Unit 1: Introduction to Kinesiology and Sports Biomechanics
Kinesiology-Meaning

• Kinesiology = Kinein(motion) + Logus(Study)
• Thus, Kinesiology = Study of Motion.
• This field of knowledge concerned with studying the joint, bone, muscle, etc. and their degree and sequence in the motion along with the mechanical principle applied on...
Thus, kinesiology can be defined as,

“Kinesiology is a whole scholarly field of motion analysis that analyzes the movement on the basis of anatomical (osteology, arthrology, myological, etc.), physiological and associated mechanical principle relevant to it.

It seeks to answer following questions about a movement:

i. Which bones, muscle and joints are involved?
ii. What is the degree of their involvement?
iii. What is the sequence of their involvement?
iv. What mechanical principles are applied in their involvement?
Biomechanics - Meaning

• Technical and scientific development in the domain of kinesiology prompted the need for the refinement of subject in 1960.

• This lead to the development of “Biomechanics”.

• Biomechanics = Bio(life) + Mechanics(branch of physics).

• ‘Studying the locomotion of living systems with the help of principles and concepts of Mechanics.’
Biomechanics-Definition

• Biomechanics can be defined as,

• ‘Biomechanics is a field of knowledge that is concerned with studying the motion of a living organism via analyzing, assessing and describing it via the application of mechanical principles.’

Or

• ‘Biomechanics is the study of forces (both internal and external forces) and their effects on the living systems and its locomotion’
Importance of Biomechanics in Physical Education

i. Knowledge of biomechanics helps to realize and understand the underlying principle of the efficient structure of the competitive sports performance.

ii. Knowledge of biomechanics helps in the improvement of motor qualities.

iii. Knowledge of biomechanics helps an athlete to conduct self evaluation.

iv. Knowledge of biomechanics helps in formulation and understanding new rules and regulation of the sports, games and facilities, etc.

v. Knowledge of biomechanics helps in development and acceptance of new technique and skills.

vi. Knowledge of biomechanics helps in the selection of athlete/players for specific sports an games.
Importance of Biomechanics in Physical Education

vii. Knowledge of biomechanics helps in the selection of equipment and facilities.

viii. Knowledge of biomechanics helps in the prevention, protection and rehabilitation from the sports injuries.

ix. It helps to identify the mechanical advantage and disadvantage of the human locomotion.

x. It helps in diagnostic teaching.

xi. It helps in diagnostic coaching.

xii. It helps in correcting postural deformities.
Importance of Biomechanics in Physical Education

Knowledge of biomechanics helps to realize and understand the underlying principle of the efficient structure of the competitive sports.
Importance of Biomechanics in Physical Education

Knowledge of biomechanics helps in the improvement of motor qualities.

Biomechanics help in designing systematic and scientific training and selecting the appropriate means of development of the motor qualities.
Importance of Biomechanics in Physical Education

Knowledge of biomechanics helps an athlete to conduct self evaluation.
Importance of Biomechanics in Physical Education

Knowledge of biomechanics helps in formulation and understanding new rules and regulation of the sports, games and facilities, etc.

1. Changes in rules and regulation for decreasing sports injuries.


3. Changes in rules with respect to making sports more challenging.
FIGURE 7.5  Safe landing technique.
Importance of Biomechanics in Physical Education

Knowledge of biomechanics helps in development and acceptance of new technique and skills.
Importance of Biomechanics in Physical Education

Knowledge of biomechanics helps in the selection of athlete/players for specific sports and games.

Every game has some mechanical demands.

Some of it are:

1. Displace center of gravity of the person.
2. Produce maximum velocity at the end of movement.
3. Disruption of stability to efficiently and gracefully execute movement.
Knowledge of biomechanics helps in the selection of equipment and facilities.
Importance of Biomechanics in Physical Education

Knowledge of biomechanics helps in the prevention, protection and rehabilitation from the sports injuries.

- **Prevention**- removal of causes of injuries. (as in gymnastics rule change.)

- **Protection**- minimize the risk of injuries during the activity. (ex. Mouth guard, shin guards, or technique like catching technique in cricket.)

