11th Standard- Physical Education

Chapter 8
Kinesiology, Biomechanics in Sports

Kinesiology: The word kinesiology comes from the Greek word kinesis, which means “to move.” Kinesiology is the study of the art and science of human movement. Kinesiology and physical education study the role exercise, physical movement and sports play in the development of human health and happiness. They apply sciences like biomechanics, anatomy, physiology and psychology to better understand how the human body responds to physical activity.

Importance: We study kinesiology to improve performance by learning how to analyze the movements of the human body and to discover their underlying principles. The study of kinesiology is an essential part of the educational experience of students of physical education, dance, sport, and physical medicine. Knowledge of kinesiology has a threefold purpose for practitioners in any of these fields. It should enable them to help their students or clients.

The actual study of kinesiology can lead to multiple careers and experiences, and not just becoming a physical education teacher. One can not only be a teacher of the science, but may do research with it, coaching, fitness leadership and delivering special services related to health promotion, sports medicine, rehabilitation, and high-performance athletic competitions, and then there is also managing sport-related enterprises. Of course, depending on the person one may seem better than the other and one may seem more fulfilling than the other as well. For myself, I obviously enjoy delivering special service related rehabilitation; physical therapy. Although some of these professions may overlap or seem as if they are all similar, they have their differences. For instance, these professions are located in different settings which include schools, colleges, universities, both public and private agencies, businesses, government, military, clinical environments and hospitals.

Biomechanics: Biomechanics is derived from Greek words, BIO + MECHANICS. Bio means living thing and mechanics is a field of physics. Thus, it is the branch of science which deals with the forces related to body movements.

Biomechanics is defined as systematic study of mechanics of body joints. According to Wikipedia, “Biomechanics is the study of the structure and function of biological system of humans.”

Importnace of Biomechanics in Sports

- Improves performance in sports
- Improvement in technique
- Development of improved sports equipment
- Improve in training techniques
- Prevents sports injuries
- Helps in understanding human body
- Knowledge of safety principles
- Helps in research work
- Creates confidence in player
- Helps in maintaining healthy body
- Increases the popularity of sports

The musculoskeletal system

The **musculoskeletal system** is the combination of the muscular and skeletal **systems** working together and includes the bones, muscles, tendons and ligaments of the body. The skeletal system is comprised of bones and joints and provides the basic supporting structure of the **body**. It consists of the joined framework of bones called the skeleton. The **human** skeleton is made up of 206 bones.

The **musculoskeletal system** provides form, support, stability, and movement to the body. It **is** made up of the bones of the skeleton, muscles, cartilage, tendons, ligaments, joints, and other connective tissue that supports and binds tissues and organs together. In the **musculoskeletal system**, the **muscular** and **skeletal systems** work together to support and move the **body**. The bones of the **skeletal system** serve to **protect the body's** organs, support the weight of the **body**, and give the **body** shape.

5 primary functions of skeletal system

- support. provides structural support for the entire body.

- protection. surrounds soft tissue- ex. ...
- movement. skeletal muscle is attached to bone so it pulls on the bone when it contracts.
- blood cell production. red bone marrow produces red blood cells, white blood cells and other blood elements.
- mineral storage.

Musculoskeletal Disorders or MSDs are injuries and **disorders** that affect **the**human body's movement or **musculoskeletal** system (i.e. muscles, tendons, ligaments, nerves, discs, blood vessels, etc.). Common MSDs include: Carpal Tunnel Syndrome. Tendonitis.
It is made up of the bones of the skeleton, muscles, cartilage, tendons, ligaments, joints, and other connective tissue that supports and binds tissues and organs together. The musculoskeletal system's primary functions include supporting the body, allowing motion, and protecting vital organs. The skeletal portion of the system serves as the main storage system for calcium and phosphorus and contains critical components of the hematopoietic system. This system describes how bones are connected to other bones and muscle fibers via connective tissue such as tendons and ligaments. The bones provide stability to the body. Muscles keep bones in place and also play a role in the movement of bones. To allow motion, different bones are connected by joints. Cartilage prevents the bone ends from rubbing directly onto each other. Muscles contract to move the bone attached at the joint.

Muscles
Bones don't work alone — they need help from the muscles and joints. Muscles pull on the joints, allowing us to move. They also help the body perform other functions so we can grow and remain strong, such as chewing food and then moving it through the digestive system. The human body has more than 600 muscles. Muscles make up half of a person's body weight. They are connected to bones by tough, cord-like tissues called **tendons**, which allow the muscles to pull on bones. If you wiggle your fingers, you can see the tendons on the back of your hand move as they do their work.

