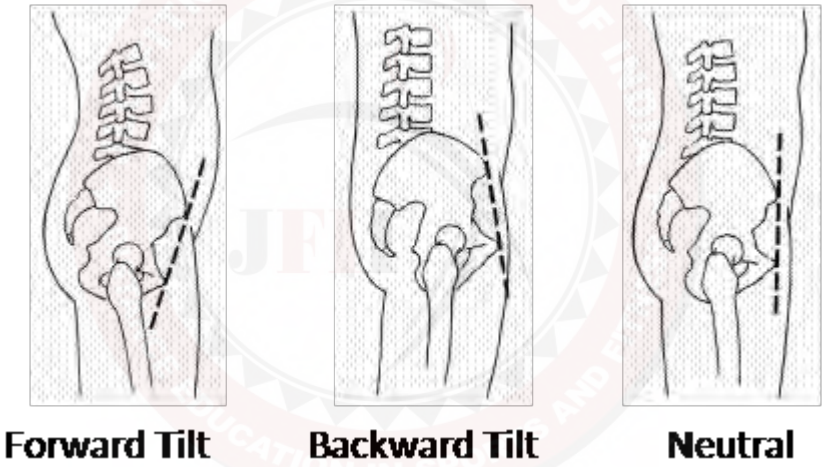


Figure 26 Postural Faults: Lateral Pelvic Tilt

The balance of the pelvis is one the most important aspect for the upper part of the body, which includes the trunk and the head. If there is tilted pelvis is tilted, its can trigger or affect cause conditions like such as scoliosis.

Figure 27 Postural Faults: bad vs good pelvic posture

The picture illustrates someone who has improved from a bad posture to an improved posture through training.

TYPES OF BAD POSTURES

Kyphosis
Kyphosis, or hunchback, is an unbalanced posture that can cause neck and back pain. The head is pushed forward, in front of your gravitational center. The upper back is rounded, accentuating the thoracic curve. This condition can develop from unhealthy posture habits, bone and joint degeneration and spinal deformity. Severe cases diagnosed as *Scheuermann's kyphosis* create a noticeable hump in the upper back.

Lordosis
Lordosis is a back posture that exaggerates the lumbar curve into a position often termed swayback. Standing with locked knees contributes to this unhealthy posture that aligns the head behind your center of gravity. Shoulders may also be pulled back too tightly. The behavioral and developmental causes may create neck or back pain.

Scoliotic
Scoliotic curvature is an abnormal sideways curve of the spine that results in improper alignment of the spine, shoulders and neck. Visible symptoms may include uneven shoulder height or a non vertical non-vertical neck angle. The majority of scoliosis cases are mild (less than 20-degree curve), however, and don't pose serious threats to healthy posture.

Correction of most common postural malalignments

1. Over Pronated Foot

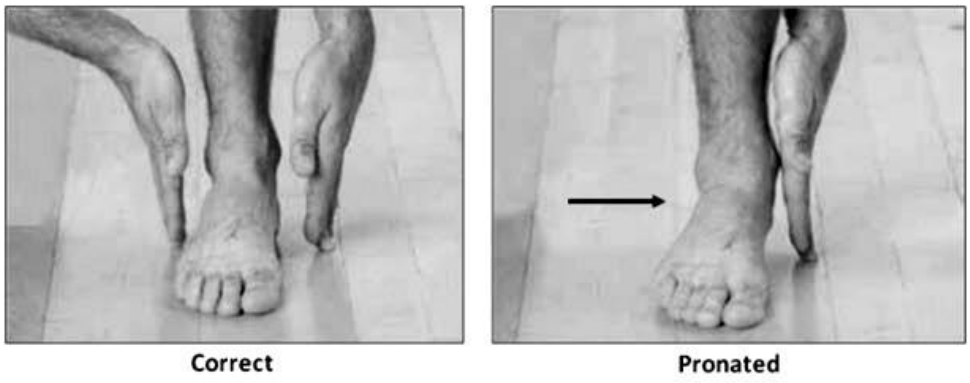


Figure 28 Over Pronated Foot

Identification – As shown in the photo above, put both hands 1 one inch away from each side of your foot. Straighten your ankle so that the space between each hand and your ankle is equidistant. Now naturally let your ankle and feet rest. If your foot and ankle caved inward, you have over-pronated feet.

Causes – Obesity, pregnancy, improper footwear, or repetitive pounding on a hard surface can weaken the arch leading to over-pronation and oftentimes flat feet.

Problem – Over-pronation adds stress to the foot, tightens calf muscles, and can internally rotate the knees. Over-pronation often leads to Plantar Fasciitis, Heel Spurs, Metatarsalgia, Post-tib Tendonitis and/or Bunions. As many as 20-30% of Americans have flat feet, or over-pronated feet.

Solution – If the arch has already fallen, orthotics are the best bet. If the arch is in the process of falling, or is weak, barefoot running/walking may help strengthen the arches, but be sure to check with your doctor (orthotics may be the best bet in this case as well). For more on barefoot running,

2. Forwarded Hip Tilt (Lumbar Lordosis)

Identification – Identifying a forward tilt can be tricky, but one method is to intruct the individual to tilt the pelvis forward as far as possible, then backward similarly. The individual may realize that their natural hip tilt is not far away from the exaggerated forward tilt.

Cause – Sitting too much and not stretching, which shortens the hip flexors

Figure 29 Natural Hip Tilt

Problem – Forward hip tilt (aka anterior pelvic tilt) is associated with tight hip flexors, which are a group of muscles on the front of the hips that pull the knee upward. As an individual walks, tight hip flexors prevent the glutes (butt muscles) from firing/activating, which forces the hamstring muscles to become overworked and excessively tight. If the individual has tight hamstrings, the root cause may be tight hip flexors and an anterior pelvic tilt.

Solution – Stretch the hip flexors with static lunges, such as the Lunges.

3. Hunch Back (Thoracic Kyphosis)

Identification –If the upper back is excessively curved (greater than 40-45 degrees), it is a hunchback posture.

Cause – Sitting with bad posture, especially at an office doing computer work

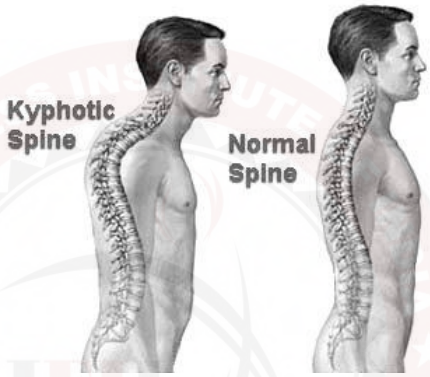


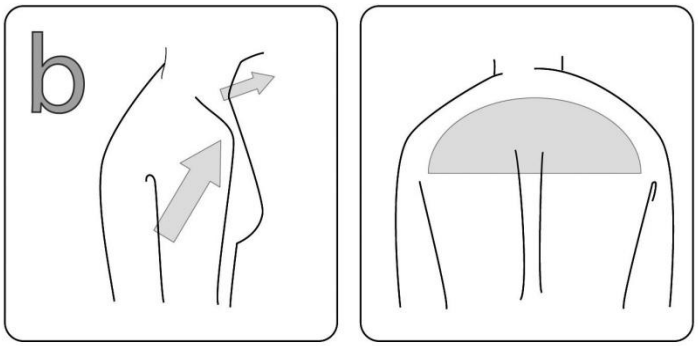
Figure 30 Huncback posture

Problem – Sitting hunched over a computer screen forces chest muscles to tighten, which can cause excessive curvature (kyphosis) of the upper back (thoracic spine). Postural muscles in the upper back weaken and loosen.

Solution – Relieve chest tightness with self myofacial release (use a massage ball) and stretching, while strengthening the upper back postural muscles. Most Important exercise for hunchback posture is upper back foam rolling.

4. Rounded Shoulder

Identification – The —Pencil Test" involves holding a pencil (or pen) in each hand. As shown in the photo, if the pencils are pointing straight forward with the arms comfortably at the sides, that indicates correct posture. If on the other hand the pencils are facing each other, or are rotated at an angle, then you have internally rotated shoulders.



Cause – Sitting with bad posture, especially in an office while typing, or using an imbalanced exercise routine with excessive chest pressing.

Problem – Sitting hunched over a computer screen forces chest muscles to tighten, which can internally rotate the shoulders forward. Postural muscles in the upper back weaken and loosen.

Solution – The solution is very similar to correcting hunchback posture – relieve chest tightness with self myofascial release (use a massage ball) and stretching, while strengthening the upper back postural muscles.

5. Scoliosis

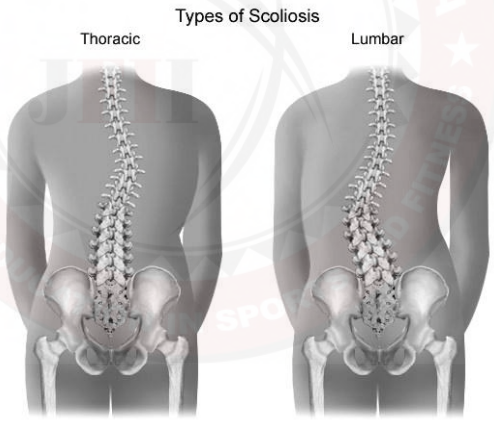


Figure 31 Scoliosis

*Identification***-** It is very easy to identify scoliosis. Some scoliosis is functional and can be corrected with exercises alone, but other is structural, which requires medical intervention.

Cause **-** There are various causes for this, one can have by birth and others may develop over a period of time holding poor posture.

*Problem***-** Scoliosis has varying degrees of problem, one can have no problem if it is mild, but some can even have breathing difficulty.

Solution-

a. Angled Wall Stretch

The angled wall stretch lengthens the spine as well as opens the shoulders to create balance in the muscles of the upper back and help counteract scoliosis. Additionally, standing poses strengthen the lower body, allowing your legs rather than the back to carry the bulk of your weight. Stand a few feet away from a wall with the feet hip-distance apart. Lean forward to place the hands on the wall shoulder-width apart. The goal is to create a right angle between the torso and the legs, with the hands pressed against the wall at the level of the hips. However, the individual may need to begin with the hands on the wall at shoulder level until the spine and shoulder flexibility allows the upper body to align parallel with the floor. The feet should be firmly planted as the individual pushes into the wall with the hands to feel the stretch through your shoulders and upper back.

b. Seated Twist

Spinal twisting exercises help to reverse the abnormal curvature in the spine due to scoliosis. The rotation of the twist provides a counterbalance to your misaligned vertebrae, helping to keep the body in its correct posture. The individual must sit up tall on a sturdy chair with the left side facing the chair back. Keeping the feet flat on the floor, the individual must grasp the back of the chair with the hands. Pushing with the left hand, the torso must be gently twisted as far to the left as is comfortable. Shoulder blades must be squeezed together behind the person as the spine is kept lengthened. With each exhalation, the twist must be deepened. After several moments, switch sides and repeat.

c. Hamstring Stretch

Tight hamstrings contribute to poor posture by decreasing mobility and flexibility in your back, hips and legs. Hamstring stretches are especially helpful in alleviating the problem of uneven hips often associated with scoliosis.

ASSESSMENT:

1. Define posture
2. What is a good posture and what is a bad posture?
3. What are the benefits of a good posture?
4. What are the various types of bad leg postures?
5. What are the various types of bad pelvis postures?
6. What are the various types of bad back postures? How will you correct them?

Student Notes

INJURIES

OBJECTIVE OF THIS LESSON

At the end of this lesson you will be able to:

→ Define an injury
→ Describe various injuries and their causes
→ Define inflammation
→ Apply the knowledge about inflammation to manage inflammations
→ Understand the causes of injuries of various body parts
→ Apply the knowledge of prevention mechanisms to prevent your body from injuries

INTRODUCTION TO INJURY

An injury is the physical damage that results when a human body is suddenly or briefly subjected to intolerable levels of energy. It can be a bodily lesion resulting from acute exposure to energy in amounts that exceed the threshold of physiological tolerance, or it can be an impairment of function resulting from a lack of one or more vital elements (i.e. air, water, warmth), as in drowning, strangulation or freezing. The time between exposure to the energy and the appearance of an injury is short.

The energy causing an injury may be:

- Mechanical (e.g. An impact with a moving or stationary object, such as a surface, knife or vehicle)
- Radiant (e.g. A blinding light or a shock wave from an explosion)
- Thermal (e.g. Air or water that is too hot or too cold)
- Electrical
- Chemical (e.g. a poison or an intoxicating or mind-altering substance such as alcohol or a drug).

INFLAMMATION

Inflammation is the body's attempt at self-protection; the aim being to remove harmful stimuli, including damaged cells, irritants, or pathogens - and begin the healing process.

In the recent year as awareness of fitness is increasing the injuries in gym set up has also increased;, there has been a 35 percent increase in gym injuries in recent years. The first is poor posture during the day, which eventually weakens your entire musculoskeletal structure. The other mistake is trying to do too much too fast, in both reps and weight.

Acute inflammation is a short-term process, usually appearing within a few minutes or hours and ceasing upon the removal of the injurious stimulus. It is characterized by five cardinal signs. The acronym that may be used for this is "PRISH" for Pain, Redness, Immobility (loss of function), Swelling and Heat.

The traditional names for signs of inflammation come from Latin: (Cardinal Signs)

- Dolor (pain)
- Calor (heat)
- Rubor (redness)
- Tumor (swelling)
- Functio laesa (loss of function)

MANAGEMENT OF INJURIES

To reduce inflammation and the resulting swelling and pain, injured tissue needs to be properly treated. The earlier you start treatment, the better. Treatment for acute inflammation consists of —R.I.C.E." therapy— which stands for Rest, Ice, Compression, and Elevation. For acute inflammation in the foot or ankle, your foot and ankle surgeon will recommend the following:

- **Rest:** The individual must stay off of the foot as much as possible to prevent further injury. In some cases, complete immobilization may be required. A doctor will have to decide whether crutches are needed and whether movement of the foot or ankle is appropriate.

- **Ice:** Icing, which decreases blood flow to the tissue, thus reducing swelling and pain, should be continued until symptoms resolve. Ice cubes—or a bag of frozen peas or corn—in a thin towel can be placed the pack on the injured area for 20 minutes of each hour. If the skin turns blue or white, discontinue icing for a few hours. Two cautions: Never apply ice or frozen bags directly to the skin. An ice pack must never be left on the injury while sleeping.

- **Compression:** The inflamed area must be kept compressed by wrapping it in an elastic bandage or stocking. Compression prevents additional fluid accumulation and helps reduce pain. Wrap the bandage more firmly at the toes and less firmly at the calf. If toes tingle or the foot throbs, the wrapping may need to be loosened. If the tingling or throbbing continues after loosening the wrap, a doctor must be consulted as soon as possible.

- **Elevation:** Keeping the foot elevated reduces the swelling by allowing excess fluid to drain to the heart. The proper way to elevate the foot is to keep it level with or slightly above the heart. Place one or two pillows under the calf, and make sure your hip and knee are slightly bent. Never keep the leg extended straight out.

CAUSES AND PREVENTION OF INJURIES

Foot and Ankle

Cause: When the shoulders are rounded and you stand up, the weight falls to the front of the foot. Take that misplaced center of gravity and put it into running shoes, which naturally tip you forward with a heel higher than the toe, and the feet and ankles start to bear the brunt of any impact.

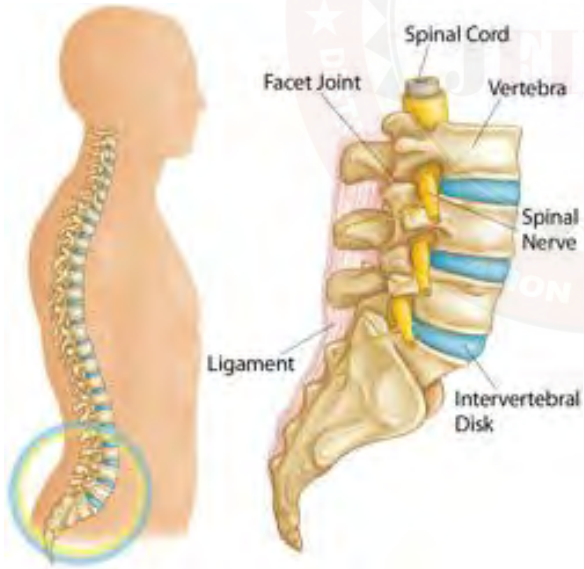
Prevention: By helping spread the impact to the whole foot, one can prevent problems like plantar fasciitis, achilles tendonitis, anterior compartment syndrome (a compression in the front of the ankle), lateral compression syndrome (a compression at the side of the ankle).

Knee

Cause: If feet aren't stable, due to improper footwear, and the hip muscles aren't strong, the knee gets all the stress. Leg extensions, curls, and presses don't help resolve the problem because they don't strengthen the muscles of the feet and hips.

Prevention: A better exercise would be lunges. With a lunge the hip and ankle are bending together, stabilizing and strengthening the knee

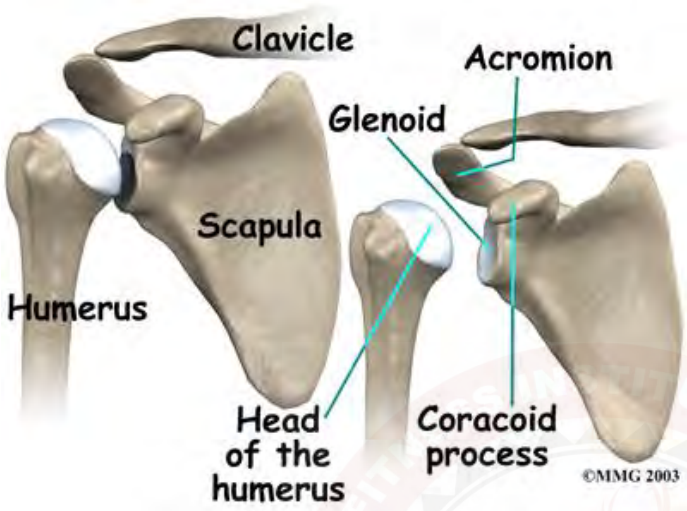
Lower Back



Cause: If someone is rounded throughout the day in their upper back, and then they go to the gym and do an overhead shoulder lift standing, their upper back cannot extend properly. They straighten and arch upward from their lower back, which has a nervous breakdown (anything from soreness to more permanent injury) because it's getting all the stress.

Prevention: Stretch and strengthen your upper back to compensate for all that hunching you do at the office. Flatten your lower back into the wall, by tilting your pelvis under you. Straighten your arms in front of you, and try to raise arms up to your ears, without letting a gap form behind your lower back.

