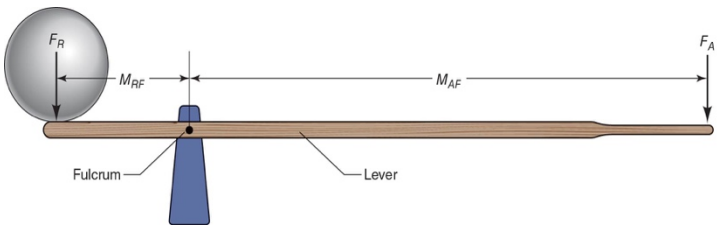
Chapter 2
The Biomechanics of Resistance Exercise
(Pages 19 to 42)

MUSCULOSKELETAL SYSTEM

- Skeleton: Through the system of bony levers, muscle force can be manifested as pulling or pushing.
  - Muscles can only PULL, not push.
  - The skeleton can be divided into the axial (cranium, verterbral column, ribs, sternum) & appendicular skeleton.

- Joints = junctions of bones
  - Fibrous joints
    - Allows virtually no movement
      - I.e. Sutures of the skull
  - Cartilaginous joints
    - Allow limited movement
      - I.e. Intervertebral disks
  - Synovial joints
    - Allow considerable movement
      - I.e. Elbow/knee
- Skeletal Musculature = enables the skeleton to move.
  - Origin:
    - **Proximal** (toward the center of the body) attachment.
    - More stationary structure to which the muscle is attached.
  - Insertion:
    - **Distal** (away from the center of the body) attachment.
    - More mobile structure to which the muscle is attached.
  - Agonist:
    - The muscle most directly involved in bringing about a movement
    - Prime mover
  - Synergist:
    - A muscle that assists indirectly in a movement.
- Levers of the Musculoskeletal System
  - Many muscles in the body do not act through levers.
  - Body movements directly involved in sport and exercise primarily act through the bone levers of the skeleton.
  - A lever is a rigid or semi-rigid body that, when subjected to a force whose line of action does not pass through its pivot point, exerts force on any objected impeding its tendency to rotate.
  - Force (R or A) always perpendicular to the moment arm.



  - Torque
    - A rotary force
    - Also called moment
    - Degree to which a force tends to rotate an object about a specified fulcrum.
    - Is the magnitude of a force times the length of its moment arm

        - **T = F x d⊥**
    - Mechanical advantage
        - Ratio of the moment arm through which an applied force acts to that through which a resistive force acts.
        - **MA = M_{AF} / M_{RF}**
        - Moment arm = perpendicular distance from the line of action of the force to the fulcrum
            - Also called force arm, lever arm, or torque arm
        - Muscle force = force generated by biochemical activity, or the stretching of noncontractile tissue, that tends to draw the opposite ends of a muscle toward each other.
        - Resistive force = force generated by a source EXTERNAL to the body that acts contrary to muscle force.
        - 1st class lever: Fm x Mm = Fr x Mr
        - Because Mm is much smaller than Mr, Fm must be much greater than Fr
        - **MA > 1.0**
            - Allows $F_A < F_R$ to produce an equal amount of torque.
            - Is an advantage.
            - Favors high strength & low velocity.
        - **MA < 1.0**
            - Allows $F_R < F_A$ to produce an equal amount of torque.
            - Is a disadvantage.
            - Favors low strength & high velocity.

Mechanical advantage: MA = M_{AF}/M_{RF} = F_{RF}/F_{AF}. MA=1 = Equilibrium; MA > 1 (Advantage); MA < 1 (Disadvantage)

- Class of levers:
  1st: **F_{AF}** ---------- Fulcrum ---------- F_{RF}
  2nd: **F_{AF}** ---------- F_{RF} ---------- Fulcrum
  3rd: F_{RF} ---------- **F_{AF}** ---------- Fulcrum (>95% of our musculoskeletal system)

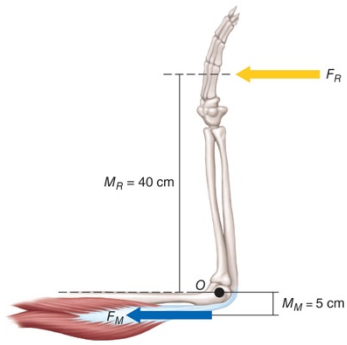
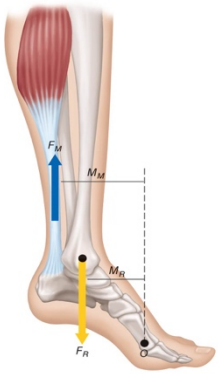
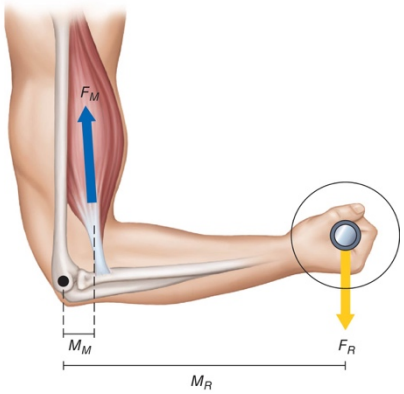
    - The patella and mechanical advantage
        - The patella increases the MA of the quads muscle group by maintained the quads tendon's distance from the knee's axis of rotation.
    - Moment arm & mechanical advantage
        - The moment arm (M) varies throughout the range of joint motion.
        - When the M is shorter, there is less MA.
        - Bicep curl
            - Between 90 and 100 degrees → maximal torque
        - As a weight is lifted, the *M* through which the weight acts, & thus the resistive torque, changes with the horizontal distance from the weight to the elbow.
        - Same set up with a constant resistance machine

How to identify a lever's class?