Humans have three different kinds of muscle:

1. **Skeletal muscle** is attached to bone, mostly in the legs, arms, abdomen, chest, neck, and face. Skeletal muscles are called **striated** (pronounced: STRY-ay-ted) because they are made up of fibers that have horizontal stripes when viewed under a microscope. These

muscles hold the skeleton together, give the body shape, and help it with everyday movements (they are known as voluntary muscles because you can control their movement). They can contract (shorten or tighten) quickly and powerfully, but they tire easily and have to rest between workouts.

2. **Smooth**, or **involuntary**, muscle is also made of fibers, but this type of muscle looks smooth, not striated. Generally, we can't consciously control our smooth muscles; rather, they're controlled by the nervous system automatically (which is why they are also called involuntary). Examples of smooth muscles are the walls of the stomach and intestines, which help break up food and move it through the digestive system.
   Smooth muscle is also found in the walls of blood vessels, where it squeezes the stream of blood flowing through the vessels to help maintain blood pressure. Smooth muscles take longer to contract than skeletal muscles do, but they can stay contracted for a long time because they don't tire easily.
3. **Cardiac** (pronounced: KAR-dee-ak) muscle is found in the heart. The walls of the heart's chambers are composed almost entirely of muscle fibers. Cardiac muscle is also an involuntary type of muscle. Its rhythmic, powerful contractions force blood out of the heart as it beats.

Muscles and Movement

Even when you sit perfectly still, there are muscles throughout your body that are constantly moving. Muscles enable your heart to beat, your chest to rise and fall as you breathe, and your blood vessels to help regulate the pressure and flow of blood through your body. When we smile and talk, muscles are helping us communicate, and when we exercise, they help us stay physically fit and healthy.

The movements your muscles make are coordinated and controlled by the brain and nervous system. The involuntary muscles are controlled by structures deep within the brain and the upper part of the spinal cord called the brain stem. The voluntary muscles are regulated by the parts of the brain known as the cerebral motor cortex and the cerebellum. When you decide to move, the **motor cortex** sends an electrical signal through the spinal cord and peripheral nerves to the muscles, causing them to contract. The motor cortex on the right side of the brain controls the muscles on the left side of the body and vice versa.

The **cerebellum** (pronounced: ser-uh-BEL-um) coordinates the muscle movements ordered by the motor cortex. Sensors in the muscles and joints send messages back through

peripheral nerves to tell the cerebellum and other parts of the brain where and how the arm or leg is moving and what position it's in. This feedback results in smooth, coordinated motion. If you want to lift your arm, your brain sends a message to the muscles in your arm and you move it. When you run, the messages to the brain are more involved, because many muscles have to work in rhythm.

Muscles move body parts by contracting and then relaxing. Your muscles can pull bones, but they can't push them back to their original position. So they work in pairs of flexors and extensors. The **flexor**contracts to bend a limb at a joint. Then, when you've completed the movement, the flexor relaxes and the **extensor** contracts to extend or straighten the limb at the same joint:

For example, the biceps muscle, in the front of the upper arm, is a flexor, and the triceps, at the back of the upper arm, is an extensor. When you bend at your elbow, the biceps contracts. Then the biceps relaxes and the triceps contracts to straighten the elbow.

A **joint** or **articulation** (or **articular surface**) is the connection made between bones in the body which link the skeletal system into a functional whole. They are constructed to allow for different degrees and types of movement. Some joints, such as the knee, elbow, and shoulder, are self-lubricating, almost frictionless, and are able to withstand compression and maintain heavy loads while still executing smooth and precise movements.

Humeroscapular or Shoulder Joint

- Multiaxial, Ball-and-Socket Joint. Most mobile joint of body.
- Head of humerus articulates in shallow glenoid fossa of scapula (although depth is increased by glenoid labrum, a fibrocartilagenous band around the glenoid fossa).
- Allows flexion, extension, (rotation), adduction, abduction and circumduction.

High mobility due to:

1. Shallowness of glenoid cavity
2. Loose or "redundant" ligaments.

Stability due to:

1. Rotator cuff muscles (a.k.a. "SITS muscles") or musculotendinous cuff muscles.
2. Baseball pitchers often have "rotator cuff injuries"-- this is when SITS muscles and/or their tendons are damaged.

