INTRODUCTION

Biomechanics is the study of physics applied to human movement. The purpose of dealing with biomechanics is to develop a basic understanding of fundamental physics principles as applied to the human body in athletic performance.

I. NEWTON'S THREE LAWS OF MOTION

1. Law of Inertia. This law states that a body will maintain a state of rest or constant velocity unless acted upon by an external force that changes the state.
2. Law of Acceleration. This law states that a force applied to a body causes an acceleration of that body of a magnitude proportional to the force, in the direction of the force, and inversely proportional to the body's mass.
3. Law of Reaction. This law states that for every action, there is an equal and opposite reaction.

II. BIOMECHANICAL TERMS AND DEFINITIONS

1. Center of Gravity (COG) or Center of Mass (COM)- The point where the body's mass is considered to be concentrated. It is not a fixed point in the human body.
2. Parabolic Curve- The regular flight curve followed by the jumper's COG when projected in the air. The curve cannot be altered by movement in the air.
3. Action - Reaction (Newton's Third Law)- For every action there is an equal and opposite reaction. In the long jump landing, downward movement of the upper body and arms (action), helps the upward movement of the legs(reaction).
4. Inertia- The body's resistance to change in motion. A body at rest tends to stay at rest; a body in motion tends to stay in motion.
5. Force- Any physical cause that modifies the motion of a body, such as the force the shot putter exerts against the shot, the force the high jumper exerts against the ground, etc.
6. Impulse- Force x time. A change of velocity (e.g. of a shot or of the human body) is dependent upon the force itself and upon the time during which the force is applied. An increase in the force or in the time of the force will increase impulse.
7. Axis- A straight line about which a body, either animate or inanimate, rotates.
8. Linear Motion- Motion along a generally straight line, such as the path of the long jumper during the approach run.
9. Rotary Motion- Motion which is turning or rotating around an axis, such as the motion of the high jumper going over the crossbar, the turning of the discus thrower before the throw, or the movement of a runner's arms and legs.
10. Velocity- A distance traveled in a specific direction, divided by time.
11. Acceleration- A positive rate of change of velocity (speeding up).
12. Deceleration- A negative rate of change of velocity (slowing down).
13. Acceleration due to Gravity- The acceleration of a freely falling body, with an increasing velocity of approximately 32 feet per second every second that it falls.
14. Acceleration of a Limb- The acceleration in one direction creates a force in the opposite direction. The fast acceleration of the limbs at the beginning of take-off increases the ground reaction force.
15. Deceleration of a Limb- The deceleration in one direction creates a force in that direction. The sudden deceleration of the limbs "unweights" the take-off leg to facilitate its fast extension. (Also thought of as Transference of Momentum).
16. Centrifugal Force- A force fleeing the center.
17. Centripetal Force- A force seeking the center.
18. Transference of Momentum- The process through which momentum may be transferred from the entire body to one part, as in discus throwing.
19. Checking Linear Motion or Hinged Moment- When linear motion of a rigid object is interrupted at one end of the object, the other end continues ahead at an increased speed.
20. Conservation of Rotary Momentum- When the radius of a rotating body (or limb) is increased, the rotational velocity decreases. When the radius is decreased, the rotational velocity increases. (The classic example is of an ice skater spinning slowly with arms outstretched, and very quickly with arms held tightly to the body).

21. Rotary Inertia- The closer the mass to the axis of rotation, the less the resistance is to speeding up rotation. The arm of a metronome oscillates more rapidly as its weight is moved closer to the axis of rotation. The pole vaulter should keep as long and low as possible in the early part of the vault to speed the pole's rotation. The vaulter speeds up the body's rotation by tucking the knees in.
22. Radius of Rotation- For a constant turning speed, the greater the radius of rotation can be, the greater the linear velocity of the most distant part. In the discus the implement should be kept as far away from the body as possible. The throwing arm should be at a right angle (90 degrees) to the body.
23. Stretch Reflex- A stronger concentric muscle contraction can be obtained when it is directly preceded by a previous eccentric contraction. In other words, by breaking a motion opposite to the intended action, the stretched muscle will now contract more forcefully.
24. Torque or Body Separation- In the power position of the throwing events the hips open first or lead while the shoulders are still semi-closed and trailing. This is more obvious in the discus and the hammer where the mass of the implement and the radius of rotation slow the upper body and keeps it trailing the lower body throughout the turn. This creates a stretch reflex.

III. GENERAL MECHANICS

1. FORCE SHOULD BE APPLIED IN THE PROPER DIRECTION.
2. APPLY FORCE OVER THE GREATEST RANGE OF MOTION.
3. PROPER BODY POSITION- Body parts must be aligned correctly to apply maximum force in the desired direction.
4. SLOW TO FAST RHYTHM- Gradual acceleration should be used. It is the velocity (and direction) at take-off or release that determines the ultimate height or distance achieved.
5. SUMMATION OF FORCES- The movement should begin with the big/slow/strong muscles at the center of the body and end with the smaller/faster/weaker muscles at the extremities. The movement flows outward simultaneously from the center of the body in a slow to fast rhythm. The proper sequence and timing of the joint's contractions result in a fast continuous movement.