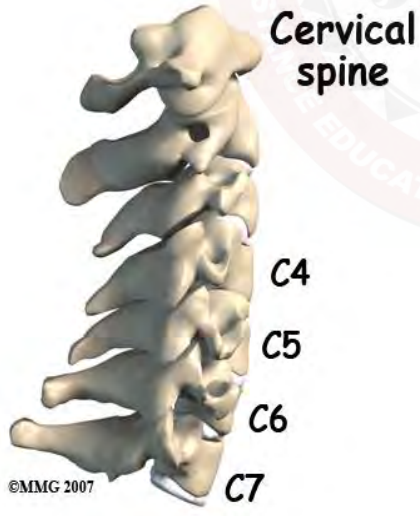
Shoulder



Cause: Your arms have to internally rotate when you type, which puts pressure on the shoulders. Then you go to the gym and do chest press, shoulder press, pushups, and also with your arms rotated in and the outcome? *Supraspinatus tendonitis*, an overuse injury of the rotator cuff.

Prevention: You need to externally rotate your arms to balance your shoulders, and a great way to do that is by rowing with cables.

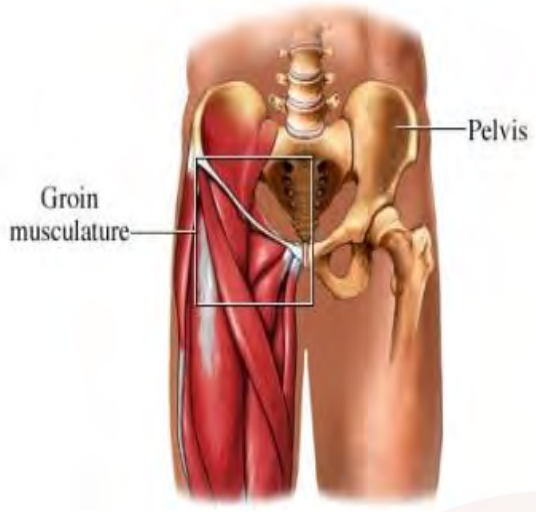
Neck



Cause: A lack of mobility and extension in the upper back will put stress on the lower back and neck.

Prevention: Clearly, when doing the bench press, make sure the lower back and neck are supported properly. Then, avoid putting additional stress on the neck with exercises that cause you to raise the arms over your head. Finally, strengthen the mid and upper back and improve the posture by doing reverse shrugs. Sit at the lat pull down. Grab the bar in front and do straight arm pull downs. Pull down just the shoulder blades, not the arms and go just slightly in front for three to four inches.

Pulled groin



Cause: The last injury to be aware of is a pulled groin. This is quite common also the individual is into doing heavy lunges or squats and unfortunately even though it's just a muscle pull, it can nag at for weeks if not given enough rest.

Prevention: To help prevent this one, be sure that the individual is using a weight that is realistic for him/her (lifting far too heavy is a sure-fire way to cause this injury) and then also make sure that the individual is fully warmed up before performing any of these exercises. Cold muscles asked to lift a heavy weight will always lead to problems.

ASSESSMENT

1. Define an injury.
2. What are the different types of energies that cause an injury?
3. What is inflammation?
4. Inflammation can be treated by RICE therapy. What is RICE?
5. List down the causes and explain the preventive methods for injuries to various parts of the body:
   - Foot and ankle
   - Knee
   - Lower back
   - Shoulder
   - Neck
   - Pulled Groin

Student Notes

SPORTS SPECIFIC TRAINING

OBJECTIVE OF THIS LESSON

At the end of this lesson you will be able to:

→ Define sport specific training
→ Describe the exercises for various types of sports such as archery, football, cricket, badminton, and tennis
→ Explain the steps for sports training
→ Apply this understanding to train people involved in various sports

INTRODUCTION TO SPORTS-SPECIFIC TRAINING

Sport specific training is simply fitness and performance training designed specifically for athletic performance enhancement. Training programs for athletic performance enhancement could include such areas as strength, speed, power, endurance, flexibility, mobility, agility, mental preparedness (including goal setting), sleep, recovery/regeneration techniques and strategies, nutrition, rehabilitation, pre-habilitation, and injury risk reduction.

A personal training program should include all of these components and a more specific program may only include a few, depending upon the athlete's specific needs (based on strengths, weaknesses and/or imbalances) and the demands of the sport they participate in.

Specific Skills
While there may be some sense of specificity to a program designed for an athlete of a specific sport, the truth is that there is a limit to the amount of application/carryover of a sports performance exercise to a sports skill. The most sports specific training that can be done is the sport itself. Sports specific skills practiced for the sport are as specific as one can get.

Injury Risk Reduction
Statistics about the most prevalent injuries for a particular sport, position, gender, and age group can be used to specifically address areas that are most susceptible to injury in that sport. The strength and conditioning coach can then design effective programs for reducing the risk of athletes getting injured from non-contact related injuries.

STEPS FOR SPORTS-SPECIFIC TRAINING

Step 1 - Evaluation and Assessment

The first step, and perhaps the most important, is to evaluate the characteristics of the sport and to assess the athlete's physical profile. This should be done by professional exercise scientist or exercise physiologist. Ultimately, a resistance training program should mirror the movement patterns of the sport as closely as is feasible. While early stages of the program may focus on developing a general strength base, as the competitive season approaches, conditioning exercises should become more specifically tailored to the sport. The same applies to the physiological demands of the sport - a cross country runner for example, requires high levels of muscular endurance. A volleyball player would benefit from explosive power and a football lineman from exceptional muscle mass. A hockey player would benefit from basic strength, explosive power and strength endurance.

Step 2 - Exercise Selection

Once a movement analysis of the sport has been considered and the strength objective for the program set (i.e. hypertrophy, maximum strength, power, strength endurance or a combination of several), the most appropriate exercises can be selected.

Core exercises (those that incorporate one or more large muscle groups) should form the basis of a maximal strength or hypertrophy resistance training program. Examples include back squats, bench presses, and dead lifts and shoulder presses. Core exercises suitable for power development include power cleans, push jerks and snatches.

When explosive power and strength endurance are more a priority (perhaps for a late pre-season strength program) more assistance exercises can be incorporated into the routine.

Assistance exercises recruit smaller muscle groups and are usually single joint exercises. They can be useful for maintaining a balance between agonists and antagonist muscle groups - especially if the sport places an uneven demand on the body. They can also closely match some of the movements in sport:

- Kicking - leg extensions, hip abduction/adduction
- Jumping - power cleans, calf presses, jump squats
- Rowing - seated rows, hip sled, single arm rows
- Swimming (front crawl) - lat pull downs, lateral raises, overhead pulls
- Sprinting - lunges, step-ups, calf raises
- Throwing - overhead pullovers, triceps extensions, internal/external shoulder rotations

A resistance training program should aim to develop balance throughout the body even if the sport has an upper or lower body emphasis. This is an important step in injury prevention.

Step 3 - Frequency

Many athletes choose to lift weights in three workouts a week. This often works well allowing sufficient recovery time and fits nicely into the 7-day week. More advanced lifters may benefit from a four, five or even six day a week program.

Beginners are recommended to start with two, total body sessions a week.

Guidelines from the National Strength and Conditioning Association suggest that there should be at least one rest day but not more than three between working each muscle group. At a minimum, a resistance training session that works the entire body could be completed Monday and Thursday or Tuesday and Saturday.

It's also important to take the phases of season into consideration:

- Off Season - 4-6 sessions per week
- Pre Season - 3-4 sessions per week
- In Season - 1-2 sessions per week
- Transition - 0-3 sessions per week

Of course frequency design cannot be complete without taking other elements of training (such as speed and endurance sessions) into account. A resistance training program for a hockey player for example, might be coupled with plyometric training. In this scenario, only two resistance training sessions per week is feasible.

Step 4 - Exercise Order

The order in which exercises are performed in a session should not be overlooked. Sports conditioning is more demanding than general fitness training and with various forms of training often taking place in the week it's important to maximize overload to recovery ratio.

One method for structuring exercise order is power, core, and assistance exercises. So, for example, power cleans (which involves the most complex movements) should start the session if they are included.

A resistance training session that follows this structure might look as follows:

- Hang cleans (power)
- Back Squats (core)
- Bench Presses (core)
- Bent Over Rows (assistance)
- Triceps Push Downs (assistance)

A second approach is to alternate upper and lower body exercises:

- Lunges
- Seated Rows
- Leg Curls
- Reverse Flies
- Calf Presses
- Barbell Curls

Finally, the push-pull format is an effective resistance training session structure. For the upper body:

- Incline Bench Presses
- Lat Pull Downs
- Military Presses
- Hammer Curls

And for the lower body:

- Front Squats
- Stiff Leg Dead lifts
- Hip Sleds
- Leg Curls

Step 5 - Loading & Repetitions

Assigning the right intensity or load to the exercises depends on two main factors: the training objective and the athlete's current level of strength. Loads are usually assigned as a percentage of the athlete's one repetition maximum.

Strength endurance, on the other hand, is developed when a greater number of repetitions are completed (more than 12) and loads usually correlate to less than 67% 1RM. It's important to remember that adequate overload, even when strength endurance is the primary objective, occurs when each set is performed to, or close to failure.

Explosive power development is a little different. Power for multi-sprint sports (as opposed to single power events such as Olympic Weightlifting) is best developed in a repetition range of 3-5.

However, if exercises were performed to failure in this repetition range, loads of approximately 87-93% 1RM would be used. This is too heavy for substantial power production as it limits the athlete's ability to generate speed of movement. Instead, the 3-5 repetitions are completed with loads of 75-85% 1RM with emphasis on the quality of the lifts.

Step 6 - Volume

Volume can be classed called as the total amount of weight lifted in a resistance training session. This is calculated by multiplying the weight used for each set for all exercises by the number of repetitions completed. So if 3 sets of bench presses are completed, each for 10 repetitions, using 175lbs (80kg) the total volume load equates as:
3sets x 10reps x 175lbs = 5250lbs

However, many more studies suggest that while suitable for beginners, more advanced lifters require additional volume to make further gains in strength. It's also interesting to note that there is evidence that 3 sets of 10 repetitions completed without going to failure increase strength to a greater degree than 1 set of 10 repetitions completed to failure.

As with load, volume is dependent on the athlete's previous training history and the primary strength objective. One or two sets are suitable for beginners and up to 6 sets for experienced athletes.

Rest Periods
Maximal strength training places the greatest demands on the neuromuscular system and requires the longest rest interval between sets and should last between 2-6 minutes.

Resistance training for power demands high quality of movement and the resulting fatigue from too short a rest interval compromises lifting technique. Rest periods of 2-5 minutes are also recommended for power training.

Rest interval of 30 seconds to 1.5minutes is suggested for hypertrophy and less than 30 seconds for improvements in strength endurance.

Step 7 – Progression

From phase to phase over the course of a season, resistance training usually progresses from general strength to sport-specific power and strength endurance. The in-season sees a reduction in training volume where the goal is to maintain the gains made in the off and pre-season phases.

From session to session loads and volume should increase gradually. The 2-for-2 rule is a useful guideline for increasing the resistance. For example, 3 sets of 8 repetitions may be prescribed for a particular exercise. When the athlete completes 2 more repetitions (i.e. 10 reps) on the final set for 2 consecutive sessions the weight should be increased. For smaller muscle groups an increase of 2.5-5lbs (1.25-2.5kg) is suggested and 5-10lbs (2.5-5kg) for larger muscle groups.

EXERCISES FOR SPECIFIC SPORTS

Sports-specific training needs to take into account fitness requirements specific to the demands placed on the body by each sport. However some fitness requirements are common to all sports. The degree to which each of these needs to be honed will vary according to the sport. Regular training is essential for maintaining fitness levels of sports athletes. The training should be directed to achieve specific goals and be individualized to maximize the physical capabilities of particular players. In order to improve, the physical load needs to be increased over time as the players get fitter. By using cross training and by incorporating fitness into the training drills it will keep it interesting and maintain the motivation of the players.

Fitness requirements for all sports:

- **STRENGTH** — resistance training exercises should focus on those areas which are actively involved in playing badminton, such as the wrist, elbows, shoulders, neck, chest, abdomen, back, thighs, knees and ankles. Strength is one area of fitness that can easily be trained. The emphasis is on lifting moderately heavy weights in order to train the nervous system in

conjunction with the muscle fibers to move bigger loads. Hypertrophy, which is building muscle size, does not necessarily imply strength, although in this foundation phase some muscle building will serve well for strength development.

- **FLEXIBILITY** —Flexibility is something that can be improved with regular stretching. The sportsman should stretch before each activity (training and competition), plus along with other stretches, such as PNF and active stretches, to increase the flexibility of specific muscle groups.

- **SPEED** — Movement speed training should focus on reaction time, acceleration and agility (change of direction). There are drills to increase foot speed, such as quick feet ladder drills. Training should also focus on strength and power development.

- **POWER** — Power is the ability to move the heaviest loads in the shortest time. Power is essentially a product of strength and speed. Some exercises that help build power are Barbell squat, dumbbell squat or sled hack squat, dumbbell incline bench press, Romanian deadlift, dumbbell biceps arm curl, dumbbell bent-over row, dumbbell triceps extension or machine pushdown, cable wood chop, lat pulldown to the front with wide grip, and reverse crunch.

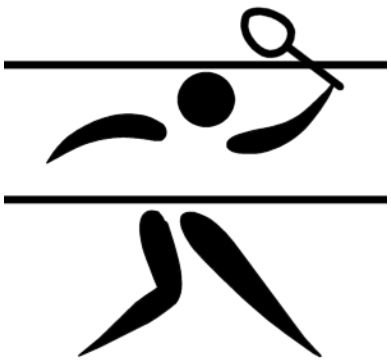
- **ENDURANCE** — Endurance is a very important component of fitness for many sports like badminton and tennis. Such players cover a lot of ground during a match with little rest. Not only is aerobic fitness important for court play, but you need to be fit for long technical training sessions and to recover well between games during extended tournament play.

- **ASSESSMENTS** — Regular fitness assessments are required to monitor training improvements and to determine which areas are best to concentrate on.

Archery

Archery is not usually seen as a sport requiring high levels of fitness. However archers need to attain a certain level in many aspects of fitness to allow them to perform with accuracy and be able to repeat the actions without fatigue. With high fitness levels the archer can shoot with greater intensity and frequency during training, and to shoot without fatigue during competition. A successful archer requires good vision, hand/eye coordination and balance, flexibility, strength, aerobic fitness and low body fat level. Training should be sport specific, addressing the specific needs of the archer. Training on the range will not be enough to improve fitness; it needs to be supplemented with extra training, such as resistance exercises in the gym and other cross training activities. An archer uses his flexibility to perform the required technique, and any tightness may affect accuracy and increase injuries. Key fitness components for archery are strength and flexibility.

Badminton



Badminton is a popular fast-paced indoor sport. To be successful in badminton you need excellent court speed and agility, with a good background of endurance. The fitness training for badminton should focus on speed, agility and endurance, with also strength and flexibility also being important as well

On court training, such as playing games and badminton drills, will provide some fitness benefits, but it needs to be supplemented with extra off-court training, such as resistance exercises in the gym and other cross training activities. A badminton player uses their flexibility to reach, dive and turn to cover all parts of the court. Endurance is a very important component of fitness for badminton.

Badminton players cover a lot of ground during a match with little rest. Movements around the badminton court are of very short distance, so movement speed training should focus on reaction time, acceleration and agility (change of direction). Resistance training exercises should focus on those areas which are actively involved in playing badminton, such as the wrist, elbows, shoulders, neck, chest, abdomen, back, thighs, knees and ankles.

Cricket

Cricket is a sport in which fitness is traditionally not thought of as very important. With the introduction of one day cricket and more recently Twenty20, the game has gone through major changes and the physical demands made on a cricketer's body have also increased dramatically.

Depending on the version of the game being played and the role of the player in the team, the importance of fitness will vary: the fitness requirements of a fast bowler will be greater and also different than that of an opening batsman, and one-day cricket will be more demanding than a test match.

FITNESS COMPONENTS FOR CRICKET

In addition to the high level of skill required to play cricket, a successful player needs good balance and core strength, speed for running between the wickets and in the field, and fast bowlers particularly need very good speed and power. However, which of these are more important? The following outlines the fitness requirements for cricket, which can help with developing training programs for this sport. It will also help you in interpreting fitness testing results and determining the relative strengths and weaknesses of a player.

Most important factors for success in order of importance

- Speed / Quickness, Balance & Coordination
- Motivation & Self Confidence, Skill and Technique
- Strength & Power, Reaction Time
- Coping with Pressure Situations
- Analytic & Tactical Ability
- Flexibility, Agility
- Body Size and Composition, Aerobic Endurance.

Soccer

Aerobic endurance fitness is one of the most important physical fitness attributes for soccer players. Players need to be able to maintain a high level of intensity throughout the 90 minute game. Another very important fitness component is anaerobic fitness, which means running speed and particularly repeat sprint ability. Players also need good agility, strength, power and flexibility.

FITNESS COMPONENTS FOR SOCCER

Strength

Strength training for soccer should address the specific muscles used, such as the gluteus maximus and quadriceps, which are important at the start and at each turn. The shoulder, chest and back muscles - which generate about 85% of the swimmers‘ power, are also critical. While in the kick, the hamstring and quadriceps muscles maintain body balance and the horizontal body position.

Playing Positions
The physical demands will vary for players in different playing positions, and the training should reflect that. The goal keeper has very specific fitness demands. Fitness training for the goalkeeper should concentrate on explosive power and flexibility. The body's intrinsic reaction time is not something that is easily trained, though practice and technique can enable the goalie to better read the play and be in the best position to make quicker decisions.

Speed Abilities
Here are 5 key soccer related speed abilities that you should develop in your players.

Speed Ability	Description
Speed of Thought	Soccer players have a great deal to concentrate on. Their senses are constantly being bombarded with information, which they need to quickly decipher. Here are some examples: ▪ Where opponents are positioned ▪ Actions of their team mates ▪ What's in front of them and their peripheral vision ▪ The conditions of the pitch and the weather ▪ The noise from team mates, crowd, coaches and opponents ▪ Their tactical position and the strategy of the team
Speed of Anticipation	Some players have a great reading of the game. It is important that players develop a knack of interpreting the actions of the opponents and what that means to the game‘s development.
Speed of Reaction	Speed of reaction is vital. Anticipation is one thing, being able helps to react quickly. Consider the role of the goal keeper; their reaction time to a sudden shot, deflection, switch in angle of attack, flight of the ball – all these, must be very acute. But how does a goal keeper react and what to? In this instance, the goal keeper will react to a number of external stimuli. Some these are: The visual element of the opponent with the ball, are if they are carrying it or not, have if they have got back lift as if ready to strike the ball or not, is if the opponent is in space and is if there‘s a clear line of sight on goal. All of these stimuli will have an effect on the player. Once stimulated the player should choose the best option available to them to react to that situation.
Speed of Feet	Here we are talking about the basic running / sprinting motor skills. Initial explosion and acceleration are vital to covering the ground quickly. Speed of feet is without the ball, and since it is without the ball it is rarely in a straight line. Therefore, as a player‘s progress is often inhibited by other players, they must adjust and change direction in relation to their team mates‘ actions and those of the opponents. Explosive speed is generated from the leg muscles stretching and contracting to achieve maximum power, but good running technique, driving through the arms and co-ordination are also vital.
Speed of Skill	Watching a player run at pace and carry the ball is a truly awesome sight. Sprinting full out while keeping possession and holding off any challenges from opponents to dribble and create an opportunity to shoot at goal is a tremendous ability. This key skill though is still built on the last point, which is speed of feet. However, while a player may be very quick, it is only advantageous if their ball manipulation and technical skills are as up to speed as their pace (pardon the pun).