- What is the location of the fulcrum relative to the muscle force (F_M) & the resistive force (F_R)?
    - Between or on an end.
- What is the location of the muscle force (F_M) relative to the resistive force (F_R) & the fulcrum?
    - Between or on an end.
- On which sides of the axis of rotation (fulcrum) are the muscle & resistive forces applied?
    - The same side or opposite sides of the fulcrum.
- Which force is closer to the fulcrum?
    - The muscle force (F_M) or resistive force (F_R).
- In which direction are the muscle & resistive forces acting?
    - The same side or opposite sides.

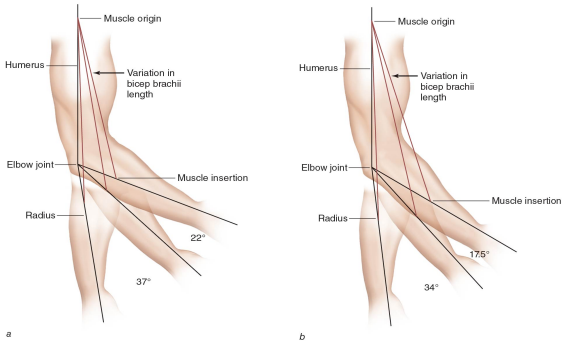
KEY POINTS:

- Most of the skeletal muscles operate at a considerable mechanical **disadvantage**.
  - MA = MA/MR
- The primary lever orientation in the human musculoskeletal system (>95%) is **3rd class**.
- FA closer to the fulcrum
- Thus, humans are built more for **speed** than strength.
  - We can't improve our strength*
- Thus, during sports and other physical activities, forces in the muscles and tendons are much higher than those exerted by the hands or feet on external objects or the ground.
- Understanding the principle of MA is of greater importance than classifying the lever.

1st class lever	2nd class lever	3rd class lever
		
Examples: -elbow extension against resistance -Atlanto-occipital joint = weight of head & capitis Spenius	Examples: -Plantarflexion gainst resistance	Examples: - Elbow flexion against resistance - Pulling a nail with a hammer
Orientation: like a seesaw	Orientation: like a wheel-barrow	Orientation: like a pair of tweezers
Pivot is located between resistance and effort	Resistance located between the pivot and the effort	Effort in the middle of pivot and resistance
MA = M_M / M_R	MA = M_M / M_R	MA = M_M / M_R
Disadvantage: MA < 1.0 .	Advantage: MA > 1.0 . (When the body is stationary or moving upward at a constant velocity, because $M_M > M_R$, $F_M < F_R$.)	Disadvantage: MA < 1.0 . (This is a disadvantage because a larger muscular force is required to move the resistance.)
During isometric exertion or constant-speed joint rotation, F_M x M_M = F_R x M_R . Because $M_M < M_R$, $F_M > F_R$.	When the body is stationary or moving upward at a constant velocity Because $M_M > M_R$, $F_M < F_R$.	When the arm is stationary or moving upward at a constant velocity, Because $M_M < M_R$, $F_M > F_R$.

***3rd class = Most common levers in the body in the human body because muscle insertion are so close to the joint that they move

- Variations in Tendon Insertion
  - Tendon insertion:
    - The points at which tendons are attached to bone.
  - Tendon insertion **farther** from the joint center:
    - Results in the ability to lift heavier weights.
  - This arrangement:
    - Results in a loss of maximum speed.
    - Reduces the muscle's force capability during faster movements.
  - Insertion close to joint: Shorter moment arm, but faster movement speed
  - Insertion farther from joint: Longer moment arm, higher torque, but slower movement speed.



- A → better for speed, not strength
- B → better for strength, not speed = GREATER MA
  - Has a larger moment arm and thus greater torque for a given muscle force, but less rotation per unit of muscle contraction and thus slower movement speed.

- Anatomical Planes & Major Body Movements
  - Sagittal plane = cuts the body in a left/right way
  - Transverse plane = cuts the body into a superior/inferior way
  - Frontal plane = cuts the body in a anterior/posterior way
  - Always come back to the anatomical position = palms facing forward

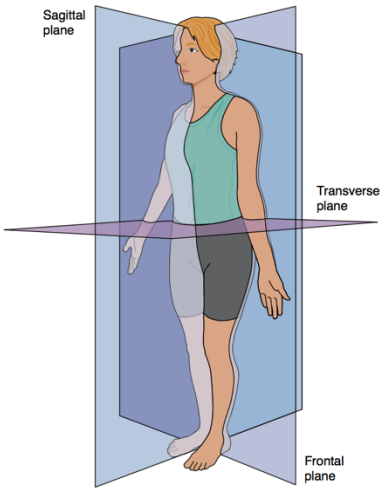


Figure 4.10 The three planes of the human body in the anatomical position.

Resistance Exercise	Anatomical Plane
Standing barbell curl	Sagittal plane
Lateral dumbbell raise	Frontal plane
Dumbbell fly	Transverse plane
Curl-ups	Sagittal plane
Standing heel raise	Sagittal plane
Leg extension	Sagittal plane
Bench press	Transverse plane
Triceps pushdown	Sagittal plane

HUMAN STRENGTH AND POWER

Basic Definitions

1) Strength: The maximal force that a muscle or muscle group can generate at a specific velocity. I.e Powerlifting: heavy loads + slow movement
    - Capacity to exert force at ANY given speed
    - Often associated with slow speeds of movement
2) Power: The time rate of doing work. **Power = Work/Time** (W or J/s)
    - Where Work* (Joules) = Force(N) * Distance(m)
    - *Work is used to quantify the volume of a workout
    - Often associated with fast speeds of movement
    - Note: Force = health related / Velocity = skill related