- **Rehabilitation**- extensive biomechanical data on exercises and their effect on the body assists in physiotherapy.
Importance of Biomechanics in Physical Education

*It helps to identify the mechanical advantage and disadvantage of the human locomotion.*

*It helps in diagnostic teaching.*
Diagnostics = indepth analysis of all factors contributing to the occurrence of a condition.

*It helps in diagnostic coaching*

*Helps in correcting postural deformities*
As helps in identifying and developing orthotics to alleviate them.
Importance of Kinesiology in physical Education

• To provide the future physical education teacher/coaches with the knowledge necessary for analyzing human motion.
• To assist in the learning and improvement of motor skills via the application of analysis of motion.
• With the applied anatomic background the knowledge of kinesiology helps to prevent injuries.
• Economy of the movement can be ensured.
• Effectiveness of the movement can be ensured.
• For clinical/rehabilitation purposes kinesiology has great importance.
• Designing and teaching of exercise/conditioning/fundamental movements the knowledge of kinesiology is must.
Importance of Kinesiology in physical Education

• Self realization about own performance is best realized by the athlete themselves with the background of kinesiology.
• To discover and recognize the underlying principles of movement.
• It is an educational experience for physical education and physical medicine.
• Effective teaching of motor skills with knowledge of kinesiology are best achieved in regards to
  a. Fundamental motor skills
  b. Specialized motor skills
• Evaluation of exercise and activity from the point of view of their effect on the human structure.
Importance of Kinesiology in physical Education

• For physiotherapy, physical medicine purposes.
• For postural analysis, and corrective physical education.
Importance of Kinesiology in physical Education

To provide the future physical education teacher/coaches with the knowledge necessary for analyzing human motion.

Analysis specific to the musculoskeletal system involved in the motion.
Importance of Kinesiology in physical Education

To assist in the learning and improvement of motor skills via the application of analysis of motion.

Using the findings of analysis to formulate the ideal technique of the motor action which assists in learning it and also in comparison to improve it.
Importance of Kinesiology in physical Education

With the applied anatomic background the knowledge of kinesiology helps to prevent injuries.

Anatomy of a Stride

- Heel Strike
- Mid-Foot Strike
- Pose Position

Forefoot strike to the Pose Position is the most efficient transfer of the body forward

The RunningPose
Facilitates Acceleration via Rotation
Proper Alignment and Balance:
Head, Shoulders, Hips and Feet are aligned
Elasticity: S-Like Body

Joints Absorb Impact
Minimal Joint Strain
Excess Strain on Knee
Importance of Kinesiology in physical Education

**Economy of the movement can be ensured.**
As, inefficiencies and unnecessary movements are removed from the movement.

**Effectiveness of the movement can be ensured.**
What do you mean by Effectiveness?

**For clinical/rehabilitation purposes kinesiology has great importance.**
Importance of Kinesiology in physical Education

Designing and teaching of exercise/conditioning/fundamental movements the knowledge of kinesiology is must.
Importance of Kinesiology in physical Education

For physiotherapy, physical medicine purposes.

For postural analysis, and corrective physical education.

Sway Back  Lumbar Lordosis  Thoracic Kyphosis  Forward Head  Good Posture
Anatomical Position

The anatomical neutral position is:

- Standing upright
- Legs together knees straight
- Toes pointing forwards
- Arms by the sides
- Palms facing forwards
Fundamental Starting Position

Reference Positions

- Fundamental position
  - Similar to anatomical position
  - Arms more relaxed
  - Palms face inward

- Relative angle
  - Included angle between two segments
Joint Movements

• Also known as Anatomical Movements.

• 3 kinds of Joint Movements:
  1. Angular Movements
  2. Rotation Movements
  3. Special Movements
Angular movements

- Increase or Decrease in the angle b/w articulating bones.