Tennis

Tennis players need a very good level of speed, agility and endurance. Great speed and agility categorize the champion tennis players of today. Speed and agility are considered the most important for success in tennis. Aerobic (endurance) fitness is also very important for tennis players for maintaining the playing intensity throughout long games, matches and tournaments. Other fitness components also important for tennis are anaerobic capacity (repeat sprint ability), power and flexibility.

Training Fitness

Regular training is required for all areas of fitness. An effective training program starts with a good plan. The training should be directed to achieve specific goals and be individualized to address the strengths and weaknesses of the player. In order to improve, the physical load needs to be increased over time as they player gets fitter. By using cross training and by incorporating fitness into the training drills it will keep it interesting and maintain the motivation.

Assessing Fitness

Fitness assessment can be used to determine the fitness level of tennis players at the start of a training period, and to monitor changes in fitness in response to the training.

Care and precautions to be taken while training

- Adjust the weight so that the final few repetitions are taxing but don't cause you to "fail" completely.
- Although the upper body is where the action is expressed in tennis, the "posterior chain" of the hips, gluteals (butt) and upper legs and the abdominals is of equal importance. The squats and deadlifts build strength and power in this region.
- Don't work to failure for the upper body exercises such as the dumbbell press, woodchops and lat pulldown, and do hold good form. Keep the forearms in a vertical plane with the upper arms not extending excessively below parallel at the bottom of the movement. It's important to protect the vulnerable shoulder joint when training for sports where the shoulder gets a lot of specific "out of gym" work -- in this case on the court.
- If you are unable to recover from a session with only one rest day in between, re-schedule this program to two sessions each week rather than three. Strength training can be physically and mentally demanding.
- You may be sore after these sessions. Muscle soreness or delayed onset muscle soreness (DOMS) is normal; joint pain is not. Be sure to monitor your arm and shoulder reactions to this phase. Back off when any joint pain or discomfort is felt.

ASSESSMENT

1. Define sports specific training
2. What are the two main types of exercises an archer should practice in addition to archery?
3. What are the four types of fitness training a badminton player should include in one‘s routine?
4. Mention some important factors for achieving success in cricket.
5. What are the various steps in building a sport fitness training program for cricket?
6. What are the five speed abilities that a soccer player should possess?

7. Chart out a fitness training program for a tennis player.
8. Describe three precautions to be taken when training for sports.

Student Notes

PHYSIOLOGY

OBJECTIVE OF THIS LESSON

At the end of this lesson you will be able to:

→ Define calorie and coefficient of digestibility
→ Apply the concept of energy systems and energy transfer to the intensity of exercises and the food intake
→ Describe the physiology of heart and lungs and the interplay function of these two vital organs

CALORIES AND DIGESTIBILITY

Calories

One Calories Calorie expresses the quantity of heat needed to raise the temperature of one kg of water by 1^0C. So, if we want to convert one calorie into Joules (work done);1 calorie s= 4.184 Joules.

Digestibility

Food, which is ingested, has some digestive value; not every morsel of food is digested fully. —Percentage of ingested food actually digested and absorbed to meet the body's requirements" is called as ***coefficient of digestibility***.

Factors for Digestibility and net energy values of Protein, Lipids and Carbohydrates		
Food Group	Digestibility (In %)	Net Energy (Kcal/ grams)
Protein		
Animal Food	97	4.27
Meats, fish	97	4.27
Eggs	97	4.37
Dairy products	97	4.27
Cereals	85	3.74
Legumes	78	3.47
Vegetables	83	3.11
Fruits	85	3.36
Lipids		
Meat and Eggs	95	9.03
Dairy products	95	8.79

Animal food	95	8.93
Vegetables food	90	8.37
Carbohydrates		
Animal food	98	3.82
Cereals	98	4.11
Legumes	97	4.07
Vegetables	95	3.99
Fruits	90	3.60
Sugars	98	3.87
Vegetable food	97	4.03

(From Merill AL, Watt BK. Energy values of foods: basis and derivation. Agriculture Handbook no. 74, Washington DC; USDA, 1973)

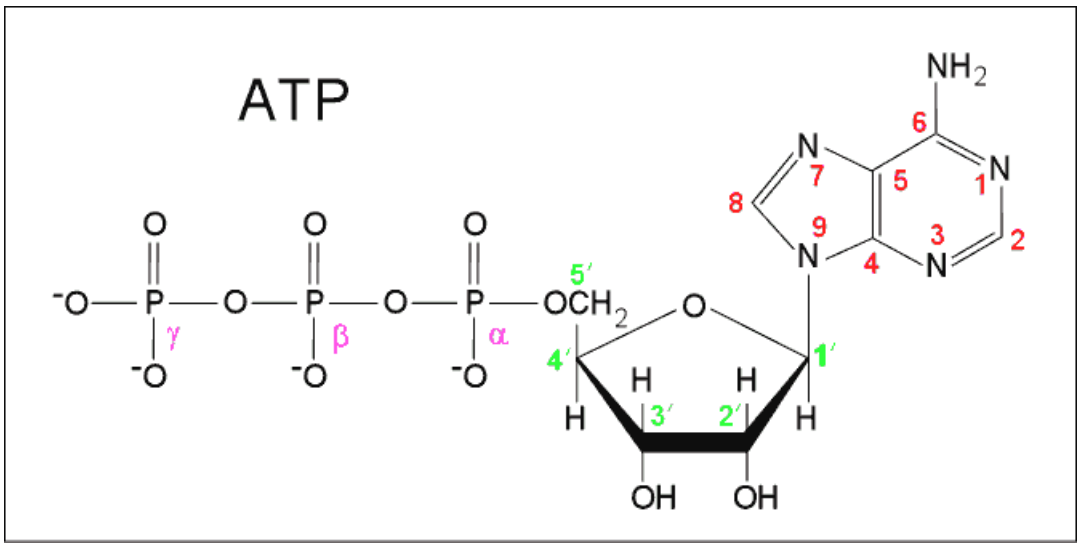
ENERGY TRANSFER

The body's capacity to extract energy from food nutrients and transfer it to the contractile elements in skeletal muscle determines our capacity. Energy transfer occurs through thousands of complex chemical reactions that require the proper mixture of macro- and micronutrients continually fueled by oxygen.

The term energy suggests a dynamic state related to change; thus, the presence of energy emerges only when change occurs.

Adenosine Triphosphate (ATP):

The energy of food does not transfer directly into the cells for biological work. Rather, energy from macronutrients oxidation is harvested and funneled through the energy-rich compound ***Adenosine Triphosphate*** (ATP). ATP is an energy currency and helps in various activities.



ATP in the presence of oxygen or in absence breaks to produce energy and forms ADP (Adenosine Diphosphate). This ADP can be restored again with the presence of one Phosphate molecule (P_i).

Energy transfer during exercises

Exercises provide greatest demand for energy transfer. In a short duration sport like sprinting and swimming, the energy output from active muscles exceeds their resting value by 120 times or more. During less intense but sustained marathon running, the whole body energy requirement increases 20 to 30 times above resting levels.

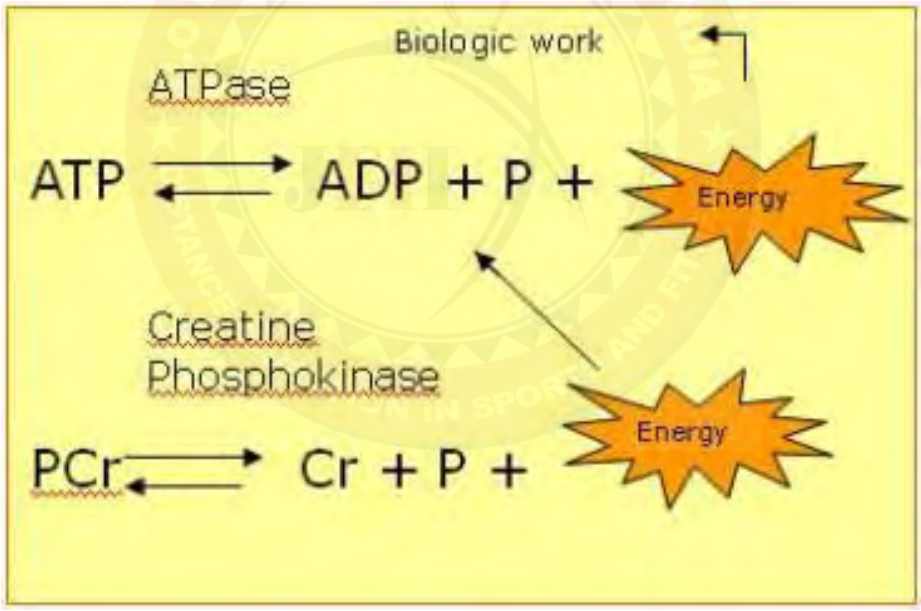
Energy Systems

There are different energy systems, which are responsible to provide energy:

1. Immediate energy (ATP-PCr System)
2. Short term energy (Lactic acid system)
3. Long term energy (Aerobic system)

All these three systems have their relative contribution for the different energy transfer systems, and depend markedly on intensity and duration of exercise and the participant's specific fitness levels.

1. **Immediate energy (ATP-PCr system):**
   High intensity exercises of short duration require immediate energy supply. This energy comes exclusively from intramuscular high energy phosphate bonds that are *adenosine triphosphate* (ATP) and *Phospocreatinine* (PCr).



2. **Short term energy (Lactic acid System):-**
   Re-synthesis of the high energy phosphates must proceed at a rapid rate to continue intense, short duration exercises. The energy to phosphorylate ADP during such exercise comes mainly from stored muscle glycogen breakdown. And this breakdown occurs in the presence of CO_2 and forms lactic acid. This breakdown in presence of CO_2 is much faster than O_2. The rate at which the ATP is formed is much quicker with anaerobic system. Rapid and large accumulation of Lactate occurs during maximal exercise that lasts between 60 to 180 seconds.

3. **Long term energy (Aerobic system):-**
   Glycogen breakdown in presence of oxygen produces few ATP's. Consequently, aerobic metabolism provides nearly all the energy transfer when intense exercise continues beyond several minutes. Here oxygen is a main switch which starts glycogen breakdown.

PHYSIOLOGY OF HEART

Heart is the central most portion of human body and is responsible for pumping blood to different parts of the body. It is situated just behind the sternum bone. The heart is a most vital organ for exercises and it fulfills muscle's requirement of exercises by supplying blood.

Heart has four chambers:

1. Left Atrium
2. Left Ventricle
3. Right Atrium and
4. Right Ventricle

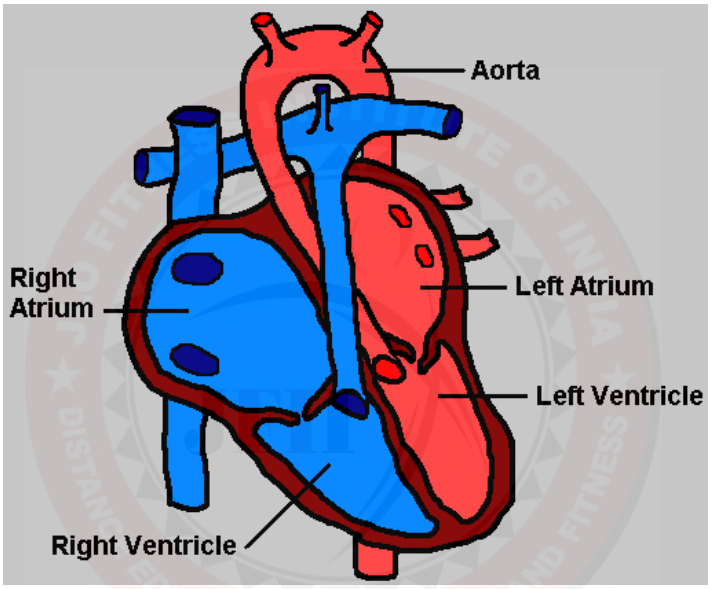


Figure 32 Structure of the Heart

As the diagram shows, the right side accepts blood from different parts of the body and it is bad blood (Deoxygenated blood), and left side holds good blood (Oxygenated blood). It follows the particular pathway for one cycle (one heart beat). The average heart beat is 72- 78, and varies from person to person and exercises. During exercises the heart beat can go up to 180 bpm or even 200 bpm depending on intensity of exercises.

PHYSIOLOGY OF LUNGS

Lungs are the most important organs in any living organism as they helps in absorbing oxygen from the atmosphere. As everyone knows, we breathe in oxygen and exhale carbon dioxide and later in this chapter we will discuss how this process occurs. Lungs are also referred to as the Pulmonary System.

Lungs are situated on either side of the heart and there is a connection between heart and lungs.
The vessels include Pulmonary artery and Pulmonary vein. In our body the artery always carries good blood (Oxygenated blood), and the vein carries bad blood (Deoxygenated blood). But in the Pulmonary system there is an exception, as the Pulmonary Artery carried carries oxygenated blood and Pulmonary Vein carries Deoxyigenated blood.

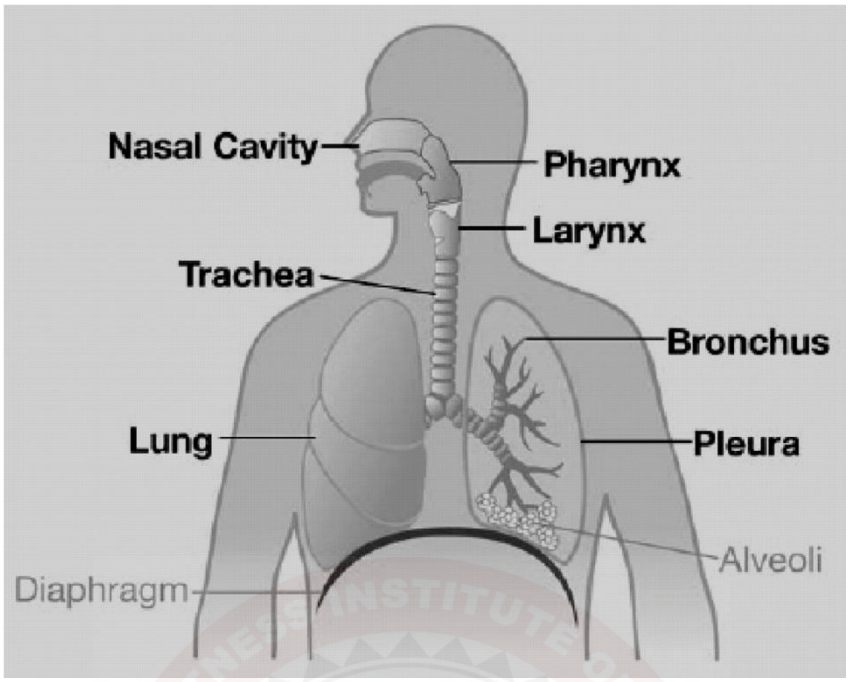


Figure 33 The lungs

The normal average breathing rate is 12- 18, but can go up to 25- 30 depending on disease or exercises. But in exercises it totally depends on intensity.

The heart and lungs has have to work together to meet the body‘s demand during any activity.
Working of Heart and Lungs flow chart:

ASSESSMENT

1. Define the unit calorie.
2. Define coefficient of digestibility.
3. What are the three types of energy systems? How do these energy systems function during exercising?
4. Describe the physiology of lungs.
5. Describe the physiology of heart.
6. Explain the process of blood circulation in the human body.

Student Notes

NUTRITION AND HEALTH

OBJECTIVES OF THE LESSON

At the end of this lesson you will be able to:

- → Explain the importance of following an appropriate nutrition and diet plan
- → Classify the type of nutrients
- → Explain the composition of proteins, various types, their functions, and apply this knowledge to formulate a diet that has adequate proteins
- → Explain the composition of carbohydrates, various types, their functions and apply this knowledge to follow a diet that can meet your body's carbohydrate needs
- → Explain the composition of fats, their types, essential functions, food sources and apply this knowledge to follow a diet that has the right fatty acid composition
- → Outline the significance of water to the human body, effects of over hydration, de-hydration
- → Outline the significance of vitamins and minerals to the human body, effect of their deficiencies and food sources rich in vitamins and minerals and appropriate consumption of these minerals and vitamins

NUTRITION AND DIET PLAN

Nutrition and diet are extremely important aspects of achieving balanced health and fitness for the human body. You might find people who don't exercise just follow a diet plan and are fit, but you will never find people who exercise regularly don't follow a diet and are fit. It simply means that you may have the best car in the world but if you don't provide it with the right fuel you will only ruin it once and for all. During exercise we require a fair and decent amount of fuel to supply us with energy that ultimately helps in performing work. This energy is available to us in the form of calories. The calories that we burn while doing exercise can come from several different sources.

Best source of fuel for the human body:

Best fuel for the human body are those substances which can be easily absorbed and utilized by the body's energy systems to efficiently help perform work and at the same time ensure that excess of this food energy does not get converted to metabolically less active tissues like fats inside the storage areas of adipose tissues. Furthermore the adequate knowledge of diet and nutrition will help to bust a lot of myths and bring to light a lot of relevant important information that can be used for supplying good quality nutrients to the body. Therefore in this lesson all the different sources of nutrition that will be required to build, repair, maintain and fuel body tissues will be discussed with regards to their quality and quantity.

Composition of diet

Diet or food consists of Macronutrients and Micronutrients. Macronutrients are **Proteins**, **Carbohydrates** and **Fats**. Micronutrients comprise of **vitamins**, **minerals**, **anti-oxidants, electrolytesanti-oxidants, electrolytes**.

Micronutrients are nutrients required by humans and other organisms throughout life in small quantities to orchestrate a range of physiological functions. For people, they include dietary trace minerals in amounts generally less than 100 milligrams/day as opposed to macrominerals, which are required in larger quantities. The microminerals or trace elements include at least iron, cobalt, chromium, copper, iodine, manganese, selenium, zinc and molybdenum. Micronutrients also include vitamins, which are organic compounds required as nutrients in tiny amounts by an organism.