- **Do not study Table 2.1.**
- Strength Versus Power
    - Although the word strength is often associated with slow speeds and the word power with high velocities of movement, both variable reflect the ability to exert force at a given velocity. Power is a direct mathematical function of force and velocity.
    - Force, velocity, power (if 2, can calculated 3rd)
    - Strength is the capacity to exert force at any given velocity.
    - Power is the mathematical product of force and velocity at any given speed.
    - Weightlifting (Olympic lifting) → + power (faster)
    - Powerlifting → + strength (slower)
- **You are not responsible for any calculations in this section but you need to understand the concepts of positive work, negative work, angular work, and power are & how they are interrelated.**
    - Positive work = Force and displacement have the same direction
    - Negative work = Force and displacement have opposite directions
    - Angular work = The angle through which an object rotates
    - Interrelation = Angular Work = Torque * Angular Displacement

- Biomechanical Factors in Human Strength

1. **Neural control =** Affects the max. Force output of a muscle by determining which and how many motor units are involved in a muscle contraction (recruitment) and the rate at which the motor units are fired (rate coding)

- Muscle force is greater when
    - More motor units are involved in a contraction
    - The motor units are greater in size
    - The rate of firing is faster
- Much of the improvement in strength evidenced in the first few weeks of resistance training is attributable to neural adaptations as the brain learns how to generate more force from a given amount of contractile tissue.

2. **Muscle cross-sectional area**

- All else being equal, the force a muscle can exert is related to its cross-sectional area RATHER THAN to its volume.
    - (same circumference)
- Resistance training increases both the strength and cross-sectional area of muscle.

3. **Arrangement of muscle fibers**

- Variation exists in the arrangement and alignment of sarcomeres in relation to the long axis of the muscle.
- Pennate muscles have fibers that align obliquely with the tendon. Muscles with greater pennation have more sarcomeres in parallel and fewer sarcomeres in series; they are therefore better able to generate force but have lower max. Shortening velocity than nonpennate muscle.

- Pennate muscle = fibers that align obliquely with the tendon, creating a feather-like arrangement.
- Angle of pennation:
    - Angle between the muscle fibers and an imaginary line between the muscle's origin and insertion
    - 0° = no pennatation
    - Most often the pennation angle is ≤ 15 degrees.
    - The angle of pennation does not remain constant for a given muscle, but increases as the muscle shortens.
- Less pennation → more speed
- More pennation → more strength
- Pennation is modifiable through training.
- As long as s muscle's CSA remains the same, an increase in pennation:
    - Allows a muscle to generate a greater amount of force than a nonpennate muscle
    - Results in a lower maximal shortening velocity than nonpennate muscle
- Pennation:
    - Results in a decreased capability to generate isometric, eccentric, or low-speed concentric force.

4. Muscle length

- A muscle can generate the greatest amount of force when it is at its resting length.
- When the muscle is stretched beyond or contracted below its resting length, it generates less tension.
    - This is explained by the sliding filament theory.
- Resting length → max number of potential crossbridges sites are available.
- Myosin and actin filaments lie next to each other
- Stretched beyond resting length = fewer cross-bridge available
- Contracts too much = cross-bridge overlap

5. Joint angle

- The forces that muscles produce must be manifested as torques.
    - Torque → anything rotational
- Higher torque value indicates a greater tendency for the applied force to rotate the limb or body part around a joint.
- Always associate torque with joint angle (rather than force because torque is a rotational force)
- Amount of torque that can be exerted about a given body joint varies throughout the joint's ROM and depends on:
    - The force versus muscle length relationship,
    - The variation in leverage attributable to the dynamic geometry of the muscles, tendons, & internal joint structures,
    - Type of exercise,
    - The body joint in question,
    - The muscles used at that joint, and
    - The speed of contraction

6. Muscle contraction velocity

- Muscle action = contraction

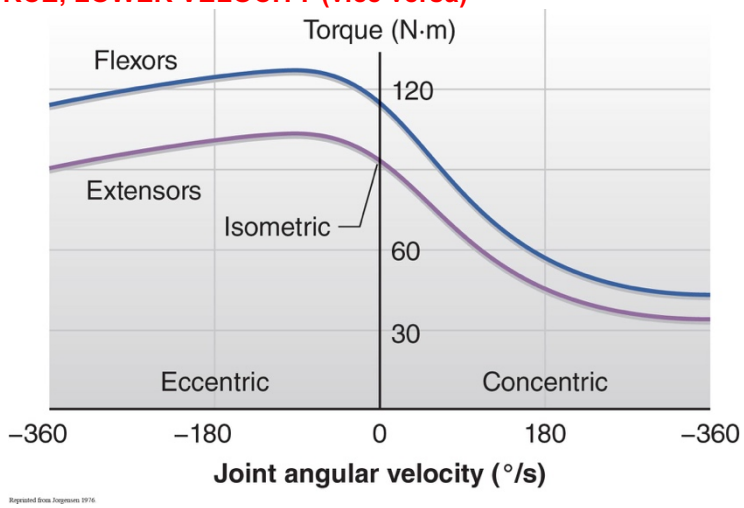
→ Concentric muscle action
    - Muscle shortens BECAUSE the contractile force is greater than the resistive force.
    - The forces generated within the muscle and acting to shorten it are greater than the external forces acting at its tendons to stretch it.
    - I.e.: sports with concentric muscle action exclusively: swimming and cycling

→ Eccentric muscle action
    - Muscle lengthens BECAUSE the contractile force is less than the resistive force
    - Increases the risk of soreness and injury
    - Always occurs during the lowering phase of any resistance exercise.

