10 Kinesiology, Biomechanics and Sports

Read this new topic before Article 10.1 on page 199 of the main book.

High jump with Fosbury technique

In the history of physical education and sports, individuals have always been interested in enhancing their performance. Today, physical education teachers, coaches and physical trainers are concerned with helping individuals to learn how to move efficiently and effectively. In primary and high schools, stress is laid down on learning the fundamental motor skills, which provide a base for the learning of advanced sports skills. The teachers as well as coaches always make their best efforts to improve the performance of their students in various competitive games and sports. They can help to improve the performance of students if they have adequate knowledge of "Kinesiology" and "Biomechanics". Nowadays, kinesiology and biomechanics are playing a very vital role in improving the performance of sportspersons.

The term **kinesiology** means "the study of movement" and the academic discipline of kinesiology comprises the sub-disciplines of exercise physiology, biomechanics, sports and exercise psychology, athletic training and sports medicine, sports administration, fitness and health promotion. "Kinesiology is the branch of physiology that studies mechanics and anatomy in relation to human movement."

Biomechanics is a sub-discipline of physical education. The term 'biomechanics' is a combination of two words i.e., 'Bio' and 'mechanics'. Here, 'bio' is a Greek word that refers to **life or living things** and 'mechanics' refers to **the field of physics and the forces that act on bodies in motion.** The primary purpose of biomechanics is to evaluate a living organism's motion as well as its application of force. In other words, biomechanics is a sub-discipline that applies the laws of mechanics and physics to study the bodily movements and the causes of movements, both internally and externally. It can also be said that **biomechanics is the study of forces and their effects on living systems.**

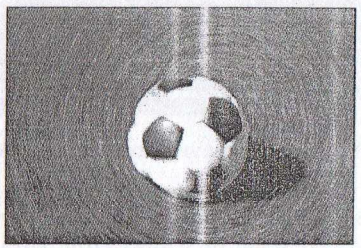
Read these new topics after Article 10.1 on page 201 of the main book.

10.1A NEWTON'S LAWS OF MOTION AND THEIR APPLICATION IN SPORTS

The three laws of motion were formulated by **Newton**. These are described below.

1. **Law of Inertia:** It is the first law of motion. According to this law, "*A body at rest will remain at rest and a body in motion will remain in motion at the same speed and in the same direction unless acted on by an external force.*"

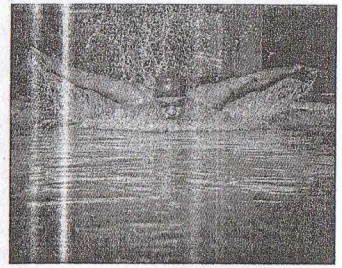
Stationary ball



Moving ball

There are a great number of examples of this law in the field of sports and games, such as starting in rowing, starting on roman rings, starting in sprinting, starting in throwing the hammer, raising an opponent in wrestling, etc. Basically if an object is in motion, it remains in motion unless something or some external force stops it. The external force may be gravitational force, the surface of the playing field, a defensive player or the braking action of the sportsperson's body to stop.

2. **Law of Acceleration:** It is the second law of motion. According to this law, "*A change in the acceleration of an object is directly proportional to the force producing it and inversely proportional to its mass.*" If two unequal forces are applied to objects of equal mass, the object that has greater force applied will move faster. Conversely, if two equal forces are applied to objects of different masses, the lighter mass will travel at a faster speed. This law is also applied in various sports, for example, in hammer throw, the thrower, who is stronger (who has more force), will throw the 12 lbs hammer farther than a thrower who has less force or strength. A hammer thrower will find that more force is required to throw 16 lbs hammer than a 12 lbs hammer. If a baseball player hits a ball with the double force, the rate at which the ball will accelerate will be doubled. Football players can slow down, stop or reverse the direction of other players depending upon how much force they can apply and in which direction.
3. **Law of Reaction:** It is the third law of motion. According to this law, '*For every action, there is always an equal and opposite reaction.*' There are also many examples in sports where this law is applied, e.g., springing on diving board for gaining maximum height, bouncing on trampoline, thrust against the water in swimming. The application of this law in various sports is given below.



Swimming

(*a*) **Swimming:** A swimmer pushes the water backwards (action). The water pushes the swimmer forward (reaction) with the same force.

(*b*) **Walking:** When a person walks, he presses the ground in the backward direction (action) by his feet. The ground pushes him in the forward direction with an equal force (reaction).

(*c*) **Shooting:** In shooting, when a gun or pistol is fired, the bullet moves forward (action). The gun or pistol jerks backward (reaction).