The word "Vitamin" is composed of two parts: "vital", which means essential and "amine" because it was previously thought that this compound was amine in its nature. Multivitamins are a mixture of vitamins and minerals which are essential for the body to work and stay healthy.

MACRONUTRIENT - PROTEINS

Introduction to proteins

Proteins are the chief body builders of the body. They are complex molecules made up of carbon, hydrogen, oxygen and nitrogen (sometimes sulphur and phosphorus). Proteins are used to synthesize enzymes (e.g., pepsin, trypsin), hormones (e.g., insulin, adrenaline), carrier proteins (e.g., Haemoglobin), contractile proteins (e.g., myosin, actin), structural proteins (e.g., collagen) and protective proteins (antibodies). They also form skin pigments like melanin and nucleic acids of the genetic material, DNA and RNA - purines and pyrimidines.

Normal protein requirement of a non exercising non-exercising adult is 1g/kg to 2g/kg of lean body mass depending upon the intensity of physical activity. However, growing children, pregnant and nursing mothers, atheletes need more proteins.

Proteins are of both animal and plant origin. Some of the common sources of protein are groundnuts, beans, whole cereals, pulses to mention a few; among plants and fish, egg, meat, milk, cheese; among animal products.

Composition of proteins

Proteins are polymers made of monomers called the ***amino acids***. There are 20 different kinds of amino acids that make up the proteins. However, they are present in different proportions in each of the proteins.

Classification of amino acids

There are two types of amino acids as per the nutritional requirement. They are classified into essential and non-essential amino acids.

***Essential amino acids* :-** Are those that are not synthesized by the body and are needed in the diet. *Methionine, threonine, tryptophan, valine, isoleucine, leucine* and *phenylalanine* are the essential amino acids.

***Non-essential amino acids*:-** are those that are synthesized in the body and are not necessary in the diet. Glycine, alanine, serine, cysteine, tyrosine, proline, aspartic acid and glutamic acid are the non-essential amino acids.Semi-indispensibleindispensable amino acids are arginine and histidine.

Most plant proteins lack in one or more essential amino acids and thus therefore should be taken in combination to fulfill all the protein requirements. On the other hand, animal proteins contain all essential amino acids. Thus they are better providers of complete protein requirements.

Classification of Proteins

Proteins are classified based on their composition. They are of two types:

1. ***Simple proteins:*** Simple proteins are those which contain only amino acids. Example: Egg albumin and seed globulin.
2. ***Conjugate proteins:*** Conjugate proteins are those which contain a non-amino acid component in addition to the amino acids. This non-amino acid component is called the prosthetic group. For

example: glycoprotein (with carbohydrate as the prosthetic group), phosphoprotein (with phosphate as the prosthetic group), lipoprotein (with lipid as the prosthetic group).

Biosynthesis

Your body can create non-essential amino acids from a variety of sources. For example, as your cells burn carbohydrates to create energy, the carbohydrates undergo several chemical processes, and some of the intermediate molecules produced during these reactions can serve as precursors to specific non-essential amino acid synthesis. For other non-essential amino acids, your cells can create them from modifying another amino acid that is similar in biological structure. In this way, you can make up for a lack of any dietary non-essential amino acids and still maintain optimal health.

Diet and Protein Absorption

As long as you consume adequate levels of protein and carbohydrates each day, your cells will either have or make enough non-essential amino acids to support tissue growth and repair, immune function, red blood cell formation and hormone synthesis. Both plant- and animal-based proteins are rich sources of non-essential amino acids, and, although you can manufacture the non-essential amino acids, including a variety of protein sources in your diet helps ensure you have all the starting materials you need to keep the process running smoothly if your diet ever runs low on this particular nutrient.

CONSIDERATIONS

Several amino acids considered essential are actually non-essential in the sense that your cells can synthesize them; however, you may not be able to synthesize them in large enough amounts to satisfy your body's requirements. For example, although you can manufacture the amino acid arginine, during times of rapid growth your body cannot keep up with its need for this amino acid and therefore you must consume some in your diet to augment the quantities your cells can produce.

The ten essential amino acids for adults are given below and a useful mnemonic to remember this list is to read the first letter of each amino acid (highlighted), which gives "Pvt. Tim Hall".*

1. Phenylalanine
2. Valine
3. Tryptophan
4. Threonine
5. Isoleucine
6. Methionine
7. Histidine
8. Arginine
9. Leucine
10. Lysine

A useful mnemonic for this list is to read the first letter of each amino acid (highlighted), which gives **"Pvt. Tim Hall".*

DIETARY SOURCES OF PROTEIN

Meat, Poultry and Seafood	**Eggs and Milk**
Meat, poultry, fish and shellfish are complete, or high-quality, proteins because they supply each of the essential amino acids that we need to get from the diet. Saturated fat and cholesterol intake can be reduced by choosing lean meat and skinless, white-meat poultry instead of fatty meats or dark-meat poultry with the skin. Fatty fish and shellfish provide heart-healthy omega-three fatty acids. The 2010 Dietary Guidelines from the U.S. Department of Health and Human Services recommend two servings of them per week.	All animal-derived proteins are high-quality, so eggs or dairy can be a possible choices if you want a meatless meal or if you are a lacto-ovo vegetarian. All of the protein in eggs is found in the fat-free whites, so skip the yolks to reduce your fat and cholesterol intake. Milk, yogurt and cheese are high in protein, and they provide calcium, an essential mineral for bone strength. Choose reduced-fat dairy products because they are lower in calories and saturated fat.

Soy Proteins	Incomplete Proteins
Soy protein can be a healthy choice, especially if you are a vegan, or strict vegetarian, because it is a rare plant-based source of each of the essential amino acids. Firm or soft tofu, soy milk, soy yogurt, vegetarian burgers or other meat substitutes and soybeans are all high in protein. Soy provides heart-healthy unsaturated fats, or you can choose reduced-fat products, such as light tofu or non-fat soy milk, to keep your fat and calories lower.	Most plant-based sources of protein supply some, but not all, of the essential amino acids. You can meet your needs by eating a variety of incomplete sources throughout the day. Legumes, such as beans, peas and lentils, whole grains, nuts, seeds and vegetables are cholesterol-free, low in saturated fat and high in dietary fiber. Nuts and seeds provide heart-healthy unsaturated fat and vitamin E, whole grains have iron, beans provide potassium, and vegetables may have vitamin A or C.

Functions of proteins

The following are some of the key functions of proteins:

1. They build new tissues of the body.
2. They maintain and replace damaged tissues.
3. They carry out regulating activities as of enzymes and hormones. Enzymes are chemicals that help to complete chemical reactions in the body. Hormones are chemicals messengers of the body that are directly poured into the blood by glands.
4. They are protective as antibodies.
5. They help in other important activities such as movement of skeletal muscles, transport of oxygen, pigmentation of skin, etc.

CALCULATING PROTEIN REQUIREMENTS FOR TRAINING

ACSM recommends that endurance and strength-trained athletes have between 1.2 and 1.7 g/kg (0.5 - 0.8 grams per pound of lean body mass) of protein per day for the best performance and health.

1. Weight in pounds divided by 2.2 = weight in kg (lean body mass)
2. Weight in kg x 0.8-1.8 gm/kg = protein gm.

Use a lower number if you the individual is in good health and are sedentary (i.e., 0.8). Use a higher number (between 1 and 1.8) if the individual is under stress, pregnant, recovering from an illness, or if is involved in consistent and intense weight or endurance training.

Example: 154 lb male who is a regular exercise and lifts weights
154 lbs/2.2 = 70kg
70kg x 1.5 = 105 gm protein/day

MUSCLE BUILDING AND PROTEIN

It is a common misconception that protein intake must increase if bodybuilding is a goal, but this is not necessarily the case. There's evidence that bodybuilders, much like exercisers or athletes, do require more protein but that any more than double the RDA won't necessarily help you build more muscle. In one study, experts studied three groups of weight lifters: A low protein group (0.86 g/kg), a moderate protein group (1.40 g/kg) and a high protein group (2.40 g/kg) and found that, "There were no effects of varying protein intake on indexes of lean body mass."

In essence, the more an individual exercises, the greater the protein needs will be. However, taking it too far, for example more than doubling the protein intake, won't necessarily help build more muscle

Biological value of a protein

The Biological Value (BV) of a Protein is a value that measures how well the body can absorb and utilize a protein. The higher the Biological Value of the protein, the more nitrogen the body can absorb, use, and retain. As a result, proteins with the highest BV promote the most lean muscle gains. Whey protein has the highest BV value, rating as a 104. Egg protein is only second to whey rating as a 100 with milk proteins being a close third rating as 91. Beef rates as an 80 with soy proteins a distant 74. Bean proteins, due to the fact that are plant-based proteins, only rate a 49.The proteins consumed for health and body building effects should be of high biological value.

Lean Body Mass (LBM)

Simply put, lean body mass is comprised of everything in the body besides body fat. The lean body mass includes vital organs, bones, muscles, body fluids, skin and anything else in our bodies that has mass and is not fat.

As an aside, for the average adult male about 42% of body weight is skeletal muscle and it's about 35% for females.

LEAN BODY MASS FORMULA:

Lean Body Mass = Body Weight – (Body Weight x Body Fat %)

This equation subtracts body weight (pounds) from body fat weight (pounds). .

Estimation of lean body mass

LBM is usually estimated using mathematical formulas.

The following formula may be used:

For men: LBM = (0.32810 * W) + (0.33929 * H) - 29.5336

For women: LBM =(0.29569 * W) + (0.41813 * H) - 43.2933

where W is body weight in kilograms and H is body height in centimeters.

A Nomogram based on height, weight and arm circumference may also be used as an alternative.

Actual measurement of LBM

Instead of mathematical estimation the actual value of LBM may be calculated using various technologies such as BIA (Bio Electrical Impedance analysis), dual energy X-ray absorptiometry (DEXA).

Importance of knowing the lean body mass

Most people rely 100% on the weight scale when attempting to track changes in body fat. Tracking body fat directly and tracking LBM is helpful to make sure that a person islosing only fat and no muscle. Losing muscle is highly undesirable because the metabolism will decrease and aesthetically, the person may not look leaner even if they do lose weight.

Assessment for Proteins

1. What is the composition of protein?
2. What are the functions of proteins?
3. List the various amino acids that make up the proteins. What is an easy mnemonic to remember the 10 amino acids required for an adult?
4. What is the normal requirement of protein for a non-exercising adult?
5. What are the two types of amino acids? Define them and give examples for each.
6. What are the two types of proteins? Define and give examples.
7. What is biosynthesis?
8. What are the sources of protein and how should protein diet be governed?
9. How will you calculate the protein requirement of the body?

10. What is the biological value?
11. What is LBM? Why is knowing your LBM important and how will you determine LBM?

MACRONUTRIENT - CARBOHYDRATES

Introduction to Carbohydrates

A carbohydrate is an organic compound that consists only of carbon, hydrogen, and oxygen, usually with hydrogen: oxygen atom ratio of 2:1 (as in water). One of the primary functions of carbohydrates is to provide the body with energy and regulate the blood glucose levels. Additionally carbohydrates help break-down fatty acids, provide dietary fiber, and ensure that proteins are not brought into play for the generation of energy.

Glycemic Index

The glycemic index (GI) is a numerical system of measuring how much of a rise in circulating blood sugar a carbohydrate triggers–the higher the number, the greater the blood sugar response. So a low GI food will cause a small rise, while a high GI food will trigger a dramatic spike. A list of carbohydrates with their glycemic values is shown below. A GI of 70 or more is high, a GI of 56 to 69 inclusive is medium, and a GI of 55 or less is low.

GLYCEMIC LOAD

Glycemic load tells you how much of that carbohydrate is in a serving of a particular food. The Glycemic Load is the most practical way to apply the Glycemic Index to dieting, and is easily calculated by multiplying a food's Glycemic Index (as a percentage) by the number of net carbohydrates in a given serving. Glycemic Load gives a relative indication of how much that serving of food is likely to increase your blood-sugar levels.

GL = GI/100 x Net Carbs

(Net Carbs are equal to the Total Carbohydrates minus Dietary Fiber)

SERVING SIZE

Serving size is the amount of a food or drink that is generally served at a meal. The United States Department of Agriculture (USDA) sets a serving size for fruit or vegetables to be equal to about one-half cup. Greens like spinach and lettuce have a serving size equal to one full cup. One serving of sliced fruit is equal to one-half cup; however a single piece of fruit, such as an apple or an orange counts as one serving.

Fruits and vegetables are rich in vitamins, minerals, fiber and phytochemicals that may act as antioxidants that protect the cells in the body. Colorful and dark green fruits and vegetables must be chosen for the most antioxidants. They're usually low in calories unless you add high calorie sauces, turn them into pies, or deep-fry them in oil. Vegetables like potatoes and corn are vegetables are usually high in fat and sodium when deep-fried.

Many nutrition and dietary experts suggest eating five to nine servings of fruits and vegetables every day. That is a total. Older or inactive women and smaller children need at least three servings of vegetables and two servings of fruit. Growing kids, teen girls, most men and active women should eat at least four servings of vegetables and three servings of fruit every day. Teen boys and active men should eat at least five servings of vegetables and four servings of fruit every day. Unfortunately many people fail to eat even the minimum suggested level of five servings of fruits or vegetables each day.

Here are some typical serving sizes for fruits and vegetables:

Fruits	Vegetables
• One banana • Six strawberries • Two plums • Fifteen grapes • One apple • One peach • One-half cup of orange or other fruit juice	• Five broccoli florets • Ten baby carrots • One Roma tomato • Three-fourths cup tomato juice • Three-fourths cup vegetable juice • Half a baked sweet potato • One ear of corn • Four slices of an onion

LOW AND HIGH GLYCEMIC INDEX

All carbohydrate sources are classified into three general categories:

- **High glycemic index foods (GI 70 or above):** they induce an immediate rise in blood sugar
- **Intermediate glycemic index foods (GI 55 - 69)**: they induce an average rise in blood sugar
- **Low glycemic index foods (GI 55 or below)**: they cause a relatively gradual rise in blood sugar

Example of common foods with high, medium, and low GI

High GI	Value
1. Baked Potato	85
2. Bagel	72
3. White Bread	70
4. Morning coffee	79
Medium GI:	**Value**
1. Croissant	67
2. Sugar	65
3. Sweet Biscuits	69
4. Basmati Rice	58
5. Honey	58
6. Popcorn	55
Low GI:	**Value**
1. Noodles	47
2. Pasta	41
3. Baked beans	48
4. Kidney beans	27
5. Lentils (Masoor)	29
6. Chick peas(ChholaChanna)	33
7. Apples	**36**

8.	**Bananas**	55
9.	**Kiwi fruit**	52
10.	**Milk**	27
11.	**Lentil Soup**	44
12.	**Yogurt**	44

Here is a list of GI for some of our Indian food:

Bengal Gram Dal	Chana Dal	16
Rajmah	Red Kidney Beans	27
Baisen Chapati	Chick Pea Flour	39
Green Gram	Mung Moong Beans	54
Barley	Chapati	61
Black	Gram	61
Horse	Gram	73
Whole Green	Gram	81
Bajra	Millet	82
Maize	Chapati	89
Semolina	Suji	94
Tapioca	Steamed 1 Hr	100
Jowar	Jowar	110
Ragi	Raggi	123

Tips to maintain a low GI

Low GI Diet tips:

1. A Low GI breakfast is the best way to start the day as it improves attention span and memory. Oats, oat bran and toasted sugar free muesli are great picks with a side of milk or fruit. Oats being a good source of dietary fiber and protein can also be added to milkshakes, parathas or poha to increase the health quotient. Cornflakes must be avoided since they're high GI.
2. Multigrain bread is the perfect way to shift to a low GI diet as it can be included in sandwiches, sides with soups, etc.
3. Grilled meat or fish during dinner is another low GI alternative along with vegetables. This will make for a full all-rounded meal, which can be made fun with different gravies and spices.
4. It is essential to ensure that one meal in the day is a Low GI one.
5. Snack bars are important to keep blood sugar levels steady in between meals. Along with these, nuts like walnuts, almonds, cashews and peanuts are also low in GI. Frozen low fat fruit desserts are safe bets.
6. Intake of fruits like apples, cherries, plums, pears, peaches, grapes, oranges, strawberries, prunes and kiwi fruit, and vegetables such as peas, carrots, cauliflower, cabbage, tomatoes, lettuce, chilies, onions and sweet potato must be increased.

Functions of Carbohydrates

Carbohydrates have six major functions within the body:

1. Providing energy and regulation of blood glucose
2. Sparing the use of proteins for energy
3. Breakdown of fatty acids and preventing ketosis
4. Biological recognition processes
5. Flavor and Sweeteners
6. Dietary fiber

PROVIDING ENERGY AND REGULATING BLOOD GLUCOSE

Glucose is the only sugar used by the body to provide energy for its tissues. Therefore, all digestible polysaccharides, disaccharides, and monosaccharide must eventually be converted into glucose or a metabolite of glucose by various liver enzymes. Because of its significant importance to proper cellular function, blood glucose levels must be kept relatively constant.

Process of glucose regulation in the blood

Among the enormous metabolic activities the liver performs, it also includes regulating the level of blood glucose. During periods of food consumption, pancreatic beta cells sense the rise in blood glucose and begin to secrete the hormone insulin. Insulin binds to many cells in the body having appropriate receptors for the peptide hormone and causes a general uptake in cellular glucose. In the liver, insulin causes the uptake of glucose as well as the synthesis of glycogen, a glucose storage polymer. In this way, the liver is able to remove excessive levels of blood glucose through the action of insulin.

In contrast, the hormone glucagon is secreted into the bloodstream by pancreatic alpha cells upon sensing falling levels of blood glucose. Upon binding to targeted cells such as skeletal muscle and brain cells, glucagon acts to increase the amount of glucose in the bloodstream. This hormone inhibits the uptake of glucose by muscle and other cells and promotes the breakdown of glycogen in the liver in order to release glucose into the blood. Glucagon also promotes *gluconeogenesis*, a process involving the synthesis of glucose from amino acid precursors. Through the effects of both glucagon and insulin, blood glucose can usually be regulated in concentrations between 70 and 115mg/100 ml of blood.

Other hormones of importance in glucose regulation are epinephrine and cortisol. Both hormones are secreted from the adrenal glands; however, epinephrine mimics the effects of glucagon while cortisol mobilizes glucose during periods of emotional stress or exercise.