→ Isometric muscle action

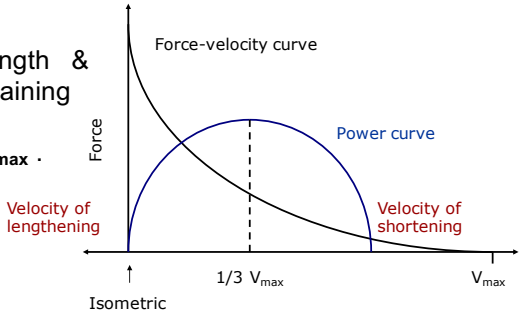
- Muscle length does NOT change BECAUSE contractile force = resistive force

- Force-velocity relationship (FOR CONCENTRIC)
  - The force capability of muscle decreases as the velocity of contraction increases.
  - More specifically, as the velocity of movement increases, the maximal force a muscle can produce concentrically decreases.
  - This relationship is not linear.
  - The decline is steepest when speed is increasing from slow to moderate, & less steep when speed is increasing from moderate to fast.
- **GREATER FORCE, LOWER VELOCITY (vice versa)**



1. At 0 = isometric contraction (more force here)
2. *** Steeper at lower velocities

- Muscle torque varies with joint angular velocity.
- Torque capability declines as angular velocity increases.
- During eccentric exercise, as joint angular velocity increases, maximal torque capability increases! → The greatest muscle force can be obtained during eccentric muscle action.
  - Why do you produce more torque/force in eccentric?
    - 2 tensions: passive & active tensions
    - The more you lengthen, the more passive technique you have that will you have to add up to your active tension in your concentric movement
- Relationship between force-velocity & power
  - This relationship is used by sports scientists and strength & conditioning coaches to design effective strength & power training programs.
  - **The maximum power of a muscle is typically around 1/3 V_{max} .**
    - Concentric muscle action = V_{max}
  - Goos strength-power training program will shift the force-velocity curve to the right & the power curve upwards.



7. Joint angular velocity

- Muscle torque varies with joint angular velocity, according to the type of muscular action:
  a. Concentric muscle action,
     i. Shortening of muscle because contractile force greater than resistive
  b. Eccentric muscle action,
     i. Lengthening of muscle because contractile force is less than resistive
     ii. Max. Torque increases to 90°/s, then decreases.
        1. We don't see the inverse relationship anymore

c. Isometric muscle action.
    i. No change in muscle length because contractile force = resistive.
2. During isokinetic concentric exercise:
    a. Torque capability declines as angular velocity increases.
3. During eccentric exercise:
    a. Maximal torque capability increases until about 90°/s, after which it declines gradually.
        i. We don't see the inverse relationship anymore
4. Muscle force (torque also in angular movement): Eccentric > isometric > concentric.

8. Strength-to-Mass ratio

- Directly reflect an athlete's ability to accelerate his or her body.
- Force of muscle generated / body mass
- Important in a variety of sports:
    - Sprinting (body like a projectile)
    - Jumping
    - Weight classification (judo).

9. Body size

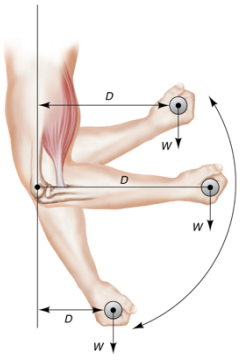
- Smaller athletes are stronger pound for pound than larger athletes.
- As body size increases, body mass increases more rapidly than does muscle strength.
- Classic formula: load lifted / (body weight ^2/3).
- Muscle contractile force proportional to CSA & muscle mass proportional to volume.

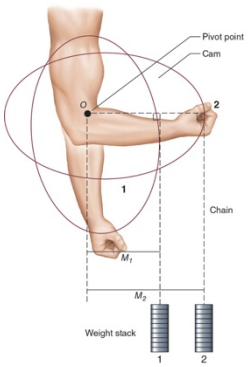
SOURCES OF RESISTANCE TO MUSCLE CONTRACTION

- Gravity
    - Applications to Resistance Training
    - Weight-Stack Machines
- Inertia
- Friction
- Fluid Resistance
- Elasticity

1. Gravity

- $F_g = m \times a_g$
    - F_g = force due to gravity = object's weight (N).
    - M = the mass of an object (kg).
    - A_g = the local acceleration due to gravity (9.8 m/s).
- Gravitational Force
    - On an object always acts downwards.
- Moment Arm
    - Of a weight is always horizontal.
- Weight = includes gravity
- Mass = same everywhere
- **Application of Gravity to Resistance Exercise Training**
    - During an exercise with a free weight, the weight does not change, but the length of moment arm changes.
    - When weight is horizontally closer to joint = less resistive torque
    - When weight is horizontally farther to joint = more resistive torque
    - In cam-based weight-stack machines, the moment arm of the weight stack varies during the exercise movement.
    - When the cam is rotated in the direction shown from position 1 to position 2, the moment arm of the weights, and thus the resistive torque, increases.
    - Cam-based machines (anything oval) → resistance changing
- **Weight-stack machines**





- Gravity is the source of resistance
- The machines provide increased control over the direction and pattern of resistance

2. Inertia

- Resistance to movement
- Is the tendency for a body to resist acceleration
- Is the tendency of a body at rest to remain at rest or of a body in motion to stay in motion in a straight line unless disturbed by an external force
- To overcome inertia → apply external force
- Acceleration and deceleration are characteristic of virtually all natural movements.
- Majority in sports acceleration & deceleration involved
- Inertial Force
  - Can act in any direction. (difference from gravity)
  - MA always 90 to vector force
  - Vector has both magnitude and direction
- **Application of Inertia to Resistance Exercise Training**
  - Upward Phase of the Biceps Curl
    - Must overcome gravitational & inertial forces to move the barbell upwards.
    - At the beginning of the exercise,
      - The bar is accelerated from a zero velocity to an upward velocity.
    - Near the top of the exercise,
      - There is some deceleration to bring the bar's velocity back to zero.
    - Early in the ROM,
      - The agonist muscles receive resistance in excess of the bar weight.
    - Toward the end of the ROM,
      - The agonist muscles receive resistance less than the bar weight.
- **Forms of acceleration training**
  - Explosive Exercises
    - Snatch
    - Classified as a power exercise
      - Over head
    - Clean & Jerk
    - Power Clean
      - End point: in front of clavicles
    - High Pull
  - Bracketing Technique
    - A sport movement is performed with less than normal & greater than normal resistance.
    - BOTH TYPE of exercises!!
    - Neuromuscular training