Elbow Joint uniaxial joints:

- Olecranal joint formed between ulna and humerus, allowing flexion and extension. Trochlea of humerus articulates with trochlear notch of ulna.
- Radioulnar joint formed between radius and ulna, allowing supination and pronation. Head of radius pivots in radial notch of ulna and capitulum.
- One joint capsule houses both joints. Medial and lateral collateral ligaments reinforce joint.
- lateral epicondylitis = "tennis elbow"
- medial epicondylitis = "golfer's elbow"

Coxal or Hip Joint

- Multiaxial, ball-and-socket joint.
- Head of femur articulates in acetabulum formed by pelvic bones.
- Compared with shoulder joint:
- Greater strength and less mobility.
- Like glenoid fossa, acetabulum is ringed by fibrocartilagenous lip or labrum.
- Three major ligaments surround the outside of the joint and form the capsule. Ligaments arise from 3 bones of pelvis and attach to greater trochanter and neck of femur (thus, they are called iliofemoral, ischiofemoral and pubofemoral ligaments).
- The teres ligament is present within the joint and attaches the head of femur to acetabulum.
- Strength of ligaments of hip is so great that little muscular strength is needed to maintain standing position. But, walking with an upright posture means that hip joint must bear considerable loads during one's lifetime. Osteoarthritis of the hip is common.

Tibiofemoral or Knee Joint

- Largest and most complicated joint of the body. It is a modified hinge joint. It is a composite joint
- medial femoral and medial tibial condyles articulate.
- lateral femoral and lateral tibial condyles articulate.
- patella and patellar surface of femur.

- Functions of Patella: protection and leverage.
- Basic motions are flexion and extension. Some rotation possible.
- Main flexors are hamstring muscles, main extensor is quadriceps femoris.

Main ligaments:

- Collaterals (tibial and fibular)--sides of knee.
- Cruciates (anterior and posterior)--cross within joint. Named for their attachment sites on tibia.
- Patellar ligament

The anterior cruciate becomes more taut with extension, prevents hyperextension and forward sliding. The posterior cruciate becomes more taut with flexion to prevent backward dislocation and hyperflexion.

Functions:

- Cushion between ends of bones that meet in joint.
- Fill space of non-matching surfaces
- Medial Meniscus is often injured, esp. in football--it is attached to medial collateral ligament.
- When knee is twisted, the ligament can tear the meniscus.

"The 3 Cs of knee injuries"

1. Cartilage
2. Cruciates
3. Co-laterals

Bursa in knee joints--around patella. "Water on the knee" is really frictional, or pre-patellar bursitis

Newton's Law of Motion and their application in Sports

- **First Law of motion or Law of Inertia:** According to first law of motion an object at rest will remain at rest or an object in motion will remain at motion at constant velocity unless acted upon by a force.
  Example: A moving football slows down and then stops often sometime. It comes to

rest due to the fraction between the ground and the ball.

- **Second Law of motion (The Law of Acceleration):** According to Newton's second law of motion, the rate of change of momentum of a body is directly proportional to the impressed force and takes place in the direction of force.
  Example: A cricket player while catching a ball moves his hands backwards. Initially the ball is moving with a certain velocity. The player has to apply a retarding force to bring the ballot rest in his hands.
- **Third Law of Motion:** According to the Newton's third law of motion, to every action there is always an equal and opposite reaction.
  Example: The swimmer pushes the water in the backward direction with a certain force. Water pushes the man forwards with an equal and opposite force.

Levers - It's Types and It's Application in Sports

Lever: Lever is a rigid bar which is capable of rotating about a fixed point called the fulcrum.
Example: see-saw, scissors, pulley etc. Skeletal system also acts like lever.

- **Class I Lever** - A first class lever has the fulcrum located between the force and the resistance.
  Example- See-saw, a pair of scissors, bicycle brake.
- **Class II Lever -** A second class lever has the load or resistance located Between the fulcrum and the force.
  Example- wheel barrow, punching machine, Straight pushups, calisthenics etc.
- **Class III Lever** - A third class lever has the force located between the fulcrum and the resistance.
  Example- baseball bat, Tennis racket, boat-paddles.

Equilibrium: Dynamic and Static

Equilibrium: is defined as a state of balance or a stable situation, where opposite forces cancel each other out and where no changes are occurring.

Types of Equilibrium

1. Dynamic equilibrium: dynamic stability is a balance of body during movement

2. Static equilibrium is the balance of the body during its rest or stationary position.

Guiding Principles to Determine Degree of Stability

1. Broader the base, greater the stability.
2. Lower the Centre of gravity, higher the stability.
3. When the body is free in air, if the head and feet moves down then hip move up and vice versa.
4. Body weight is directly proportional to stability.

Centre of Gravity and its Application in Sports

Centre of Gravity: Centre of gravity is that point in a body or system around which its mass or weight is evenly distributed or balanced and through which the force of gravity acts. The Centre of gravity is fixed, provided the size and shape of the body do not change.
Force: Force can be defined as a push or pull by one body acting upon another. Force is a product of mass and acceleration of an object or person.

Types of Force

1. Centripetal force
2. Centrifugal force
3. Gravitational force
4. Frictional force
5. Static force

Importance and Application of Force in Sports

1. Helps to move
2. Stops the moving object
3. Helps to accelerate
4. Helps in throwing object.
5. Helps to lift the object.
6. Helps to pull the object