Gluconeogenesis and Ketosis

Despite the liver's unique ability to maintain homeostatic levels of blood glucose, it only stores enough for a twenty-four hour period of fasting. After twenty four hours, the tissues in the body that preferentially rely on glucose, particularly the brain and skeletal muscle, must seek an alternative energy source. During fasting periods, when the insulin to glucagons ratio is low, adipose tissue begins to release fatty acids into the bloodstream. Fatty acids are long hydrocarbon chains consisting of single carboxylic acid group and are not very soluble in water. Skeletal muscle begins to use fatty acids for energy during resting conditions; however, the brain cannot afford the same luxury. Fatty acids are too long and bulky to cross the blood-brain barrier. Therefore, proteins from various body tissues are broken down into amino acids and used by the liver to produce glucose for the brain and muscle. This process is known as ***gluconeogenesis*** or "the production of new glucose."

If fasting is prolonged for more than a day, the body enters a state called ***ketosis***. Ketosis comes from the root word ketones and indicates a carbon atom with two side groups bonded to an oxygen atom. Ketones are produced when there is no longer enough oxaloacetate in the mitochondria of cells

to condense with acetyl CoA formed from fatty acids. Oxaloacetate is a four-carbon compound that begins the first reaction of the Krebs Cycle, a cycle containing a series of reactions that produces high-energy species to eventually be used to produce energy for the cell. Since oxaloacetate is formed from pyruvate (a metabolite of glucose), a certain level of carbohydrate is required in order to burn fats. Otherwise, fatty acids cannot be completely broken down and ketones will be produced.

SPARING PROTEIN AND PREVENTING KETOSIS

So why are carbohydrates important if the body can use other carbon compounds such as fatty acids and ketones as energy? First of all, maintaining a regular intake of carbohydrates will prevent protein from being used as an energy source. Gluconeogenesis will slow down and amino acids will be freed for the biosyntheses of enzymes, antibodies, receptors and other important proteins. Furthermore, an adequate amount of carbohydrates will prevent the degradation of skeletal muscle and other tissues such as the heart, liver, and kidneys. Most importantly, ketosis will be prevented. Although the brain will adapt to using ketones as a fuel, it preferentially uses carbohydrates and requires a minimum level of glucose circulating in the blood in order to function properly. Before the adaptation process occurs, lower blood glucose levels may cause headaches in some individuals. To prevent these ketotic symptoms, it is recommended that the average person consume at least 50 to 100g of carbohydrates per day.

Although the processes of protein degradation and ketosis can create problems of their own during prolonged fasting, they are adaptive mechanisms during glucose shortages. In summary, the first priority of metabolism during a prolonged fast is to provide enough glucose for the brain and other organs that dependent upon it for energy in order to spare proteins for other cellular functions. The next priority of the body is to shift the use of fuel from glucose to fatty acids and ketone bodies. From then on, ketones become more and more important as a source of fuel while fatty acids and glucose become less important.

FLAVOR AND SWEETENERS

A less important function of carbohydrates is to provide sweetness to foods. Receptors located at the tip of the tongue bind to tiny bits of carbohydrates and send what humans perceive as a "sweet" signal to the brain. However, different sugars vary in sweetness. For example, fructose is almost twice as sweet as sucrose and sucrose is approximately 30% sweeter than glucose.

Sweeteners can be classified as either nutritive or alternative. Nutritive sweeteners have all been mentioned before and include sucrose, glucose, fructose, high fructose corn syrup, and lactose. These types of sweeteners not only impart flavor to the food, but can also be metabolized for energy. In contrast, alternative sweeteners provide no food energy and include *saccharin, cyclamate, aspartame,* and *acesulfame*. Controversy over saccharin and cyclamate as artificial sweeteners still exists but aspartame and acesulfame are used extensively in many foods in the United States. Aspartame and acesulfame are both hundreds of times sweeter than sucrose but only acesulfame is able tocan be used in baked goods since it is much more stable than aspartame when heated.

DIETARY FIBER

According to the medical dictionary, dietary fiber means *"Nutrients in the diet that are not digested by gastrointestinal enzymes."* Fiber is also known as roughage. It is the indigestible part of plant foods that pushes through our digestive system, absorbing water along the way and easing bowel movements. Fiber is made up of non-starch polysaccharides, such as cellulose, dextrins, inulin, lignin, chitins, pectins, beta-glucans, waxes and oligosaccharides.

Two types of fiber - Soluble and Insoluble

There are two broad types of fiber, soluble and insoluble. Soluble dissolves in water, while insoluble does not.

No fiber can be digested. However, soluble fiber changes as it goes through the digestive tract, where it is fermented by bacteria. Soluble fiber absorbs water, and as it does so it becomes gelatinous.

Insoluble fiber goes through the digestive tract without changing its forms.

Dietary fiber foods are generally divided into predominantly soluble or insoluble. Both types of fiber are present in all plant foods, but rarely in equal proportions.

Fiber make-up of some foods

Cereal grains - ½ cup cooked

	Soluble	Insoluble
Barley	1g	4g
Oatmeal	1g	2g
Oatbran	1g	3g

Seeds

	Soluble	**Insoluble**
Psyllium seeds ground (1 Tbsp)	5g	6g

Per day consumption of fiber

Women need 25 grams per day and men should get 38 grams per day, according to an Institute of Medicine formula based on getting 14 grams of fiber for every 1,000 calories.

Benefits of consuming fiber daily. Fiber:

- **Normalizes bowel movements:** Dietary fiber increases the weight and size of your stool and softens it. A bulky stool is easier to pass, decreasing your chance of constipation. If you have loose, watery stools, fiber may also help to solidify the stool because it absorbs water and adds bulk to stool.
- **Helps maintain bowel health:** A high-fiber diet may lower your risk of developing hemorrhoids and small pouches in your colon (diverticular disease). Some fiber is fermented in the colon. Researchers are looking at how this may play a role in preventing diseases of the colon.
- **Lowers cholesterol levels:** Soluble fiber found in beans, oats, flaxseed and oat bran may help lower total blood cholesterol levels by lowering low-density lipoprotein, or "bad," cholesterol levels. Studies also have shown that fiber may have other heart-health benefits, such as reducing blood pressure and inflammation.
- **Helps control blood sugar levels:** In people with diabetes, fiber — particularly soluble fiber — can slow the absorption of sugar and help improve blood sugar levels. A healthy diet that includes insoluble fiber may also reduce the risk of developing type 2 diabetes.

- **Aids in achieving healthy weight:** High-fiber foods generally require more chewing time, which gives your body time to register when you're no longer hungry, so you're less likely to overeat. Also, a high-fiber diet tends to make a meal feel larger and linger longer, so you stay full for a greater amount of time. And high-fiber diets also tend to be less "energy dense," which means they have fewer calories for the same volume of food.

- Another benefit attributed to dietary fiber is prevention of colorectal cancer

BIOLOGICAL RECOGNITION PROCESSES

Carbohydrates not only serve nutritional functions, but are also thought to play important roles in cellular recognition processes. For example, many *immunoglobulins* (antibodies) and peptide hormones contain glycoprotein sequences. These sequences are composed of amino acids linked to carbohydrates. During the course of many hours or days, the carbohydrate polymer linked to the rest of the protein may be cleaved by circulating enzymes or be degraded spontaneously. The liver can recognize differences in length and may internalize the protein in order to begin its own degradation. In this way, carbohydrates may mark the passage of time for proteins.

Basal Metabolic Rate (BMR)

Basal metabolic rate (BMR) is the amount of energy required to maintain the body's normal metabolic activity, such as respiration, maintenance of body temperature (thermogenesis), and digestion. Specifically, it is the amount of energy required at rest with no additional activity. The energy consumed is sufficient only for the functioning of the vital organs such as the heart, lungs, nervous system, kidneys, liver, intestine, sex organs, muscles, and skin.

How to calculate BMR with Harris Benedict equation

BMR calculation for men (metric)
BMR = 66.47 + (13.75 x weight in kg) + (5.003 x height in cm) - (6.755 x age in years)

BMR calculation for women (metric)
BMR = 655.1 + (9.563 x weight in kg) + (1.850 x height in cm) - (4.676 x age in years)

Calculating Per Day Calorie Requirement

Activity / Stress factors:
The following activity/stress factors when used along with an estimation of the resting or basal metabolic rate can be used to estimate an individual's total energy expenditure (TEE) in kcal/day (recommend daily calories to maintain current weight = RMR + TEF + ADL).

Sedentary: Little to no exercise	Daily calories needed = BMR x 1.2
Mild activity level: Intensive exercise for at least 20 minutes 1 to 3 times per week. This may include such things as bicycling, jogging, basketball, swimming, skating, etc. If you do not exercise regularly, but you maintain a busy life style that requires you to walk frequently for long periods, you meet the requirements of this level.	Daily calories needed = BMR x 1.3 - 1.375
Moderate activity level: Intensive exercise for at least 30 to 60 minutes 3 to 4 times per week. Any of the activities listed above will qualify.	Daily calories needed = BMR x 1.5 - 1.55
Heavy or (Labor-intensive) activity level: Intensive exercise for 60 minutes or greater 5 to 7 days per week (see sample activities above). Labor-intensive occupations also qualify for this level. Labor-intensive occupations include construction work (brick laying, carpentry, general labor, etc.). Also farming, landscape worker or similar occupations.	Daily calories needed = BMR x 1.7
Extreme level: Exceedingly active and/or very demanding activities: Examples include: athlete with an almost unstoppable training schedule with multiple training sessions throughout the day or a very demanding job, such as shoveling coal or working long hours on an assembly line. Generally, this level of activity is very difficult to achieve.	Daily calories needed = BMR x 1.9

Carbohydrate Intake Requirements

CARBOHYDRATE INTAKE PER DAY

- About half the calories per day should come from carbohydrates.
- Once the daily calorie need is determined it must be divided by half. That is the daily calorie requirement for an individual.
- The gram value of carbohydrates can be determined by dividing the number from the previous step by the total calories in the gram value. Each gram of carbohydrate has four calories. For example, a person who eats approximately 2,000 calories per day should take in about 250 grams of carbohydrates (2,000 divided by 2 = 1,000 and 1,000 divided by 4 = 250).

CARBOHYDRATE INTAKE BEFORE AND AFTER WORKOUTS

There are really only two times of the day to take in simple carbohydrates: first thing in the morning and after the workout.

Pre-workout Carbohydrates

In the morning an individual is coming off a "fast" - which is how ever long you slept the night before. So, at that time the carbohydrate source should be simple and a source of quick digesting protein. If an individual is planning on a morning cardio, the carbohydrates can be skipped and only a small protein shake will suffice. This will ensure that when the individual is doing a cardio exercise he or she will be burning mostly fat for fuel. The carbohydrates and protein can be taken after the workout.

Post-workout Carbohydrates

After the workout is the other time to take in simple carbs: this is critical because it starts the whole recovery/muscle growth process. Following a hard workout, the body is severely depleted of glycogen and glucose.

During the workout hard working muscles use glucose (usable energy) and glycogen (stored energy) for energy. As such, there is a point at which blood glucose levels (available energy) and glycogen levels (stored energy) get so low that intense exercise can't continue. There just isn't enough available energy for the muscles to use. So what happens is that the hormone *cortisol* is secreted, this is the body's "stress" hormone and it has very catabolic effects. What cortisol does is eat up muscle tissue for protein and convert it into glucose. A process called *gluconeogenesis* ensues, producing glucose from these amino acids in the liver. The net result is a loss of muscle tissue.

The post-workout shake prevents this. It also allows insulin to be released, this is one of several anabolic hormones in the body (a natural trainer especially, would want to maximize the release of all your body's anabolic hormones through all available methods).
So, whey protein is the best protein source at this time because it is absorbed quickly.,

A high glycemic carbohydrate source is the best source. This term refers to carbs that are high on the glycemic index (70 and above rates as high). The Glycemic Index is a measure of how quickly a food raises blood sugar and hence insulin levels. Normally, it is best to eat lower glycemic foods so as not to initiate an insulin spike (55 and under rates as low). But post-workout, the exact opposite is true.

It is critical to get the carbs (and protein) to the muscle cells as fast as possible. As well, the elevated insulin levels will help to drive nutrients into the muscle cells. And again, high-glycemic carbs are best for this purpose.

Types of Carbohydrates

SIMPLE CARBOHYDRATES

Simple carbs are naturally present as simple sugars, occurring in mainly fruits and milk, as well as some other foods. The two main types of sugars are:

1. **Monosaccharides** - consisting of a single sugar molecule.
2. **Disaccharides** - consisting of a double sugar molecule.

Listed below are some common sugars:

Monosachharides

1. ***Fructose*** - fruit sugar. The glycemic index for fruit sugar is only 11 for a 25 gram portion. This means then that it is not digested quickly and does not raise insulin levels to any great degree. What this means is that fruit sources are not a good source of carbohydrates for the post-workout drink.

2. ***Dextrose*** - also known as glucose. This can be bought as a powder from various different sources. It has a rating of 96 for a 50 gram portion. This is one of the more common sugars used in post workout shakes. Dextrose is a good choice, however, some users find that they have a spill over effect that results in fat gain, so that makes more of an individual choice as you would have to test it and assess the results.

Disaccharides

1. ***Sucrose*** - this is common table sugar. It's made up of one molecule of glucose and one molecule of fructose. It has a rating of 60 for a 25 gram portion.
2. ***Lactose*** - milk sugar. This has a rating of only 48 for a 25 gram portion.

So as you can see, other than dextrose, most of these sources are not ideal as part of the post workout shake.

COMPLEX CARBOHYDRATES

Maltodextrin - Maltodextrin is actually a complex carbohydrate made from either corn, rice or potato starch, but its molecular chain is shorter than other complex carbs. As well, it consists of loosely bonded glucose molecules. And like dextrose, maltodextrin is absorbed directly through the gut. So it raises blood sugar and insulin levels as much as dextrose does.

However, before maltodextrin can be utilized, it must first pass through the liver for the bonds between the glucose molecules to be broken down. So the rate at which it is used for glycogen replenishment is slower than with dextrose. However, because it is metabolized slower, there will not be as quick of a drop of insulin and blood sugar levels as with dextrose. There appears to be no potential for fat gain from the use of maltodextrin.

Two Good Choices

So here we have two good choices: dextrose and maltodextrin. Each one can be tried to see which one seems to work better for an individual, but what has become a popular approach is to combine dextrose with maltodextrin, in a 50/50 combination. This makes sense because consumption of dextrose by itself can be inferior for several reasons. First, studies show that gastric emptying (the process of digesting and emptying food out of the stomach) is slowed quite a bit when the concentration of dissolved particles in a solution (osmolarity) is raised.

Dextrose, being a single sugar molecule, will raise a solution's osmolarity;, this in effect slows gastric emptying. Combining dextrose with a glucose polymer (a processed form of complex carbohydrates, in this case maltodextrin) allows more even digestion, with no slowing taking place. So this combination will optimize glycogen replenishment, hydration and performance.

This is still a great choice for post workout carbs, although somewhat outdated, considering the new advancements as we will look at next.

ASSESSMENT FOR CARBOHYDRATES

1. What is glycemic index? What are the three types of glycemic index foods?
2. What is a serving or what do you understand by the term serving size? Give few examples.
3. State the formula to calculate the glycemic load.
4. List the various functions of carbohydrates and explain in detail.
5. What is Basal Metabolic Rate and how will you calculate the same?
6. What is a calorie and how will you calculate the number of calories required per day for various types of people based on their activity pattern?
7. How much carbohydrates must be taken per day?
8. Explain the significance of pre- and post- work-out carbohydrates.
9. Explain the significance of glycemic value to the sugar metabolism of the body.
10. What are the different types of carbohydrates?

Student Notes

MACRONUTRIENT: FATS

About Fats

Fats consist of a wide group of compounds that are generally soluble in organic solvents and generally insoluble in water. Chemically, fats are triglycerides: triesters of glycerol and any of several fatty acids. Fats may be either solid or liquid at room temperature, depending on their structure and composition. Although the words "oils", "fats", and "lipids" are all used to refer to fats, in reality, fat is a subset of lipid. "Oils" is usually used to refer to fats that are liquids at normal room temperature, while "fats" is usually used to refer to fats that are solids at normal room temperature. "Lipids" is used to refer to both liquid and solid fats, along with other related substances, usually in a medical or biochemical context, which are not soluble in water. The word "oil" is also used for any substance that does not mix with water and has a greasy feel, such as petroleum (or crude oil), heating oil, and essential oils, regardless of its chemical structure.

Examples of edible animal fats are lard, fish oil, butter/ghee and whale blubber. They are obtained from fats in the milk and meat, as well as from under the skin, of an animal. Examples of edible plant fats include peanut, soya bean, sunflower, sesame, coconut and olive oils, and cocoa butter. Vegetable shortening, used mainly for baking, and margarine, used in baking and as a spread, can be derived from the above oils by hydrogenation.

Classification of fats

SATURATED FATS

These fats are derived from animal products such as meat, dairy and eggs. But they are also found in some plant-based sources such as coconut, palm and palm kernel oils. These fats are solid at room temperature. Saturated fats directly raise total and LDL (bad) cholesterol levels. Conventional advice says to avoid them as much as possible. More recently, some have questioned this, as there are different kinds of saturated fats, some of which have at least a neutral effect on cholesterol.

TRANS FATS OR HYDROGENATED FATS

Transfats are actually unsaturated fats, but they can raise total and LDL (bad) cholesterol levels while also lowering HDL (good) cholesterol levels. Transfats are used to extend the shelf life of processed foods, typically cookies, cakes, fries and donuts. Any item that contains —hydrogenated oil" or —artially hydrogenated oil" likely contains transfats. Hydrogenation is the chemical process that changes liquid oils into solid fats. The tide is turning against transfats. Since January 2006, all food manufacturers are required to list transfat content on food labels.

UNSATURATED FATS

Monounsaturated fats and polyunsaturated fats are two types of unsaturated fatty acids. They are derived from vegetables and plants.

- **Monounsaturated fats** are liquid at room temperature but begin to solidify at cold temperatures. This type of fat is preferable to other types of fat and can be found in olives, olive oil, nuts, peanut oil, canola oil and avocados. Some studies have shown that these kinds of fats can actually lower LDL (bad) cholesterol and maintain HDL (good) cholesterol.
- **Polyunsaturated fats** are also liquid at room temperature. These are found in safflower, sesame, corn, cottonseed and soybean oils. This type of fat has also been shown to reduce levels of LDL cholesterol, but too much can also lower your HDL cholesterol.

OMEGA-3 FATTY ACIDS

These include an —ssential" fatty acid, which means it's critical for our health but cannot be manufactured by our bodies. Good sources of omega-3 fatty acids include cold-water fish, flax seed, soy, and walnuts. These fatty acids may reduce the risk of coronary heart disease and also boost our immune systems.

Unsaturated fats are beneficial for the health of humans . They raise the levels of HDL (High Density Lipoprotiens) which help in fighting against atherosclerosis of the blood vessels and heart diseases .