(*d*) **Dribbling in Basketball:** When a basketball player dribbles, he exerts force on the ball and the ball strikes on the floor with a force (action). Then the ball comes up with an equal force from the floor (reaction).

Shooting

(*e*) **High Jump:** A high jumper can jump higher off a solid surface because it opposes his body with as much force as he is able to generate, in contrast to sand or any other unstable surface.

10.1B AERODYNAMICS PRINCIPLES

The word 'Aerodynamics' is originated from two Greek words 'aerios' means related to air and 'dynamics' means motion, so collectively aerodynamics means the study of motion of air. In fact, aerodynamics is the study of properties of moving air and the interaction between the air and solid bodies moving through it. Aerodynamics is the way air moves around the things. Anything that moves through the air reacts to aerodynamics. In simple words, 'Aerodynamics is related to the flow of air around a projectile, which can influence speed and direction of the object'.

Indeed, any object or sports equipment that goes or thrown into the air such as a javelin, discus, baseball, cricket ball, football, basketball and volleyball, the principles of aerodynamics are applied. Not only this, aerodynamics principles are applied on the design, structure and shape of cycle, racing cars, clothing worn by cyclist and position of the body while riding on the cycles.

The Basic Forces of Aerodynamics

There are four basic forces of aerodynamics such as lift weight, thrust and drag. These forces make an object move up and down, faster or slower. How does the sports equipment or object move through the air largely depends on the quantity of each basic force.

The amount of each force compared to its opposing force determines how an object moves through the air. The basic forces of aerodynamics are stated below:

1. **Lift.** Lift is the force that pushes the object to move upward. In fact, it is the force that is the opposite of weight. Lift plays a very important role in any sport involving balls. In sports, when a ball is thrown or hit into the air its lift depends on the force the individual applies. If more force is applied to the ball, its lift will also be higher.
2. **Weight.** Weight is the force generated by the gravitational attraction of the earth. The weight of an object controls how strong the push has to be. A shot of 16 pounds requires more force (push) than a javelin. If the weight of two objects is different and same force is applied on both the objects then the lighter object will travel more than the heavier object.

3. **Drag.** Drag is a force that tries to slow the object down. It makes hard for an object to move. It is harder to walk through the water than through the air. It is because water causes more drag than air. The shape of an object also changes the amount of drag. Most probably the round objects have less drag than flat objects. Even narrow surfaces such as javelin racing cars, motor bikes, etc., have less drag than wide ones. In fact the more air that hits a surface of an object, the more drag it makes.

4. **Thrust.** Thrust is the force that is the opposite of drag. Thrust is the push that moves some objects forward. In case of sports, the equipment like javelin or discus does not have thrust. So, that is why such objects can move into the air until the drag causes them to slow down and land on the ground.

Effects of Aerodynamics on a Ball

The flow of air around a ball thrown through the air differ greatly depending on whether it has a smooth surface or rough surface. For example, the surface is affected by the stitches made on baseball and cricket ball and dimples on golf ball. As a matter of fact, in the flight of a smooth ball, the air molecules travel around the ball to the back where they meet, mingle and combine to push the ball forward. The pressure behind the ball is less, than the pressure in front. If the ball has uneven or rough surface, turbulence occurs as the air flows over the ball. The turbulence causes the air to stick to the ball just a little longer and increases the wake, which increases drag. If you don't put any spin on the ball, the airflow around the ball will be symmetric. However, if you put spin on the ball, it will begin to curve. The spin on the ball imparts vorticity in the air, which causes the air flow to lose its symmetry, and for the air to curve to one direction on the other as it goes around the ball.

Read these new topics after Article 10.4 on page 205 of the main book.

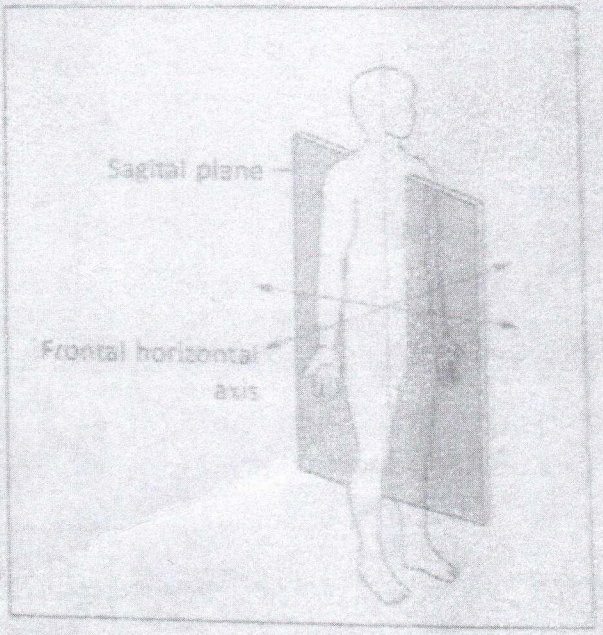
10.4A INTRODUCTION TO AXES AND PLANES

Human movements are stated in three dimensions on a series of planes and axes.