- It’s types:
  1. Flexion
  2. Extension
  3. Hyperextension
  4. Abduction
  5. Adduction
  6. Circumduction
  7. Lateral Flexion
Flexion

• Decreasing angle b/w articulation bones.
• Takes body forward from anatomical position.
• Allowed in:
  1. Ball and socket Joint
  2. Condyloid joint
  3. Hinge joint
  4. Pivot joint
  5. Saddle joint
Extension

• Increase angle b/w articulation bones.
• Takes body backward from anatomical position.
• Allowed in:
  1. Ball and socket Joint
  2. Condyloid joint
  3. Hinge joint
  4. Pivot joint
  5. Saddle joint
Hyper Extension

• Increase angle b/w articulation bones beyond the normal ROM.
• Takes body further backward from anatomical position.
• Allowed in:
  1. Ball and socket Joint
  2. Condyloid joint
  3. Pivot joint
  4. Saddle joint
Abduction

• Takes body part away from the midline of the body.

• Joints permit these:
  1. Ball and socket
  2. Condyloid joint
  3. Saddle joint
Adduction

• Takes body part towards the midline of the body.

• Joints permit these:
  1. Ball and socket
  2. Condyloid joint
  3. Saddle joint
Circumduction

• Combination of;
  Flexion, extension, abduction, adduction.
• Conical Movement from joint.
• Allowed at;
  1. ball and socket joint
  2. condyloid joint
  3. saddle joint
Lateral Flexion

- Body part is taken away from median plane by bending.
- Only possible at; Trunk and Neck joint.
- “Side Bending”
Figure N-7. Lateral flexion of neck right and left
Rotation movement

• Where something revolves around a single long axis.

• Two kinds of rotation:
  1. Medial/Internal Rotation
  2. Lateral Rotation
  3. Left/right rotation.
Medial Rotation

• Internal rotation
• Takes part of body inwards.
Lateral Rotation

• External Rotation
• Takes body part outwards.
Left and Right rotation

• At Trunk and Neck joint.
• Reference point: Front of chest or neck.
Special Movement

• Only occurs at certain joints.
• Cannot be classified as angular and rotational.
• Movements are as follows:
  i. Elevation
  ii. Depression
  iii. Protraction
  iv. Retraction
  v. Eversion
  vi. Inversion
  vii. Dorsiflexion
  viii. Plantarflexion
  ix. Pronation
  x. Supination
Special Movements

• **Elevation**
  Upward movement of structure.
  ex. Shrugging your shoulder; elevation of scapula.

• **Depression**
  Downward movement of structure of the body.
  ex. Depression of shoulder joint.
Special Movements

• **Protraction**
  Movement of structure in the anterior direction. ex. Crossing of arms; protraction of clavicle.

• **Retraction**
  Movement of structure in the posterior direction. ex. Uncrossing of arms; retraction of clavicle.
Special Movements

• **Eversion**
  Movement wherein plantar surface faces away from midline.
  ex. Foot eversion.

• **Inversion**
  Movement wherein plantar surface faces towards the midline.
  ex. Foot inversion
Special Movements

- **Dorsiflexion**
  Dorsum= upper surface; superior surface.
  bending at the ankle where toe lifted toward the knee.
  ex. Ankle dorsiflexion.

- **Plantarflexion**
  bending at ankle when heel is lifted.
  ex. Ankle plantarflexion.
Special Movements

- **Pronation**
  a kind of rotational movement of radius and ulna where forearm wherein palm faces down.
  ex. Pronation of forearm.

- **Supination**
  a kind of rotational movement of radius and ulna where forearm wherein palm faces up.
  ex. Supination of forearm
Eversion - 20 degrees (pronation)
0 degrees (neutral)
Inversion - 30 degrees (supination)

RIGHT FOOT
Planes of Motion

**Plane of Motion:** the two dimensional space cut by a moving body or the plane along which movements occur.

There are generally three planes used to describe segmental and body movements in physical activity. These are:

**Sagittal plane**
- a vertical plane that cuts the body into right and left sides

**Frontal plane**
- vertical plane that cuts the body into anterior (front) and posterior (back) parts

**Transverse plane**
- horizontal plane that cuts the body into superior and inferior parts
Anatomical Planes

(a) Frontal section through torso
(b) Transverse section through torso (superior view)
(c) Median (midsagittal) section
Anatomical Axes

Anatomical Axis: the point about which rotation of a body or of a body segment occurs.

There are three axes of rotation. Each axis is associated with a plane of motion and the axis is perpendicular to that plane.