3. Friction

- Is the resistive force encountered when one attempts to move an object while it is pressed against another object.
- $F_R = k \times F_N$
  - F_R = resistive force.
  - K = coefficient of friction for the 2 substances in contact (coefficient of static or moving friction).
  - K higher, resistance higher
  - F_N = normal force, which presses the objects against each other.
- **Application of Friction to Resistance Exercise Training**
  - A Football Lineman Pushes a Weighted-Sled.
    - It takes more force to initiate the sled's movement than to maintain its initial movement because the coefficient of static friction is always > than the coefficient of sliding friction.
    - Must overcome the resistance due to the sled's inertia
      - Directly proportional to the sled's mass & acceleration.

        - Must also overcome the resistance due to the friction between the sled's runners & the ground
            - Proportional to the friction coefficient between the contact surfaces & the net force pressing against the sled.

4. **Fluid-resistance**
    - Is the resistive force encountered by an object moving through a fluid (liquid or gas), or by a fluid moving past or around an object or through an orifice.
    - **2 Sources of Fluid Resistance**
        - Surface Drag
            - Results from the friction of a fluid passing along the surface of an object.
            - Definitely during swimming
        - Form Drag
            - Results in the way in which a fluid presses against the front or rear of an object moving through it.
            - Try to eliminate in sports: swimming
    - Hydraulic (liquid) & pneumatic (gas) exercise machines.
    - $F_R = k \times v$
        - F_R = resistive force.
        - K = constant that reflects:
            - The physical characteristics of the cylinder & piston,
            - The viscosity of the fluid, &
                - Thicker fluid → + resistance
            - The number, size, & shape of the orifices.
        - V = piston velocity relative to the cylinder.
    - **Application of Fluid-Resistance to Resistance Exercise Training**
        - Fluid-Resisted Exercise Machines
            - Most often use cylinders in which a piston forces through an orifice.
            - How can the resistive force be increased using this machine?
            - Machines increase setting
            - Allow rapid acceleration early in the exercise movement.
                - Beginning of the movement → acceleration
                - Full ROM → machine slows down
            - Allow little acceleration after higher speeds are achieved.
            - Cannot perform isokinetic exercise on these machines.
            - Do not generally provide an eccentric exercise phase, although machines with an internal pump do.
                - Many machines do not have a eccentric phase
                - Only time they do have → internal pump

5. **Elasticity**
    - FR = k x x
        - FR = resistive force.
        - K = constant that reflects the physical characteristics of the elastic component.
        - X = distance that the elastic component is stretched beyond its resting length.
    - **Application of Elasticity to Resistance Exercise Training**
        - Stretching an Elastic Band
            - The more that the band is stretched, the greater the resistance.
            - The exercise movement begins with low resistance & ends with high resistance.
            - The adjustability of the band's resistance is limited.

Negative Work & Power

- Negative power & work occur during eccentric muscle activity.
- Negative work really refers to work performed on, rather than by, a muscle.
- The rate at which the repetitions are performed determines the power output.
- Force exerted on a weight in the direction opposite to the one in which the weight is moving

    - I.e. Lowering object in a controlled manner
- Refers to work performed ON a muscle

JOINT BIOMECHANICS: CONCERNS IN RESISTANCE TRAINING

- Study:
    - Back:
        - When standing upright, any force exerted with upper body must be transmitted through the back to the legs and ground
        - Back muscles act at a great mechanical disadvantage and must generate forces much greater than the weight of an object lifted
    - Back Injury:
        - Lower back vulnerable
        - Flat back lifting better than rounded back; minimize compression force
        - Resistance training should be performed with a lower back slightly arched
    - Intra-Abdominal Pressure
        - Diaphragm contraction creates pressure in the abdominal cavity with all the fluids.
        - Pressure is called FLUID BALL = aids in supporting vertebral column during resistance training
        - Valsalva maneuver not necessary, but it can increase the rigidity of entire torso
    - Lifting Belts
        - Have been shown to increase intra-abdominal pressure during resistance training and are this probably effective in improving safety
        - Not needed for exercise that do not affect directly lower back
        - “overuse” of belt can inhibit abs muscle to produce intra-abdominal pressure (lack of training stimulus)

- Do Not Study:
    - Shoulders
    - Knees
    - Elbows & Wrists

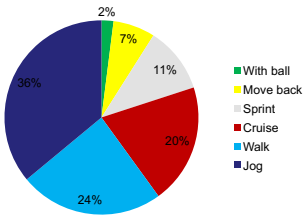
Chapter 17
Needs Analysis
(Pages 441 to 443)