Meaning of Plane: An imaginary, flat surface passing through the body or organ is called plane. In other words, plane is the surface on which the movement occurs or takes plane. There are three planes of motion that pass through the human body.

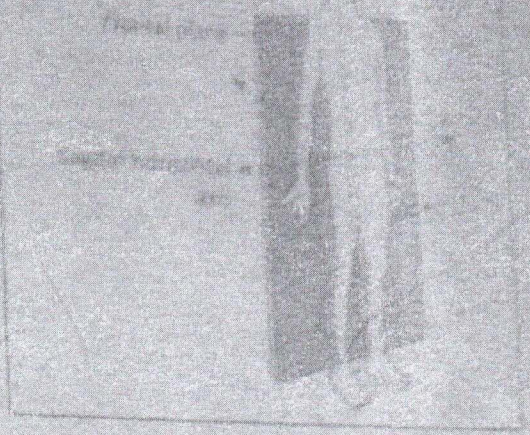
Types of Planes: There are following types of planes:

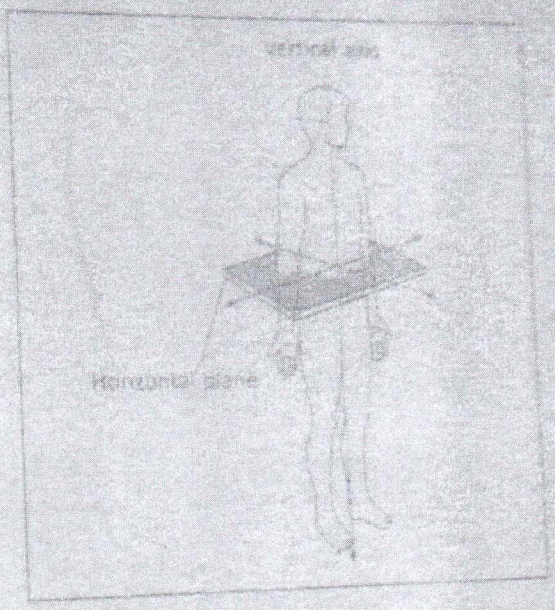
1. **Sagittal or Medial Plane.** The sagittal or medial plane is a vertical plane passing from the rear to the front, dividing the body into left and right halves. It is also known as anteroposterior plane. It can also be said that this plane lies vertically and divides the body into right and left parts. Most of the sports and exercise movements that are two dimensional, such as running, long jumping and somersault take place in this plane.



2. **Frontal or Coronal Plane.** The frontal plane is also vertical and passes from left to right dividing the body into posterior to anterior halves. It is also known as coronal plane. In simple words, frontal plane cuts the body into front and back. Movements along the frontal plane can include cartwheel and star jumps.

3. **Transverse or Horizontal Plane.** The transverse plane divides the body into top and bottom halves. It is also known as horizontal plane. This plane lies horizontally that is why it is also called horizontal plane. In simple words, it divides the body into upper and lower sections. Movements along this plane can include an ice-skating spin or rotation to play a tennis shot.





Meaning of Axis: An axis is a straight line around which an object rotates. In sports, movements at the joints of human musculoskeletal system are mainly rotational and takes place about a line perpendicular to the plane in which they occur. This line is known as axis of rotation. In other words, axis is an imaginary line (point of rotation) that passes through a joint or body to describe movement.

Types of Axes of Rotation: There are following types of axes of rotation.

1. **Sagittal Axis.** The sagittal axis passes horizontally from posterior to anterior. It is formed by the intersection of the sagittal and transverse or horizontal planes. In fact, sagittal axis passes from front to back.
2. **Frontal Axis:** The frontal axis passes horizontally from left to right. It is formed by the intersection of the frontal and horizontal or transverse planes. It can be stated that the frontal axis passes from side to side.
3. **Vertical Axis:** The vertical axis passes vertically from inferior to superior. In other words, it passes straight through the top of the head down between feet. It is formed by the intersection of sagittal and frontal planes. It is also known as longitudinal axis. It is the longest axis.