Horizontal axis (...think East and West)
- passes through the body from side to side
- perpendicular to the sagittal plane

Anteroposterior Axis
- passes through the body from front to back
- perpendicular to the frontal plane

Longitudinal Axis (...think North and South pole)
- passes through the body from top to bottom
- perpendicular to the transverse plane
Gravity

The downward acceleration that a body experience while in the air is due to the influence of the earth on all bodies near to its surface, this influence known as gravity.

- It is represented by ‘g’ and it’s value is approximately 9.81 m/s².

\[ F = \frac{G \, M \, m}{R^2} \]

Where,  
- \( M \) = Mass of earth.  
- \( m \) = Mass of body  
- \( R \) = Radius of earth

- The acceleration due to gravity varies slightly from place to place on the earth surface.
Centre of gravity

- It is the point where the sum of all the forces and force moments acting on the body is zero.
- The centre of gravity of a body is also described as its balance or pivot point or centre of mass.
- The location of the centre of gravity in the human body is extremely important in many games.
IMPORTANCE OF CENTRE OF GRAVITY

- The location of centre of gravity is dependent on the shape of the body, so if some body is to take a different shape, the C.O.G. will shift.
- It is important to calculating thing in relation to torque, rotating objects etc.
- It is important to make balance of body
MEASUREMENT OF CENTRE OF GRAVITY

Centre of gravity can be measured by using various methods:-

- Joint point method
- Main point method
- Suspension method
- Reaction board method
- Pendulum method
- Template method etc.
Definition of equilibrium

A body is said to be in equilibrium if the resultant of the forces acting on it is equal to zero.
Types of Equilibrium

1. Static Equilibrium.
2. Dynamic Equilibrium.
When the equilibrium at rest is called static EQUILIBRIUM.
• **DYNAMIC EQUILIBRIUM**

When the EQUILIBRIUM at dynamic is called Dynamic EQUILIBRIUM
Neutral Equilibrium

When the center of gravity does not effect the Equilibrium

Horizontal
1. A person has balance when the center of gravity falls within the base of support.

2. A person has balance in the direct proportion to the size of the base. The larger the base of support, the more balance.

3. A person has balance depending on the weight (mass). The greater the weight, the more balance.

4. A person has balance, depending on the height of the center of gravity. The lower the center of gravity, the more balance.

5. A person has balance, depending on where the center of gravity is in relation to the base of support. Balance is less if the center of gravity is near the edge of the base. When anticipating an oncoming force, stability may be improved by placing the center of gravity nearer the side of the base of support expected to receive the force.
6. In anticipation of an oncoming force, stability may be increased by enlarging the size of the base of support in the direction of the anticipated force.

7. Equilibrium may be enhanced by increasing the friction between the body & the surfaces it contacts.

8. Rotation about an axis aids balance
   A moving bike is easier to balance than a stationary bike.
• Conditions of Dynamic Equilibrium

1. In walking a person throws the body in and out of balance with each step.

2. In rapid running movements where moving inertia is high, the center of gravity has to be lowered to maintain balance when stopping or changing direction.

3. In jumping activities the center of gravity needs to be raised as high as possible.
4. Opposite limbs movements also counter react the loss of equilibrium during directional changes.

5. The dynamic equilibrium depends to a greater extent on physiological factor – concern with the maintenance of posture and equilibrium especially.

6. To maintain dynamic equilibrium, the required amount of friction from the base is essential and it is related to the coefficient of friction.

For example:

- More ‘c’- difficult to move
- Less ‘c’- chances of slipping
The Principle of the Equilibrium

**Principle 1**  An Athlete increases their stability when their Line of Gravity is centralised within their base of support.

**Principle 2**  An athlete increases their stability when they increase size of their Base of Support.

**Principle 3**  An athlete increases their stability when the lower the height of their Centre of Gravity

**Principle 4**  An athlete increases their stability when they extend their base ,Line of Gravity in the direction of an oncoming force.
Principle 5  An athlete increase stability by increasing mass.

Principle 6  An increase in Friction can improve an athlete’s Stability

Principle 7  Rotation can improve an athlete’s Stability

Principle 8  Shifting the line of gravity toward oncoming forces can improve stability
Refernces