- What is a needs analysis?
  - Assess an athlete for the purpose of designing a traditional or a periodized exercise training program.
  - It's the first step in the design of any exercise training program.
  - The initial task performed by the strength & conditioning professional (SCP)
  - It has a 2-stage process
- What are the stages of a need analysis?
  - Evaluation of the requirements and characteristics of the sport
  - Assessment of the athlete
- What are the minimum attributes that should be considered when evaluating a sport?
  - Movement analysis = Body and limb movement patterns & muscular involvement
  - Physiological analysis = Cardiorespiratory endurance, muscular strength, muscular endurance, hypertrophy, body composition, flexibility, speed, speed endurance, power, agility, balance, and reaction time priorities
  - Injury analysis = Common joint & muscle injury sites & causative factors
- Are there any other attributes of a sport that need to be evaluated?
  - Players position
- What factors are considered when assessing an athlete?
  - Training status
    - Resistance, cardiorespiratory, speeding, plyometric training
    - Defined as an athlete's current condition or level of preparedness to begin a new or revised program
    - Includes:
      - An evaluation of any current or previous injuries
      - Training background or exercise history
  - Injury status
    - Evaluation is performed by a sports medicine professional
    - Current or previous injuries
    - Type of injuries:
      - Acute injuries
        - Traumatic injuries
        - Hard to prevent
      - Chronic injuries
        - Overuse injuries
        - I.e. Tendonitis, patella-femoral injury, IT band sundrome, plantar fasciitis, shin splits…
  - Physical testing & evaluation
  - Determining the primary exercise training goal
- How does one assess an athlete's training status or training background?
  - Type of training program
  - Length of recent regular participation in previous training program(s)
  - Level of intensity involved in previous training program(s)
  - Degree of exercise technique experience
- What are the criteria for the physical testing and evaluation of an athlete?
  - The tests selected should be:
    - Related to the athlete's sport
    - Consistent with the athlete's level of skill
    - Realistically based on the equipment available
  - Use the results of the movement analysis to select tests

- After testing, compare results with normative or descriptive data to determine the athlete's strengths and weaknesses

- What is the importance of a needs analysis in the development of an athlete's training program?
  - A needs analysis includes the general physiological and biomechanical profile, common injury sites, and position specific attributes. This information allows the strength and conditioning professional to design a program specific to those requirements and characteristics.
- What factors determine an athlete's primary resistance training goal?
  - Athlete's test results
  - Movement & physiological analysis of the sport
  - Priorities of the athlete's sport season
    - Directly related to periodization
- **What kind of needs analysis would you perform for a professional soccer player?**
  - Skills critical to soccer
    - Turning
    - Sprinting
      - Accounts for approx. 1% of total game time
    - Changing pace
- **Definitely read the review article on the physiology of soccer. You are not responsible for the material regarding soccer referees.**
  - **Stolen, T., Chamari, K., Castagna, C., & Wisloff, U. Physiology of soccer: An Update. (2005). Sports Medicine 35(6): 501-536.**
- What factors affect soccer performance?
  - Technical
  - Tactical
  - Physical
  - Physiological
  - Mental
- What are the physical demands of soccer?
  - Distances covered at the top level:
    - Field players – 10 to 12 km.
    - Goalkeeper – 4 km.
  - Midfield players run the longest distances during a game.
  - Professional players run longer distances than non-professionals.
  - 2nd half compared to the 1st half:
    - The exercise intensity is decreased.
    - The distance covered is 5 to 10% less.
  - A sprint bout occurs approximately every 90s, each lasting an average of 2-4 s.
  - Sprinting constitutes 1-11% of the total distance covered during a game, which corresponds to 0.5 to 3.0% of effective play time.
  - 96% of the sprint bouts during a game are <30 m.
  - 49% of the sprint bouts during a game are <10 m.
- How does player position affect physical demands of soccer?
  - Fullbacks
    - Sprinted 2.5 x longer than central-defenders.
  - Midfielders
    - Sprinted 1.6 to 1.7 x longer than central-defenders.
  - Sprinting Time
    - Fullbacks & Attackers > Midfielders > Central defenders.
  - Endurance Context of the Game
    - Each player performs 1000-1400 mainly short activities changing every 4-6 s.

- Which activities are performed during a soccer game?
  - Sprints
  - High-intensity running
  - Tackles
  - Headings
  - Involvement with the ball
  - Passes
  - Changing paces
  - Sustaining forceful contractions to maintain balance & control of the ball against defensive pressure



- Which components of physical fitness are important to soccer?
  - Health-related
    - Cardiorespiratory endurance
    - Muscle strength
    - Muscle endurance
  - Skill-related
    - Power
    - Speed
    - Agility
    - Reaction time
- How are the components of physical fitness affected by a soccer player's position?
  - Since midfields run a larger distance, they will need a higher cardiorespiratory endurance.
  - A goal keeper will need a quick reaction time
- What is the physiological profile of soccer players?
  - **VO_2max**
    - Adult male field players
      - 50-75 $ml \cdot kg^{-1} \cdot min^{-1}$
    - Adult female field players
      - 38.6-57.6 $ml \cdot kg^{-1} \cdot min^{-1}$
    - Adult male goalkeepers
      - 50-55 $ml \cdot kg^{-1} \cdot min^{-1}$
  - **Anaerobic Threshold**
    - Adult male players
      - 76.6-90.3% hrmax
- Does soccer involve aerobic and anaerobic metabolism?
  - Yes, aerobic metabolism (walking, jogging) and anaerobic metabolism (short sprints, interval training)
  - Average work intensity during a soccer match:
    - Normally between 80-90% hrmax
    - Close to the anaerobic threshold

Chapter 12
Principles of Test Selection & Administration
(Page 249 to 258)

➢ REASONS FOR TESTING

- Assessment of athletic talent
  - Determine if individual has physical potential to play the sport at a competitive level.
  - Coach needs a way of determining if a candidate has basic physical abilities, that with combination of technique training and practice, could produce a competitive player.
- Identification of physical abilities & areas in need of improvement & maintenance
  - Determine which deficits of the athletes can be ameliorated through prescribed exercise programs.
- Setting realistic goals using baseline measurements
  - Test scores can be used in goal setting. Baseline measurements can establish starting points. Testing at regular intervals can help track an athlete's progress.
- Evaluation of progress
- Identification of physical staleness, burnout & overtraining
  - Relates to overtraining syndrome