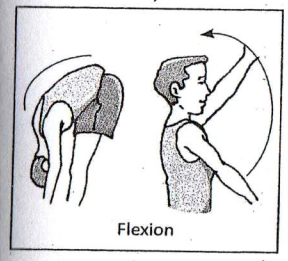
10.4B TYPES OF MOVEMENTS

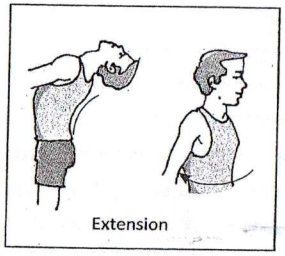
There are various types of movements in joints which may be divided into four major kinds *i.e.*, gliding and angular movements, circumduction and rotation and a few other movements.

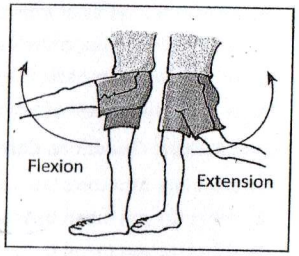
1. **Gliding Movement:** Gliding movement is the simplest kind of motion that can take place in a joint, one surface gliding or moving over another without any angular or rotatory movement. Though it is very common to all movable joints, but in most of the articulations of the carpus and tarsus, it is the only motion permitted.
2. **Angular Movement:** Angular movement occurs only between the long bones. By angular movement, the angle between the two bones is increased or decreased. It may take place forward, backward, flexion, extension, adduction and abduction. Adduction and abduction combined with flexion and extension are met within the more movable joints as in the hip and the shoulder. The various movements which fall under angular movement are described below:

(a) Flexion. Bending parts at a joint so that the angle between them decreases and parts come closer together (bending the lower limb at the knee).

(b) Extension. Straightening parts at a joint so that the angle between them increases and the parts move farther apart (straightening the lower limb at the knee).

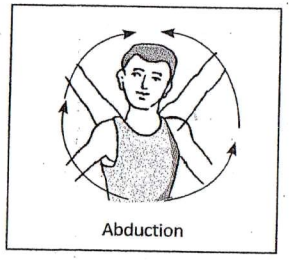

Flexion

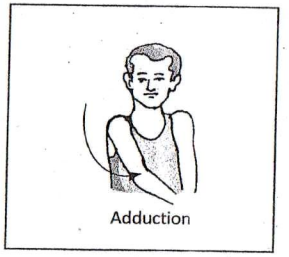

Extension



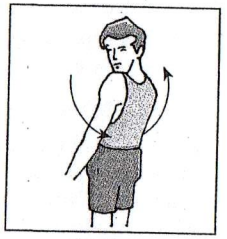
(c) Abduction. Moving a part away from the midline (lifting the upper limb horizontally to form a right angle with the side of the body).

(d) Adduction. Moving a part toward the midline (returning the upper limb from the horizontal position to the side of the body).


Abduction


Adduction

3. **Circumduction:** Circumduction is that movement which takes place between the head of a bone and its articular cavity. This kind of motion is best seen in the shoulder and hip joints. In fact, it is a compound circular movement which involves flexion, extension, adduction and abduction. In circumduction, a part moves in such a way that its end follows a circular path (moving a finger in a circular motion without moving the hand.)
4. **Rotation:** Rotation is a form of movement in which a bone moves around a central axis without undergoing any displacement from this axis. Moving a part around an axis is called rotation *e.g.*, twisting the head from side to side.


Rotation

5. **Other Movements:**

(a) Hyperextension. Excess extension of the parts at a joint, beyond the anatomical position (bending the head back beyond the upright position).

(b) Dorsiflexion. Bending the foot at the ankle toward the shin (bending the foot upward).

(c) Plantar flexion. Bending the foot at the ankle toward the sole (bending the foot downward).

(d) Inversion. Turning the foot so the sole faces medially.

(e) Protraction. Moving a part forward (thrusting the chin forward).

(f) Retraction. Moving a part backward (pulling the chin backward).

(g) Elevation. Raising a part (shrugging the shoulders).

(h) Depression. Lowering a part (drooping the shoulders).

(i) Supination. Turning the hand so the palm is upward or facing anteriorly (in anatomical position).

(j) Pronation. Turning the hand so the palm is downward or facing posteriorly (in anatomical position).

(k) Eversion. Turning the foot so the sole faces laterally.

10.4C MAJOR MUSCLES INVOLVED IN RUNNING, JUMPING AND THROWING

Major Muscles Involved in Running

There are following major muscles involved in running

1. **Glutes.** These muscles stabilise your hips and legs. These muscles give extra strength. These muscles work with the hamstring muscles and help hip flexors when your leg retracts behind you preparing to propel forward.
2. **Quads.** Quads propel you forward and help straighten out the leg in front so that it can make a good contact with the surface of the ground. These muscles are mainly used in the 'drive' phase.
3. **Calves.** These muscles give you spring in your step and at the same time these muscles act as shock absorbers.