Function of Fats

- The main function of fats in the body is to provide energy: By supplying energy, fats save proteins from being used for energy and allow them to perform their more important role of building and repairing tissues. Fats on oxidation provide almost twice as much energy as that given by carbohydrates. Fats provide on oxidation about 37 kJ of energy per gram as compared to 17kj of energy per gram of carbohydrates. Fats yield more energy than carbohydrates because fats contain less percentage of oxygen and higher percentage of carbon and hydrogen as compared with carbohydrates.
- Fats can also be stored in body for subsequent use. When we consume food which has more energy than is required by the body for performing various functions, the excess food is deposited under our skin in the form of subcutaneous fat.
- In addition to supplying energy, fats also help in forming structural material of cells and tissues such as the cell membrane.
- Fats also carry the fats soluble vitamins A, D, E and K into the body and help in the absorption of these vitamins in the intestines.
- Some fats supply essential fatty acids.

Essential fatty acids, or EFAs, are fatty acids that humans and other animals must ingest because the body requires them for good health but cannot synthesize them. Only two fatty acids are known to be essential for humans:alpha-linolenic acid (an omega-3 fatty acid) and linoleic acid (an omega-6 fatty acid). Some other fatty acids are sometimes classified as "conditionally essential," meaning that they can become essential under some developmental or disease conditions; examples include docosahexanoic acid (an omega-3 fatty acid) and gamma-linolenic acid (an omega-6 fatty acid).Healthy food sources of fat

"Healthy fats" generally refers to monounsaturated fats or polyunsaturated fats. Some of the healthiest fats are polyunsaturated fats that contain essential fatty acids, or EFAs. There are two types of EFAs, omega-3 and omega-6, but Westerners, especially Americans, tend to consume far too many omega-6 fats, which come from red meat, poultry and dairy products. To maintain a healthy dietary balance, shoppers should know which foods provide omega-3s and which provide monounsaturated fats.

Per day consumption of fats

Dietary guidelines suggest that healthy adults generally limit dietary fat to no more than 20 to 35 percent of total daily calories.

To figure out how many fat grams or calories that means for an individual, start with the number of calories they normally eat or want to eat a day. Multiply that number by the recommended percentages to get the range of fat calories that can be eaten each day.

Here's an example based on a 2,000-calorie-a-day diet.

1. Multiply 2,000 by 0.20 (20 percent) to get 400 calories
2. Multiply 2,000 by 0.35 (35 percent) to get 700 calories

How many fat grams is that? There are 9 calories in a gram of fat, so you divide the number of calories by 9.

1. Divide 400 calories by 9 (calories a gram) to get about 44 grams of fat
2. Divide 700 calories by 9 (calories a gram) to get about 78 grams of fat

So if you're on a 2,000-calorie-a-day diet, 400 to 700 calories can come from dietary fat, which translates to between 44 and 78 fat grams a day.

Use the Nutrition Facts label to find out how much fat is in the foods you eat. The Nutrition Facts label shows the amount of total fat, saturated fat and transfat in one serving. The label also shows how many calories come from fat.

To monitor the fat in the diet, simply add up the fat grams from all the food eaten during the day and compare the total to the target range. Knowing how much fat is in the foods you eat can help control the fat and calories in your diet, which can help meet the health and nutrition goals.

- Avocados
- Canola oil
- Nuts, such as almonds, walnuts
- Nut butters
- Olive oil
- Olives
- Peanut oil
- Benecol spread

Assessment for Fats

1. What are fats?
2. What are the types of fats?
3. What are fats composed of?
4. What are the functions of fats in the human body?
5. Mention some sources of omega fatty acids, after classifying omega fatty acids.

Student Notes

MACRONUTRIENT: WATER Water is a macro nutrient necessary to provide adequate hydration to the body. **46 Reasons why the body needs water everyday**

1. Without water, nothing lives. Without quality water, nothing thrives.
2. Dehydration first suppresses and eventually kills some aspects of the body.
3. Water is the main source of energy – it is the —cash flow" of the body.
4. Water generates electrical and magnetic energy inside each and every cell of the body – it provides the power to live.
5. Water is the bonding adhesive in the architectural design of the cell structure.
6. Water prevents DNA damage and makes its repair mechanisms more efficient – less abnormal DNA is made.
7. Water increases greatly the efficiency of the immune system in the bone marrow, where the immune system is formed (all is mechanisms) – including its efficiency against cancer.
8. Water is the main solvent for all foods, vitamins and minerals. It is used in the breakdown of food into smaller particles and their eventual metabolism and assimilation.
9. Water energizes food, and food particles are then able to supply the body with this energy during digestion. This is why food without water has absolutely no energy value for the body.
10. Water increases the body's rate of absorption of essential substances in food.
11. Water is used to transport all substances inside the body.
12. Water increases the efficiency of red blood cells in collecting oxygen in the lungs.
13. When water reaches a cell, it brings the cell oxygen and takes the waste gases to the lungs for disposal.
14. Water clears toxic waste from different parts of the body and takes it to the liver and kidneys for disposal.
15. Water is the main lubricant in the joint spaces and helps prevents arthritis and back pain.
16. Water is used in the spinal discs to make them —shock absorbing water cushions".
17. Water is the best lubricating laxative and prevents constipation.
18. Water helps reduce the risk of heart attacks and strokes.
19. Water prevents clogging of arteries in the heart and the brain.
20. Water is essential for the body's cooling (sweat) and heating (electrical) systems.
21. Water gives us power and electrical energy for all brain functions, most particularly thinking.
22. Water is directly needed for the efficient manufacture of all neurotransmitters, including serotonin.
23. Water is directly needed for the production of all hormones made by the brain, including melatonin.
24. Water can help prevent attention deficit disorder in children and adults.
25. Water increases efficiency at work; it expands your attention span.
26. Water is a better pick-me-up than any other beverage in the world and it has no side effects.
27. Water helps reduce stress, anxiety and depression.
28. Water restores normal sleep rhythms.
29. Water helps reduce fatigue – it gives us the energy of youth.
30. Water makes the skin smoother and helps decrease the effects of aging.
31. Water gives luster and shine to the eyes.
32. Water helps prevent glaucoma.
33. Water normalizes the blood-manufacturing systems in the bone marrow – it helps prevent leukemia and lymphoma.
34. Water is absolutely vital for making the immune system more efficient in different regions to fight infections and cancer cells where they are formed.
35. Water dilutes the blood and prevents it from clotting during circulation.

36. Water decreases premenstrual pains and hot flashes.
37. Water and heartbeats create the dilution and waves that keep things from sedimenting in the blood stream.
38. The human body has no stored water to draw on during dehydration. This is why you must drink regularly and throughout the day.
39. Dehydration prevents sex hormone production – one of the primary causes of impotence and loss of libido.
40. Drinking water separates the sensations of thirst and hunger.
41. To lose weight, water is the best way to go – drink water on time and lose weight without much dieting. Also, you will not eat excessively when you feel hungry but are in fact only thirsty for water.
42. Dehydration causes deposits of toxic sediments in the tissue spaces, joints, kidneys, liver, brain and skin. Water will clear these deposits.
43. Water reduces the incidence of morning sickness in pregnancy.
44. Water integrates mind and body functions. It increases ability to realize goals and purpose.
45. Water prevents the loss of memory as we age. It helps reduce the risk of Alzheimer‘s disease, multiple sclerosis, Parkinson‘s disease and Lou Gehrig‘s disease.
46. Water helps reverse addictive urges, including those for caffeine, alcohol and some drugs

Daily water requirements for a person

WEIGHT TIMES TWO

Calorie-burning and total body weight also play a role in daily water needs. Someone who is overweight requires more water per day than someone who is at his ideal weight. According to the University of California, Irvine, a simple way to determine how much water you need per day is to divide your weight by two. The quotient represents how much water your body requires each day in ounces. For instance, if you weigh 200 pounds, 100 oz. of water per day will keep you well hydrated.

DEHYDRATION

Failure to drink enough water leads to dehydration. Symptoms of mild dehydration include flushness, unquenchable thirst, weakness, dizziness, dark urine, cramps and headache. If left to continue, the symptoms of dehydration become more severe. Signs and symptoms of severe dehydration include faintness, low blood pressure, bloating, rapid breathing and convulsions. Once diagnosed, dehydration requires immediate attention with water and electrolyte replacement. Slow sips of water and oral rehydration solutions replace what the body has lost.

WATER OVERDOSE

Drinking too much water each day may lead to a condition known as *hyponatremia*. Hyponatremia may produce seizures and coma. In extreme cases, the condition can be fatal. While hyponatremia can happen to anyone who drinks water in excess, athletes are more prone to the condition as they try to compensate for water lost during exercise. Symptoms of hyponatremia include headache, nausea, vomiting, bloating, dizziness and confusion. Immediate medical attention is required.

Assessment for Water

- List 10 reasons as to why water is essential for living.
- What is dehydration and what are the symptoms of dehydration? How can you treat dehydration?
- What is water overdose called? And what are the symptoms of water overdose? What action should be taken when you suspect water overdose?
- How will you calculate the required water intake for a person?

Student notes

MICRONUTRIENT: VITAMINS

The Essential VITAMINS

There are two types of vitamins, fat soluble vitamins (vitamins which dissolve in fat), which are vitamins A, D, E and K, and Water soluble vitamins which are B complex, C, and folate (folic acid).

Fat soluble vitamins

Vitamin	Function	Deficiency Signs	Great Natural Sources
Vitamin A	Growth, development, enhancement of our immune system, this vitamin is essential for our eyesight, especially night vision.	Night blindness, skin problems with an increase in the rate of acquiring infections	liver, kidney, eggs and fish liver oil.
Vitamin D	This is important for bone formation, it works by controlling calcium absorption and excretion. Recent studies show that vitamin D inhibits some forms of cancer growth.	Rickets (disease characterized by deformities in the skeleton -- especially hands, legs and chest bones, and pain in the bones and muscle weakness).	Cod liver oil, milk, eggs, liver and oily fish.
Vitamin E	It works as an antioxidant (protects our tissues from free-radical damage) and has other functions such as improving blood circulation and removing wound scars.	none reported	wheat germ oil, almonds, sun flower oil and peanuts.
Vitamin K	Its major function is its role in the blood coagulation process which prevents our body from bleeding to death.	Excessive bleeding or poor blood coagulation action.	Great natural sources - spinach, broccoli, eggs and meat.

Water soluble vitamins

Vitamin	Function	Deficiency Signs	Great Natural Sources
Vitamin C	It plays a vital role in the formation of several enzymes, absorption of iron, antioxidant function, formation of collagen (which leads to healthy skin and joints) and wound healing.	Scurvy (a disease characterized by bleeding from the gums, bleeding from the skin, fatigue and delayed wound healing).	Kiwi and citrus fruits, guava, mango and broccoli.
Vitamin B complex	A complex of vitamins that total more than ten individual nutrients; the most essential being B1 (Thiamine), B2 (Riboflavin), B3 (Niacin), B5 (Pantothenic acid), B6 (Pyridoxine) and B12 (Cyanocobalamin). These vitamins play an important role in the body's energy production, nervous system, immune system, and iron absorption.	Vitamin B12 anemia (a disease characterized by fatigue, pallor, an increased heart beat rate and lack of energy). Some other signs include emotional disturbance, skin disease, tongue inflammation and hair loss.	Meat, liver, milk, yeast and its products, nuts and whole grain cereals.

Folic acid	Essential in the formation of RNA and DNA.	Megaloblastic anemia (a disease characterized by fatigue, pallor, increased heart beat rate and lack of energy) and possible infertility.	spinach, Brussels sprouts, green beans and cauliflower.

MICRONUTRIENT: MINERALS

The Essential MINERALS

Minerals are classified into three parts: **macro, trace**, and **ultra- trace** minerals. The essential minerals, which we need to be healthy are calcium, phosphorus, magnesium, sodium, potassium, iron, zinc, and fluorine. The essential trace elements are copper, chromium, manganese, molybdenum, selenium and iodine.

The functions of the most important essential minerals:

Mineral	Function	Deficiency Signs	Great Natural Sources
Calcium	Plays an important role in bone and teeth formation and nervous system health.	Leads to stunted growth, increased rate of bone fractures and nervous system problems.	Milk
Iron	Plays an important role in red blood cell formation.	Leads to iron deficiency anemia which is characterized by fatigue, pallor, concave nails with white lines and an increased heart beat rate.	eggs, meat, liver and fish
Zinc	Essential for growth and development, enhances immune function and wound healing, increases fertility.	Leads to skin inflammation, hair loss, sore throat, delayed growth and diarrhea.	Meat, vegetables with leaves, whole grains, milk and eggs.

MINERAL	FUNCTIONS	SOURCES	RESULTS OF DEFICIENCY
Calcium (Ca)	Formation of bones and teeth, blood clotting, nerve conduction, muscle contraction	Dairy products, eggs, green vegetables, legumes (peas and beans)	Rickets, tetany, osteoporosis
Phosphorus (P)	Formation of bones and teeth; found in ATP, nucleic acids	Meat, fish, poultry, egg yolk, dairy products	Osteoporosis, abnormal metabolism
Sodium (Na)	Fluid balance; nerve impulse conduction, muscle contraction	Most foods, especially processed foods, table salt	Weakness, cramps, diarrhea, dehydration
Potassium (K)	Fluid balance, nerve and muscle activity	Fruits, meats, seafood, milk, vegetables, grains	Muscular and neurologic disorders
Chloride (Cl)	Fluid balance, hydrochloric acid in stomach	Meat, milk, eggs, processed foods, table salt	Rarely occurs
Iron (Fe)	Oxygen carrier (hemoglobin, myoglobin)	Meat, eggs, fortified cereals, legumes, dried fruit	Anemia, dry skin, indigestion
Iodine (I)	Thyroid hormones	Seafood, iodized salt	Hypothyroidism, goiter
Magnesium (Mg)	Catalyst for enzyme reactions, carbohydrate metabolism	Green vegetables, grains, nuts, legumes	Spasticity, arrhythmia, vasodilation
Manganese (Mn)	Catalyst in actions of calcium and phosphorus; facilitator of many cell processes	Many foods	Possible reproductive disorders
Copper (Cu)	Necessary for absorption and use of iron in formation of hemoglobin; part of some enzymes	Meat, water	Anemia
Chromium (Cr)	Works with insulin to regulate blood glucose levels	Meat, unrefined food, fats and oils	Inability to use glucose
Cobalt (Co)	Part of vitamin B12	Animal products	Pernicious anemia
Zinc (Zn)	Promotes carbon dioxide transport and energy metabolism; found in enzymes	Meat, fish, poultry, grains, vegetables	Alopecia (baldness); possibly related to diabetes
Fluoride (F)	Prevents tooth decay	Fluoridated water, tea, seafood	Dental caries

The functions of the most important essential trace minerals

Mineral	Function	Deficiency Signs	Great Natural Sources
Iodine	This is essential for growth and development because it is a component of thyroid hormones.	Goiter (a disease characterized by an enlarged thyroid gland and a decreased heart beat rate).	Milk, sea fish, and iodized salt.
Chromium	Assists in glucose utilization by enhancement of insulin action.	Weight loss and an inability to tolerate glucose.	Meat, whole grains and nuts.

You can use the best natural sources of vitamins and minerals in your daily routine, the most important components are: milk, eggs, vegetables, fish and whole grain cereals.

RECOMMENDED DAILY ALLOWANCES FOR MICRONUTRIENTS

For each micronutrient: Recommended daily allowances of iodine, chromium , zinc , iron , calcium, B-complex, Vitamin C , vitamin Vitamin E.

Fat Soluble Vitamins

	Age	Energy	Protein	Vitamin A	Vitamin D	Vitamin E	Vitamin K			
		k. cal	g	IU	*ug RE	IU	*ug	IU	*mg TE	*ug
Children	4-6	1,800	30/24	2,500	500	400	5	9	7	-/20
	7-10	2,400/2,000	36/28	3,300	500	400	5	10	7	-/30
Males	15-18	3,000	54/59	5,000	1,000	400	5	15	10	-/65
	19-24	3,000/2,900	54/58	5,000	1,000	400	5	15	10	-/70
	25-50	2,700	56/63	5,000	1,000	-	5	15	10	-/80
	50+	2,400	56/63	5,000	1,000	-	10	15	10	-/80
Females	15-18	2,100	48/44	4,000	800	400	5	12	8	-/55
	19-24	2,100	46/46	4,000	800	400	5	12	8	-/60
	25-50	2,000	46/50	4,000	800	-	5	12	8	-/65
	50+	1,800	46/50	4,000	800	-	10	12	8	-/65

* first figure refers to the old RDA listing while the second figure refers to the newer DRI listing

Water Soluble Vitamins

	Age	Ascorbic Acid	Folacin/ Folate	Niacin	Riboflavin	Thiamine	Vitamin B6	Vitamin B12
		mg	mcg	mg	mg	mg	mg	mcg
Children	4-6	40/45	200/75	12	1.1	0.9	0.9/1.1	1.5/1.0
	7-10	40/45	300/100	16/13	1.2	1.2/1.0	1.2	2.0/1.4
Males	15-18	45/60	400/200	20	1.8	1.5	2.0	3.0/2.0
	19-24	45/60	400/200	20/19	1.8/1.7	1.5	2.0	3.0/2.0
	25-50	45/60	400/200	18/19	1.6/1.7	1.4/1.5	2.0	3.0/2.0
	50+	45/60	400/200	16/15	1.5/1.4	1.2	2.0	3.0/2.0
Females	15-18	45/60	400/180	14/15	1.4/1.3	1.1	2.0/1.5	3.0/2.0
	19-24	45/60	400/180	14/15	1.4/1.3	1.1	2.0/1.6	3.0/2.0
	25-50	45/60	400/180	13/15	1.2/1.3	1.0/1.1	2.0/1.6	3.0/2.0
	50+	45/60	400/180	12/13	1.1/1.2	1.0	2.0/1.6	3.0/2.0

* firstFirst figure refers to the old RDA listing while the second figure refers to the newer DRI listing

Minerals and others*

	Age	Calcium	Phosphorous	Iodine	Iron	Magnesium	Zinc	Selenium	Fluoride
		mg	mg	ug	mg	mg	mg	*ug	*mg
Children	4-6	800	800/500	80/90	10	200/130	10	-/20	-/1.1
	7-10	800	800	110/120	10	250	10	-/30	-/3.2
Males	15-18	1200/1300	1200/1250	150	18/12	400/410	15	-/50	-/3.8
	19-24	800/1000	800/700	140/150	10	350/400	15	-/70	-/3.8
	25-50	800/1000	800/700	130/150	10	350/420	15	-/70	-/3.8
	50+	800/1200	800/700	110/150	10	350/420	15	-/70	-/2.9
Females	15-18	1200/1300	1200/1250	115/150	18/15	300/360	15/12	-/50	-/3.1
	19-24	800/1000	800/700	100/150	18/15	300/310	15/12	-/55	-/3.1

	25-50	800/1000	800/700	100/150	18/15	300/320	15/12	-/55	-/3.1
	50+	800/1200	800/700	80/150	10	300/320	15/12	-/55	-/3.1

* First figure refers to the old RDA listing while the second figure refers to the newer DRI listing - age groups have also been changed on certain nutrients to range from 9-13, 14-18,19-30,31-50, 51-70 and 71+ - figures above merely for illustration and information.