➢ TESTING TERMINOLOGY

- Test = A procedure for assessing ability in a particular endeavor
- Field test = A test used to assess ability that is performed away form the laboratory and does not require extensive training or expensive equipment
- Measurement = The process of collecting test data
- Evaluation = The process of analyzing test results for the purpose of making decisions
- Pretest = A test administered before the beginning of training to determine the athlete's initial basic ability levels
- Midtest = A test administered one or more times during the training period to assess progress and modify the program as needed to maximize benefit
- Formative evaluation = Periodic reevaluation based on midtests administered during the training, usually at regular intervals
  - Enables monitoring of the athlete's progress
  - Enables adjusting the training program for the athlete's individual needs
  - Allows evaluation of different training methods
  - Allows collecting of normative data
- Posttest = A test administered after the training period to determine the success of the training program in achieving the training objectives

➢ EVALUATION OF TEST QUALITY

Validity

1) Construct validity
   - Face validity
   - Content validity
   - Criterion-referenced validity
     - Concurrent validity
       - Convergent validity
     - Predictive validity
     - Discriminant validity

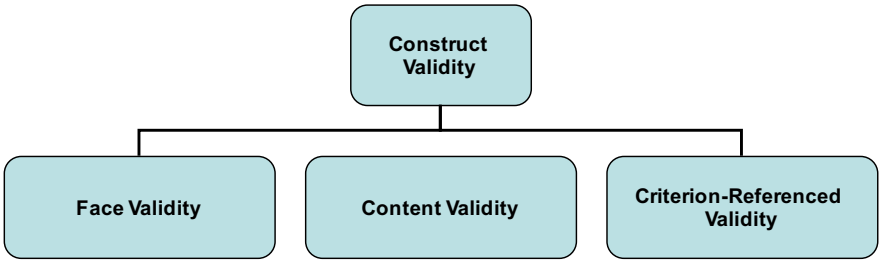
Reliability

1) Test-retest reliability
2) Typical error of measurement
3) Intrasubject variability
4) Interrater reliability

Objectivity
1) Interrater agreement
2) Intrarater variability

Validity
- The degree to which a test or test item measures what it is supposed to measure.
- One of the most important characteristics of testing.
- More difficult to establish in tests of basic athletic abilities or capacities than those of physical properties (Height & Weight).

Construct validity
- Is the ability of a test to represent the underlying construct
- Construct = the theory developed to organize & explain some aspects of existing knowledge & observations
- Refers to overall validity, or the extent to which the test actually measures what it was designed to measure



Face validity
- Is the appearance to the athlete & other casual observers that the test measure what it is purposed or supposed to measure
- The assessment of face validity is generally informal & nonquantitave.

Content validity
- Is the assessment by experts that the testing covers all relevant subtopics or component abilities in appropriate proportions
    - Example: A Test Battery for soccer players should include at minimum, tests of sprinting speed, agility, coordination, & kicking power.
- A test battery for soccer players should include, at minimum, tests of:
    - Sprinting speed
    - Agility
    - Coordination
    - Kicking power
- A test developer can ensure content validity by:
    - Listing the ability components to be assessed
    - Making sure the ability components are all represented on the test
    - Verifying that the proportion of the total score attributable to a particular component ability should be proportional to the importance of that component to total performance

Criterion-referenced validity
- Is the extent to which test scores are associated with some other measure of the same ability
- Is often estimated statistically
    - A Pearson product moment correlation coefficient
- Types of criterion-referenced validity:
    1. Concurrent validity
        a. Convergent validity
    2. Predictive validity

3. Discriminant validity

1. Concurrent validity
- Is the extent to which test scores are associated with those of other accepted tests that measure the same ability.
- Convergent validity
  - Is evidenced by a high positive correlation between results of the test being assessed & those of the recognized measure of the construct (the "gold standard").
  - Is the type of concurrent validity that field tests should exhibit.

2. Predictive validity
- Is the extent to which the test score corresponds with future behavior or performance.
- Can be measured by comparing a test score with some measure of success in the sport.
- Example:
  - The correlation between the overall score on a battery of tests used to assess basketball potential & a measurement of actual basketball performance.

3. Discriminant validity
- Is the ability of a test to distinguish between 2 different constructs & is evidenced by a low correlation between the results of the test & those of a different construct.
- It is best if tests in a battery measure relatively independent ability components.

Reliability
→ Is a measure of the degree of consistency or repeatability of a test.
→ A test must be reliable to be valid.
→ However, a reliable test may not be valid because it may not measure what it is supposed to measure.
→ Test-Retest Reliability
  - Administer same test twice to same group of athletes. Statistical correlation of the scores from the two different administrations provides a measure of test-retest reliability.
→ **Factors that produce measurement error:**
  - Intrasubject variability
  - Lack of interrater reliability or agreement
  - Intrarater variability
  - Failure of the test itself to provide consistent results.

Term	Definition
Intrasubject variability	The lack of consistent performance by the person being tested.
Intrarater variability	The lack of consistent scores by a given tester.
Interrrater reliability	The degree to which different raters agree; also referred to as objectivity or interrater agreement.

Sources of interrater differences:
1. Calibration of testing devices
2. Preparation of athletes
3. Administration of the test

Sources of intrarater error:
1. Unintentional leniency.
2. Inadequate training.

3. Inattentiveness.
4. Lack of concentration.
5. Failure to follow standardized procedures for:
    - Testing-device calibration,
    - Athlete preparation,
    - Test administration, or
    - Test scoring.

➢ **Test selection**

1) Metabolic energy system specificity
2) Biomechanical movement pattern specificity
3) Experience and training status
4) Age and sex
5) Environmental factors

1) Metabolic energy system specificity

- A valid test must emulate the energy requirements of the sport for which ability is being assessed.
- Must understand the 3 basic energy systems & their interrelationships in order to apply the principle of specificity when choosing or designing valid tests to measure athletic ability.
    - **Phosphagen, Glycolytic, Oxidative energy systems.**

2) Biomechanical movement pattern specificity

- The more similar the test is to an important movement in the sport, the better.
- Sports differ in their physical demands.
- Positions within a sport differ.