Note: *Please be advised that these tables above must not be used to treat or diagnose - they are merely brought to you for information, in order to give you a better understanding on the dynamics involved, and the changing importance of vitamins and nutrition as well as their importance in maintaining optimum health.*

ASSESSMENT FOR MICRONUTRIENTS

1. What are the various types of micronutrients?
2. What are the various types of vitamins?
3. Draw a table to list the sources of various vitamins and effect of their deficiency.
4. Explain the various types of minerals that are required for the human body and their significance.

Student Notes

SPORTS SUPPLEMENTS

OBJECTIVE OF THIS LESSON

At the end of this lesson you will be able to:

→ Recognize the role of body building supplements
→ Define ergogenic aids and understand their functions
→ Explain the male and female hormones, their effects and how their levels can be increased or decreased
→ Explain more about whey protein, how it is produced, its composition, major forms, and its muscle building activity and other health effects
→ Define creatine, arginine or nitric oxide and caffeine and understand their influence on the human body
→ Explain the concept of mass gainers, body fat percentage and bio-electrical impedence

WHAT ARE SPORTS SUPPLEMENTS?

Bodybuilding supplements are dietary supplements commonly used by those involved in bodybuilding and athletics. Bodybuilding supplements may be used to replace meals, enhance weight gain, promote weight loss or improve athletic performance. Among the most widely used are vitamin supplements, protein, branched-chain amino acids (BCAA), glutamine, essential fatty acids, meal replacement products, creatine, weight loss products and testosterone boosters. Supplements are sold either as single ingredient preparations or in the form of "stacks" - proprietary blends of various supplements marketed as offering synergistic advantages. While many bodybuilding supplements are also consumed by the general public their salience and frequency of use may differ when used specifically by bodybuilders.

WHAT ARE ERGOGENIC AIDS?

Ergogenic aids are a general category of substances that enhance performance, and this usually refers to athletic performance. This can refer to biological substances that enhance endurance, or it can refer to high tech materials that are thought to enhance speed, such as a specific type of material that would help a swimmer race faster. Ergogenic aids can also include psychological aids, which can include relaxation techniques prior to an event or imagery that allows for better performance. This can also refer to a specific training method.

The most widely known ergogenic aids are pharmacological substances. Many of these aids are banned from athletic events, and athletes must take blood tests to ensure they have not taken these substances. The most commonly abused ergogenic aids are **anabolic steroids**, which are basically male hormones. These steroids build muscle and greatly increase muscle strength.

Other pharmacological ergogenic aids include human growth hormone. This hormone is produced naturally in the body and tends to taper off as a person ages, and its loss has been associated with the muscle atrophy that occurs naturally over a person‘s lifetime. At very high levels, this hormone can increase muscle size and strength.

MALE AND FEMALE HORMONES

Ways to increase the male hormone Testosterone

1. **GET MORE ZINC**
   Zinc is very important for the production of natural testosterone because zinc prevents testosterone from being converted into estrogen (the female hormone) by making the enzyme aromatase not work (look at #3 below). Also, zinc itself turns estrogen into testosterone and zinc helps produce healthier sperm and higher sperm counts. So actually, lw levels of zinc can cause low testosterone levels.

   Foods high in zinc include oysters (a natural aphrodisiac), liver, seafood, poultry, nuts & seeds or you can supplement with at least 50-to-100mg of zinc daily.

2. **EAT MORE HEALTHY FATS**
   Research has shown that men who ate diets rich in healthy fats like monounsaturated fats & Omega-3 fats had the highest testosterone levels. One can naturally raise testosterone levels by adding more healthy fats. Eating more nuts & seeds, fatty fish like salmon & tuna, avocados, olives, vegetable oils, and natural peanut butter. Eating a very low-fat diet can actually lead to lowered testosterone levels because your body needs healthy fats in order to produce testosterone But this doesn't mean you need to eat a REAL HIGH fat diet. - Just make sure at least 20-to-30% of the total daily calories come from healthy fats.

3. **LOSE BODY FAT**
   - The more overweight an individual is or the higher the body fat percentage is, then the higher the estrogen levels will be because body fat contains an enzyme called aromatase that converts the 'manly' testosterone into 'womanly' estrogen making testosterone levels drop. Dieting or cutting too many calories when trying to lose body fat will cause the body to go into starvation or survival mode. This will cause the body to stop making testosterone.
   - So whenever the goal is to lose fat & increase testosterone at the same time ensure that 1-to-3 pounds of fat a week is shed mainly through fat loss workouts and a basic diet plan.

4. **GET RID OF EXCESS ESTROGEN**
   Estrogen makes you fatter & weaker so your body can naturally produce more testosterone….
   - Eating more RAW raw cruciferous vegetables like broccoli, cabbage, and cauliflower because cruciferous vegetables contain a chemical called di-indolylmethane (or DIM) that helps the body get rid of excess estrogen.
   - Supplementing with DIM helps to flush out excess estrogen in a similar manner to eating cruciferous vegetables like brussels, brussel sprouts, bok choi, radishes, turnips, collard greens, and kale.
   - It is advisable to eat more fiber to naturally cleanse your body and flush out toxins that cause you to have excess estrogen (like the xenoestrogens from #5 below). Most fruits & vegetables, nuts & beans are all high in fiber and can be also supplemented with d grape skin extract (resveratrol) to help the liver remove excess estrogen.

5. **TRY TO AVOID XENOESTROGENS**
   - Xenoestrogens are man-made estrogens that are found in things like pesticides, artificial growth hormones & steroids, air fresheners and plastic containers and these xenoestrogens will increase the levels of the female hormone estrogen while lowering testosterone. It is advisable to eat more organic fruits & vegetables that are free of pesticides Vegetables purchased from a regular grocery store should be washed to lower the chances of consuming any xenoestrogens.

- It is advisable to eat more naturally raised meats instead of eating beef, chicken, pork and even milk that was raised using artificial growth hormones and steroids.
- It is advisable to use glass products to store food & water instead of plastic. Plastic products tend to produce xenoestrogens thatget into the water & food especially when heated.
- Even some canned foods contain plastic coatings that contain xenoestrogens. It is advisable to not use any perfumes, colognes, or air fresheners that have parabens listed as one of the ingredients. Parabens are xenoestrogens.

Please note: It'll be fairly hard to 100% completely avoid all xenoestrogens Also note: Since most xenoestrogens accumulate in your body fat - your best defense against xenoestrogens is to lose body fat (look at #3 again).

6. **GET AT LEAST 6-TO-8 HOURS OF SLEEP EVERY NIGHT**
   - A university of Chicago study showed that men who got little sleep had way lower testosterone levels than men who got 6-to-8 hours of sleep. ,
   - Your testosterone levels can drop down by as much as 40 PERCENT when you don't get enough sleep and generally your testosterone levels are 30% higher in the morning than in the evening
   - A loss of morning erections or loss of sexual desire in the morning could be a sign that your testosterone is declining.
   - While sleeping, the body produces the most testosterone and the better you sleep the more testosterone your body.

7. **STRESS LESS**
   - Under stress the body releases a "stress" hormone called cortisol that shuts down testosterone production.
   - Research led by Population Council endocrinologist Matthew Hardy found that stress hormones like cortisol overpower the enzymes responsible for ensuring that cells in the testes produce testosterone.
   - Cortisol also makes you gain belly fat it is established that the fatter you are = you'll have more estrogen and less testosterone.
   - Trying to avoid worrying about the little things, avoid overtraining, controlling the temper can help avoid stress. Being more positive can reduce your stress levels and increase testosterone.
   - A recent study found that fans of a losing team had 50 percent lower levels of testosterone after their team lost and fans had up to 100% higher levels of testosterone after their team won.
   - Taking a natural supplement like Ashwagandha can also help reduce cortisol.

8. **TAKE 1000-TO-1500MG OF VITAMIN C PER DAY**
   If stress is unavoidable it is recommended to take 1000-to-1500mg of Vitamin C per day because Vitamin C has been shown to lower cortisol levels allowing the body to make more testosterone and like Zinc Vitamin C reduces the armostase enzyme that converts the testosterone into estrogenestrogen.

9. **WORKOUT LIKE A MAN**
   - You can force the body to produce a lot of testosterone with compound and power exercises that train several large muscle groups like Power Cleans, Squats, Bench presses, Deadlifts, Chin-ups, Dips, and Military presses and isolation exercises like triceps extensions, bicep curls or chest flyes for definition.
   - If trying to boost testosterone and build more muscle quickly, - it is better to stick with compound exercises. To get the biggest boost in testosterone when you do your compound exercises, ensure that you use heavy weights that will allow only about 3-to-5 reps per set and do about 5-to-8 sets of each compound exercise you do.

- Limit the workout time on those compound exercises to 1-to-2 hours. it is better to do 1-to-2 compound exercises followed by a few optional isolation exercises twice a week (Mon. & Thur. for example).
- Cardio workouts like hill sprints and intervals 3-to-4 times a week are preferably over long walks or runs, which can be limited to only 2 times a week.
- Ensure that rest surpasses work out because overtraining leads to more cortisol and lower testosterone and 8+ hours of sleep is required to allow the body to recuperate and produce more testosterone after the work out.

10. **ENSURESUFFICIENT INTAKE OF VITAMIN A, B & E**
    Vitamins A , B & E (along with Vitamin C & zinc) are all essential in the production of testosterone and not getting enough A, B, & E Vitamins will lead to lower testosterone levels but…
    iIf you're eating plenty of fruits & veggies, lean meats and nuts then you shouldn't have to worry too much about supplementing with any extra A, B, & E Vitamins.

11. **DON'T DRINK ANY ALOCHOL & DON'T EAT ANY GRAPEFRUIT**
    Even if only 2 drinks a day are consumed, alcohol makes it hard for the liver to breakdown estrogen making the individual have more estrogen & less testosterone. Alcohol decreases zinc levels in your body (look at #1 again) and just like alcohol - grapefruits can also make it hard for your liver to breakdown estrogen.

12. **BOOST TESTOSTERONE 40% WITH D-ASPARTATE**
    - D-Aspartate is an amino acid that's produced in your pituitary gland and your testicles and it boosts the production of testosterone.
    - D-Aspartate also increases sperm production and the Journal of Reproductive Biology and Endocrinology reported that men taking 3 grams of D-Aspartate every morning increased their testosterone by 40%.

WHEY PROTEIN

Whey protein is a mixture of globular proteins isolated from whey, the liquid material created as a by-product of cheese production. Some preclinical studies in rodents have suggested that whey protein may possess anti-inflammatory or anti-cancer properties. The effects of whey protein on human health are of great interest and are currently being investigated as a way of reducing disease risk, as well as a possible supplementary treatment for several diseases.

Whey protein is commonly marketed and ingested as a dietary supplement, and various health claims have been attributed to it in the alternative medicine community. Although whey proteins are responsible for some milk allergies, the major allergens in milk are the caseins.

Production

Whey is left over when milk coagulates and contains everything that is soluble from milk. It is a 5% solution of lactose in water, with some minerals and lactalbumin. It is removed after cheese is processed. The fat is removed and then is processed for human foods. Processing can be done by simple drying, or the protein content can be increased by removing lipids and other non-protein materials. For example, spray drying after membrane filtration separates the proteins from whey.

Whey can be denatured by heat. High heat (such as the sustained high temperatures above 72 °C associated with the pasteurization process) denatures whey proteins. While native whey protein does not aggregate upon renneting or acidification of milk, denaturing the whey protein triggers hydrophobic interactions with other proteins, and the formation of a protein gel. Heat-denatured whey can still cause allergies in some people.

Composition

Whey protein is the collection of globular proteins isolated from whey, a by-product of cheese manufactured from cow's milk. The protein in cow's milk is 20% whey protein and 80% casein protein, whereas the protein in human milk is 60% whey and 40% casein. Whey protein is typically a mixture of

beta-lactoglobulin (~65%), alpha-lactalbumin (~25%), and serum albumin (~8%), which are soluble in their native forms, independent of pH. The protein fraction in whey (approximately 10% of the total dry solids within whey) comprises four major protein fractions and six minor protein fractions. The major protein fractions in whey are beta-lactoglobulin, alpha-lactalbumin, bovine serum albumin, and immunoglobulins.

Major forms

Whey protein typically comes in three major forms: concentrate (WPC), isolate (WPI), and hydrolysate (WPH).

- Concentrates have typically a low (but still significant) level of fat and cholesterol but, in general, have higher levels of bioactive compounds, and carbohydrates in the form of lactose — they are 29%–89% protein by weight.
- Isolates are processed to remove the fat, and lactose, but are usually lower in bio-activated compounds as well — they are 90%+ protein by weight. Like whey protein concentrates, whey protein isolates are mild to slightly milky in taste.
- Hydrolysates are whey proteins that are predigested and partially hydrolyzed for the purpose of easier metabolizing, but their cost is generally higher. Highly-hydrolysed whey may be less allergenic than other forms of whey.

Whey protein and muscle building

The effects of whey protein supplementation on muscle growth in response to resistance training are debatable. One study demonstrated some increase in lean body mass and strength in men supplementing whey protein vs. no supplementation while another study found greater increases in strength in a group supplementing whey compared to another group supplementing casein, which could be evidence of whey protein's superior amino acid profile. However, other research exists that show little to no benefit of whey protein supplementation. The authors of one study concluded that "young adults who supplement with protein during a structured resistance training program experience minimal beneficial effects in lean tissue mass and strength", although it did not control for other sources of protein in the participant's diets. The timing of protein supplement ingestion may not have any significant effects on strength, power, or body-composition. A study of elderly men found supplementation with whey protein after exercise improved muscle protein synthesis.

Health effects

The use of whey protein as a source of amino acids and its effect on reducing the risks of diseases such as heart disease, cancer and diabetes is the focus of ongoing research. Whey is an abundant source of branched-chain amino acids (BCAAs), which are used to fuel working muscles and stimulate protein synthesis. In particular, leucine plays a key role in initiating the transcription of protein synthesis. When leucine is ingested in high amounts, such as with whey protein supplementation, there is greater stimulation of protein synthesis, which may speed recovery and adaptation to stress (exercise).

Whey protein contains the amino acid cysteine, which can be used to make glutathione. However, this amino acid is not essential for the synthesis of glutathione, and some studies have suggested that the amount of cysteine in the diet may have little effect on glutathione synthesis. However, another study suggested that large amounts of whey protein can increase cellular glutathione levels. Glutathione is an antioxidant that defends the body against free radical damage and some toxins, and studies in animals have suggested that milk proteins might reduce the risk of cancer.

Digestive issues

Some people experience severe digestive issues following consumption of whey protein powder. These may include gas, bloating, cramps, tiredness, weakness, fatigue, headaches, and irritability. One of the possible causes is lactose intolerance after they ingest whey concentrate. Undigested protein in the colon will undergo bacterial fermentation which leads to the production of, among other things, gas and fatty acids.

CREATINE

Creatine is a nitrogen-containing compound stored mainly as phosphocreatine in muscle tissue and the rest can be found as free creatine. Every day the body breaks down about 1-2% of the creatine pool, approximately 2 grams, into creatinine, which is excreted in urine.

We eat it in fish and meat. A pound of uncooked beef contains approximately 1-2 grams of creatine. And, we can also make about 1-2 grams of creatine daily from the amino acids glycine, arginine and methionine. Because dietary sources of creatine are found in animal flesh, some reports indicate that vegetarians have lower creatine stores in their muscle tissue than non-vegetarians.

Supplementing Creatine

Take 0.3 grams creatine per kilogram body weight for 5-7 days (5 grams four times per day for instance) to saturate creatine stores. After this period, take 3-5 grams per day to maintain stores.

How Creatine Supplements Enhance Health

- **Creatine May Boost Athletic Performance:** We know it can increase your one rep max bench press and make an athlete more explosive. But, did you know this could translate to enhanced self-esteem? When you look better, you feel better about yourself. And, physical activity itself is one of nature's best mood lifters.

- **Creatine May Help Lipid Metabolism:** The research on creatine and lipid metabolism is in the infancy stages. However, one study found that it helped decrease total cholesterol and very low-density lipoprotein cholesterol (the worst kind). Hopefully future research will examine changes in blood lipids with creatine supplementation.

- **Creatine Can Make an Athlete More Explosive.**

- **Congestive Heart Failure:-** Creatine may improve some of the symptoms in people with congestive heart failure. Supplementation may improve exercise tolerance and in one study, creatine given via IV improved cardiac function*.

- **Muscular Dystrophy:** Some studies indicate that creatine supplementation can improve muscle strength and activities of daily life in patients with muscular dystrophies.

- **Parkinson's Disease:** Studies in early Parkinson's disease patients indicate that creatine may help slow the rate of disease progression. Creatine may also improve strength and the results from physical therapy in patients with Parkinson's.

Additional Tips to Enhance Your Health

Creatine can help build a great body. In fact, that is the most noted benefit from consuming this supplement. It can help an individual work harder in the gym by providing a substrate necessary for the production of energy and when working harder builds strength, size and power. But, creatine does more than just help build a strong body.

It may help many people who suffer from debilitating diseases. In fact, clinical trials are currently examining how creatine may help people with Huntington's disease, Parkinson's disease, statin related myopathy, Amyotrophic Lateral Sclerosis and more. See www.clinicaltrials.gov for more information on these trials.

Studies indicate that creatine monohydrate is safe when taken in appropriate doses daily for a period of 1-5 years. It doesn't make sense to take it in high doses, above what the body needs, because the rest is excreted after skeletal muscle stores are saturated.

Studies Indicate That Creatine Monohydrate Is Safe When Taken In Appropriate Doses Daily For A Period Of 1-5 Years

It is advisable to consult a physician about any supplements, medicines and over the counter drugs you are taking (doses, frequency, and brand name). People with kidney disease or dysfunction should speak with their physician first, prior to taking creatine. Anyone else with a particular disease mentioned here or not mentioned here should consult with his or her physician first, prior to taking creatine.

ARGININE

Arginine is a conditionally essential amino acid that is involved in protein synthesis, the detoxification of ammonia, and its conversion to glucose as well as being catabolized to produce energy. In addition to these physiological functions, arginine has been reported to have ergogenic potential. Athletes have taken arginine for three main reasons:

1) Its role in the secretion of endogenous growth hormone
2) Its involvement in the synthesis of creatine
3) Its role in augmenting nitric oxide

Healthy adults usually do not need to take additional arginine, because their bodies produce enough for their daily needs. Bodybuilders and athletes who wish to increase growth hormone levels must take at least 3 g daily to stimulate pituitary activity. A common arginine dose is 2 to 3 g taken 3 times daily. Daily doses up to 16 g have been used in clinical studies, but such high amounts can lead to nausea, abdominal pain, diarrhea, low blood pressure and problems with balance and walking. Children and teenagers should not take arginine supplements, and diabetics should consult with their doctors before taking extra arginine.

NITRIC OXIDE

Nitric oxide (NO) is an important signaling molecule that acts in many tissues to regulate a diverse range of physiological and cellular processes. Its role was first discovered by several groups who were attempting to identify the agent responsible for promoting blood vessel relaxation and regulating vascular tone. Nitric oxide has now been demonstrated to play a role in a variety of biological processes including neurotransmission, immune defense, the regulation of cell death and cell motility.

The main ingredient of nitric oxide supplements is the amino acid arginine. Taking too much arginine may lead to a feeling of tiredness or weakness, diarrhea and nausea. No clear dosage guidelines have been set for supplementing with arginine, so you must assess your own tolerance levels.

Here's how you assess your tolerance: You take a small dosage for 1 week, assess the effects and results, then adjust your dosage accordingly. Using this method will minimize side effects and help you to find your optimal dose. Each nitric oxide supplement comes with clear instructions about dosages.

CAFFEINE

- Caffeine may be the most widely used stimulant in the world. It is found in a variety of plants, dietary sources (including coffee, tea, chocolate, cocoa, and colas), and non-prescription medications.
- The average caffeine consumption in the USA is approximately 2 cups of coffee per day (200 mg); 10% of the population ingests more than 1000 mg per day. Caffeine is a socially acceptable, legal drug consumed by all groups in society.
- Caffeine is often referred to as a nutritional ergogenic aid, but it has no nutritional value. Ingested caffeine is quickly absorbed from the stomach and peaks in the blood in 1-2 hours.

- Caffeine has the potential to affect all systems of the body, as it is absorbed by most tissue. The remaining caffeine is broken down in the liver and byproducts are excreted in urine.
- Caffeine ingestion (3-9 mg/kg body weight) prior to exercise increases performance during prolonged endurance exercise and short-term intense exercise lasting approximately 5 minutes in the laboratory. These results are generally reported in well-trained elite or recreational athletes, but field studies are required to test caffeine‘s ergogenic potency in the athletic world.
- Caffeine does not appear to enhance performance during sprinting lasting less than 90 seconds, although research in this area is lacking. The mechanisms for improved endurance have not been clearly established. Muscle glycogen sparing occurs early during endurance exercise following caffeine ingestion but it is unclear whether this is due to increased fat mobilization and use by the muscle.
- The positive effect of caffeine during exercise lasting approximately 5 minutes is not related to the sparing of muscle glycogen.
- The ergogenic effects of caffeine are present with urinary caffeine levels that are well below the IOC allowable limit (12 ug/ml). This raises ethical issues regarding caffeine use in athletics. Should the practice be condoned, as it is legal, or should it be discouraged, as it promotes the —doping mentality” and may lead to more serious abuse? One solution would be to add caffeine to the list of banned substances, thereby requiring athletes to abstain from caffeine ingestion 48-72 hours prior to competition and discouraging its use as a doping agent to increase performance in the average population.

(American College of Sports Medicine by
Lawrence L. Spriet, Ph.D., FACSM (Chair) and Terry E. Graham, Ph.D., FACSM)

MASS GAINERS

In order to build muscle mass an individual needs to be consuming more calories than are burnt, every day. Weight gainers are an easy way to get a good serving of quality whey protein, complex carbohydrates and fats. Weight gainers are very versatile and can be used at any time of the day, for the post workout shake, and for meal replacements. If the objective is to gain weight and muscle mass fast, then a good quality weight gainer is just what you need.

WHAT IS BIOELECTRICAL IMPEDANCE ANALYSIS?

Bioelectrical impedance measures the resistance of body tissues to the flow of a small, harmless electrical signal. The proportion of body fat can be calculated as the current flows more easily through the parts of the body that are composed mostly of water (such as blood, urine & muscle) than it does through bone, fat or air. It is possible to predict how much body fat a person has by combining the bioelectric impedance measure with other factors such as height, weight, gender, fitness level and age.

Another relatively common way to measure body fat percentage is called bioelectrical impedance analysis (BIA). BIA sends a low-voltage electrical current through the body, then measures the time it takes for the signal to return to the source. Because fat is a poor conductor of electricity, the longer this takes, the higher one's body fat percentage. BIA is accurate to within 3%, but the subject must fulfill a variety of pre-test measures: fasting for at least 4 hours prior to the test; no exercise for at least 12 hours beforehand; urinating prior to the test; and no alcohol or diuretics for up to 48 hours before the test is performed.

NORMAL BODY FAT PERCENTAGE

Fat Percentage in Men

On an average, men typically fall into a body fat range of 17 to 19 percent. This is slightly higher than the recommended amount. The optimal body fat level for men is between 13 to 17 percent. Percentages less than this amount are acceptable when it comes to athletes. However, falling below the desired levels could mean you are underweight, which can be just as dangerous as being overweight.

Fat Percentage in Women

Typically women have more body fat than their male counterparts. Women are designed to store more fat for childbearing purposes. When comparing a woman and man of the same height and weight, the woman is likely to have more fat. This is not always the case, however, as fitness levels play a large role in body fat percentage. The average woman falls into a body fat percentage of 22 to 25. Like men, this is slightly higher than recommended. A healthy body fat measurement for women is between 20 and 21 percent.

ASSESSMENT

1. What are body building supplements?
2. What are ergogenic aids? Why are they banned in sports events?
3. Which hormone promotes a well-built body? How will you enhance this hormone?
4. What is whey protein? How is it produced?
5. What is the composition of whey protein? Describe the major forms of whey protein.
6. How does whey protein build muscles?
7. How does creatine beneficial to the body?
8. What is argine and what is its effect on the human body?
9. What are the sources of caffeine? How does it affect your work out?
10. Compare and contrast the fat percentage in men and women.
11. What is bio-electrical impedance? Why is it significant in a body-building context?

Student Notes

PLANNING A BALANCED DIET

OBJECTIVE OF THIS LESSON

At the end of this lesson you will be able to:

→ Define meal planning
→ List the factors affecting meal planning
→ Outline the principles of meal planning
→ Apply this understanding of meal planning for various groups of healthy people and with special medical/lifestyle/life-phase needs

INTRODUCTION TO MEAL PLANNING

Meal Planning involves the right selection of foodstuffs, bringing variety in their color, taste and flavor to provide such a satisfactory meal, within the limits of time, money and energy, which can fulfill the nutritional needs of the people who eat it.

FACTORS AFFECTING MEAL PLANNING

The following factors will impact the effectiveness of a meal plan:

Nutritional Adequacy

This is the most important factor, which means that the nutritional requirements of all the family members are fulfilled. For example, you know a growing child needs more protein, a pregnant or lactating woman needs calcium, etc. While planning meals you will include food items from various food groups, that is, energy giving foods, body building foods and protective and regulating foods.

Age

People normally eat according to their age. You must have observed in your family that the diet of various members of different age groups differs in quantity. A new born baby drinks only milk, a small child‘s meal is also of very small quantity, an adolescent eats still more in amount and variety of foods. Similarly, you must have seen your grandfather eating less food and also that they prefer soft and easy to digest foods.

Sex

Sex is another factor which determines the dietary intake. Dietary requirement of adolescent and adult males are more than their female counterparts.

Physical Activity

The kind of work a person does affects the kind and amount of food they need to take. Do you remember that RDA is different for people engaged in different activities? A laborer not only eats more quantity but needs more energy because he is engaged in hard work. His body uses up more energy while performing hard work. So, if you have to plan for such a person you will include more energy giving foods in the diet.

Economic Considerations

Money available to the family to be spent on food is another major factor. Foods like milk, cheese, meat, fruits, nuts, etc., are expensive. However, alternative sources like toned milk, seasonal fruits and vegetables are less costly and at the same time nutritious. You can therefore plan a balanced diet to suit every budget.

Tips for economy: buy food in bulk, if you have enough place to store. Buy from fair price shops like ration-shops, superbazars, cooperative stores, etc. Compare prices and quality while buying. Make use of left-over food.

Time, Energy and Skill Considerations

While planning the meals, you should consider resources like time, energy and skill available to the family. Meals can be elaborate with different dishes but you can simplify them by cooking a simple but nutritious dish. For example, a working mother could prepare a Paushtik pulao, instead of preparing three or four items for dinner.

Seasonal Availability

Some foods are available in summers while some in winters. The off season foods are expensive and less nutritious, while those in season are fresh, nutritious, tasty and cheap. Hence, while planning a meal, seasonal foods should be used.

Religion, Region, Cultural Patterns, Traditions and Customs

Regional factors influence meal planning. For example, if you are a North Indian, you will consume more of wheat, while those near the coastal region, will consume more of coconut, fish, etc. Similarly your staple food would be rice if you are a South Indian. Religious beliefs prevalent in the family also have an influence. For example, if you are a vegetarian, your diet will not have any meat or meat product, Hindus do not eat beef and Muslims do not eat pork, etc.

Variety in Color and Texture

It is important to include food in the meal as per the food pyramid specifications and color of the food helps in planning such a meal. Texture of the food also matters based on the requirements of various people. For example, children and old people prefer smooth, easily digestible foods, while health conscious adults prefer salads.

Likes and Dislikes of Individuals

The food you serve should cater to the likes and dislikes of the individual family members. It is often better to change the form of some particularly nutritious food item, rather than omitting it completely. For example, if someone in your family does not like milk, you can give it in the form of curd, paneer, etc. Similarly, if one does not want to take green leafy vegetables in cooked form, what alternative would you suggest, so that it can be taken in adequate amount? Yes, it can be used in a variety of ways - mixed with flour and made into paranthas or pooris; or as culets or pakodas. It can also be given in the form of koftas, idlis, vadas, etc.

Satiety Value

While planning meals, take care that you select foods which provide satiety value. Meals which produce inadequate satiety, will lead to onset of hunger pangs, which in turn will affect the working capacity and efficiency of a person.

PRINCIPLES OF MEAL PLANNING

- **Nutrient Density**: Consider how to ingest enough nutrients without eating too many calories
- **Moderation:** Ingesting enough, but not too much, of a food. Control intake of foods that are rich in fat and sugar or do not promote good health
- **Variety:** Eating a wide selection of foods within and among the major food groups. Obtain necessary nutrients and trace minerals
- **Adequacy:** Sufficient energy, nutrients, and fiber to be healthy
- **Balance:** Achieving the proper combination of foods/food groups. Eating foods in proportion to each other and your needs

- **Calorie Control:** Eating the right amount of calories to control weight given your metabolism and activity

The knowledge of recommended dietary allowances and composition of food is necessary for the selection of an adequate diet. But if we start doing this, it will be a tedious process. Therefore, it is necessary to translate the nutritional needs into kinds and amounts of food that we should eat. Such information can then be used in everyday meal planning exercise. This is achieved by dividing/categorizing all food items into various groups called food groups. .

Sample Menu for Adult Man (Moderate Worker)

Early Morning	**Tea/Green Tea**
Breakfast	Sprouts and Vegetable stuffed Parantha Milk Small bowl of fresh fruits Mid Morning Tea Biscuits
Lunch	2 Chapattis 1 small bowl rice 1 Bowl any vegetable sabzi 1 Bowl cooked whole dal. 1 Bowl Raita Salad
Evening	Tea 3 pieces Dhokla
Dinner	Soup 3 chapattis 1 bowl cooked vegetables 1 bowl cooked dal Salad Dessert

MODIFICATIONS

A well balanced healthy diet is a must for all age groups. The modifications for various age groups are as follows:

- **School going Children**
  - A high calorie, high protein diet with plenty of vitamins and minerals.
  - Need energy rich foods for their hectic activities both at school and home.
  - Packed ‗tiffin' assumes a lot of importance as breakfast is usually skipped. ‗Tiffin' should be tasty besides being nutritious.

- **Adolescents**
  - A high calorie, high protein diet, rich in calcium and iron.
  - Quantity of food intake must be increased to meet their rapidly changing body needs.
  - Nutritious fast foods and snacks should be planned.
  - Peer group influence affects food intake and it must be kept in mind while planning.
  - Starving crash dieting/erratic eating habits must be discouraged

- **Modifications for old People**

  Many physiological changes occurring during old age affects nutritional requirements. They need less energy and fats as compared to an adult man but the proteins and other nutrient requirements remain the same. They need lots of water and fiber to check the problem of constipation. Also, you

know that they may suffer from chewing problems, so give them soft and well cooked foods. Now you have learnt how to adapt the same menu for various family members according to their requirements. It also saves time and effort and makes planning simple.

- **Meal Plan for Lactating Women**
  The National Institute of Nutrition, a part of the Indian Council of Medical Research has created Recommended Dietary Allowances during lactation for Indian mothers.

  Lactation requires Indian women to consume a healthy increment of energy, proteins, fat etc. However, the extra energy that is required is only 400 - 550 kcal/day and any consumption above this will only add empty calories and weight to the mother. So focus on nutrition, rather than the quantity of the food you eat.

  Food Groups System
  For meal planning, Indian foods have been divided into different groups.
  - Cereals & Grains
  - Pulses & Beans
  - Milk and Milk products
  - Green leafy vegetables, other vegetables, tubers and roots
  - Fruits

  Building a meal plan for lactation
  The table below shows the average meal plan for a lactating Indian woman who does moderate work during the day.

Food group	Quantity/serving	Servings/day
Cereals & Grains	60 grams	6
Pulses & Beans	30 grams	4-5
Milk and milk products	150 ml	2
Green leafy vegetables, other vegetables, roots and tubers	100 grams	4-5
Fruits	50 grams	4

Non-vegetarians can substitute 1 or occasionally 2 servings of pulses and beans with fish/meat/eggs etc.

Oils and fats are also required in the diet. The table above assumes that food groups are cooked using moderate quantities of oils which provide the required supply of oils and fats to the diet. If this is not the case, please ensure you get oils and fats as required. Use of moderate quantities of salt in cooking is advisable. Sugars are also required in the diet. The table above assumes that sugars are obtained from the foods included in the diet like fruits, tubers etc. If this is not the case, please ensure you get sugars as required. It is important to drink water regularly throughout the day.

APPLICATION OF MEAL PLANNING PRINCIPLES

Medical Requirements

There are many dietary considerations that form part of therapy for medical conditions and are prescribed by medical practitioners. A therapeutic diet is usually tailored to the needs of the individual hence the individual is well placed to advice on the foods that are suitable. However, it is common practice that therapeutic diets are, where possible, designed to be adaptations of the normal diet of the population.

The most common diets presented to caterers to accommodate are as follows:

REDUCING DIETS:
Weight reduction and weight control are frequently necessary in the affluent society of today. The basic concept is to decrease the energy value of the diet to below the energy output of the individual. There are many reducing diets advertised and serial dieters will adopt the latest ‗craze". However, a well-planned menu derived from all the food groups and utilizing the complete spectrum of cooking methods can provide appropriate foods for a reducing diet.

DIABETIC DIETS
These diets vary considerably depending on the type of diabetes diagnosed and the severity of the condition. Currently diabetes is an incurable, but manageable, condition concerning the lack or insufficiency of insulin necessary for the metabolism of carbohydrates. However, as carbohydrate is an essential nutrient, diabetics are taught to balance their carbohydrate intake with their drug treatment. It is not unusual for Type 1 diabetics dependent on daily injections of insulin to require high carbohydrate diets to provide them with sufficient energy for both work and leisure activities. Obesity is known to be a causative factor in Type 2 diabetes and in its mildest form might be treated by reducing diet alone. Often Type 2 diabetics will be prescribed drugs to reduce their blood sugar, but, additionally, they will be required to reduce and or control their weight. Most diabetics are very aware of their dietary needs and will manage their diet without you being involved

GLUTEN FREE DIETS
Coeliac Disease also known as *gluten sensitive enteropathy*, once a disease predominantly diagnosed in children is being increasingly diagnosed in adults. Gluten is the protein in grains, which, during cooking, provides structure to the product. Coeliac disease is a chronic condition, which severely impedes digestion and absorption of food and nutrients. Hence, if untreated, the individual will suffer all the symptoms of malnutrition. The gluten free diet is exactly as described, free of gluten, which means the complete avoidance of most whole grain products. Rice and maize (corn) are acceptable grains as neither contains gluten. Gluten free processed foods are becoming more available including breads and biscuits. Once the diagnosis of coeliac disease is made and treatment initiated recovery can be spectacular which concentrates the mind of the individual sufferer and most will adhere strictly to their diet. All the other food groups are suitable for ‗coeliacs', which the menu should provide. The Coeliac Society publishes a list of gluten free brand products annually, which is available through their website.

ALLERGENS
There are many components of food - some natural and some man-made, which precipitate an allergic reaction in some people. The most common are food additives, food preservatives and natural components of nuts, fish, milk, eggs, fruit, crustacean and soya. The sensitivity will vary from mild to severe. In its most severe form the reaction can lead to anaphylactic shock and is potentially life threatening. Sufferers avoid the obvious, but in food processing so many variants of these products are used that particular care with ingredients is essential.

OTHERS
There are many other therapeutic diets for medical conditions requiring the reduction, or increase of nutrients or the chemical parts of nutrients. Most are initiated in hospitals and the individual is taught to manage their own diet. It is essential that caterers listen to their needs and where possible accommodate them from the main menu.

Lifestyle Choices

Vegetarianism is the most common lifestyle choice adopted by members of the armed forces and can be taken up in varying degrees. The usual categories of vegetarians are as follows:

Category	Explanation
Demi-Vegetarians	Will eat dairy products, eggs and traces of animal derivatives. Some may also eat fish
Ovo-Lacto Vegetarians	Will eat dairy produce, eggs, honey and shellac, but no animal carcass, whether whole pieces or derivatives.
Ovo-Vegetarians	Will eat eggs, honey and shellac, but no dairy produce or animal carcass, whether whole pieces or derivatives.
Lacto Vegetarians	Will eat dairy produce, honey and shellac, but no eggs or animal carcass, whether whole pieces or derivatives.
Vegans	Will not eat dairy produce, eggs or animal produce, including shellac or honey.

ASSESSMENT

1. Define meal planning.
2. List the factors affecting meal planning.
3. List the various principles of meal planning.
4. Come up with a meal plan for a lactating mother.
5. How will you plan a meal for a diabetic patient?
6. What is your meal plan for a normal healthy adult?
7. What will you include in your child‘s meals?
8. What kind of food should be provided to the elderly?

Student Notes

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