3) Experience and training status

Consider the:

- Athlete's ability to perform the technique.
- Athlete's level of cardiorespiratory endurance, strength, speed, and power training.
- The type of resistance training equipment being used by the athlete.
- The type of resistance training exercise being used to test the athlete.

4) Age and sex

- Can affect the validity & reliability of a test.
- 1.5-Mile Run
    - Aerobic power test.
    - College-aged men & women vs. Male & female preadolescents.
    - Indirect test & field test
- Maximum # of Chin-Ups
    - Muscular endurance test.
    - Men vs. Women.

5) Environmental factors

- High Ambient Temperature + High Humidity
    - Can impair endurance exercise performance.
    - Can lower the validity of aerobic endurance tests.
    - Can pose health risks.
- Temperature fluctuations can reduce the ability to compare test results over time.
- Altitude
    - Can impair performance on aerobic endurance tests.
    - Does not impair performance on tests of strength and power.

➢ **Test administration**

1) Health & safety considerations
2) Selection and training of testers
3) Recording forms
4) Test format
5) Testing batteries & multiple testing trials
6) Sequence of tests
7) Preparing athletes for testing

1) Health & safety considerations

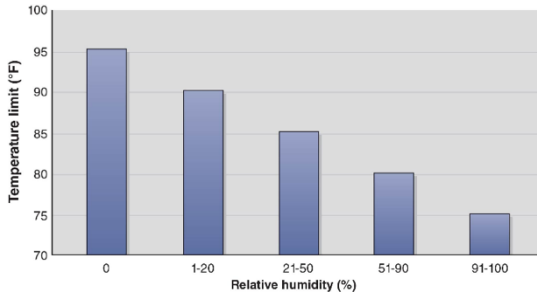
The Strength & Conditioning Professional must:

- Be aware of testing conditions that can threaten the health of athletes.
- Be observant of signs and symptoms of health problems that warrant exclusion from testing.
- Remain attentive to the health status of athletes, especially before, during, and after maximal exertions.
- Temperature limits at various ranges of relative humidity for strenuous exercise testing.

2) Selection & training of testers

Testers:

- Should be well trained.
- Should posses a thorough understanding of all procedures & protocols.
- Should perform & score all tests correctly.
- Must have sufficient practice.
- Should be trained to explain & administer the tests as consistently as possible.



3) Recording forms

Scoring forms should:

- Be developed before the testing session
- Have space for all test results & comments

4) Test format

- Consider whether athletes will be tested all at once or in groups.
- The same tester should administer a given test to all athletes if possible.
    - Ideal situation
- Each tester should administer one test at a time, especially when the tests require complex movements.

5) Testing batteries & multiple testing trials

- Duplicate test setups can be used for large groups.
- When multiple trials of a test or a battery of tests are performed, allow complete recovery between trials.

6) Sequence of tests

- Knowledge of Exercise Science can help determine the:
    - Proper order of tests &
    - The duration of rest periods between tests to ensure test reliability.
- The fundamental principle with test sequencing should be that one test should not affect the performance of a subsequent test.

1. Nonfatiguing Tests
    - Height, Weight, Flexibility, Skinfold & Girth Measurements, Vertical Jump*.
2. Agility Tests (anaerobic)
    - T-Test, Pro Agility Test, Edgren Side Step Test.
3. Maximum Power & Strength Tests
    - 1RM Power Clean, 1RM Bench Press.
4. Sprint Tests

- 40-yd Sprint with split times at 10 m & 20 m.

5. Local Muscular Endurance Tests
   - Partial Curl-Up Test, Push-Up Test.
6. Fatiguing Anaerobic Capacity Tests
   - 400-m Run, 300-yd Shuttle Run.
7. Aerobic Capacity Tests
   - 1.5-Mile Run, 12-Minute Run, Yo-Yo Intermittent Recovery Test.

- The test order should also be designed to require minimal recovery time between tests, allowing for a more efficient testing session

7) Preparing athletes for testing

- Announce the date, time, and purpose of a test battery in advance.
- Athletes should be familiar with test content and procedures.
- Host a short, supervised pretest practice or familiarization session 1 to 3 days before the test.
- Provide clear and simple instructions.
- The test administrator should demonstrate proper test performance when possible.
- Viewing a video of the test being performed properly.
- Athletes should be given opportunities to ask questions before & after the demonstration.
- The test administrator should anticipate questions & have answers prepared.
- The test administrator(s) should motivate all athletes equally.
- Whenever possible, tell athletes their test scores immediately after each trial to motivate them to perform better on subsequent trials.
- Administer a pre-test warm-up for your athletes.
- Administer a supervised cool-down period to athletes following test that dramatically increase HR and at the completion of a test battery.

The instructions should cover:

- The purpose of the test,
- How it is to be performed,
- The amount of warm-up recommended,
- The number of practice attempts allowed,
- The number of trials,
- Test scoring,
- Criteria for disallowing attempts, &
- Recommendations for maximizing performance.

Aerobic Endurance Testing in the Heat

- **Study the material in the box on page 256, which is new.**
- Also, you should study the International Marathon Medical Director's Association (IMMDA) Revised Fluid Recommendations for Runners & Walkers at **http://aimsworldrunning.com/guidelines_fluid_replacement.htm .**

- Hew-Butler, T., Rosner, M.H., Fowkes-Godek, S., Dugas, J.P., Hoffman, M.D., Lewis, D.P., Maughan, R.J., Miller, K.C., Montain, S.J., Rehrer, N.J., Roberts, W.O., Siegel, A.J., Stuempfle, K.J., Winger, J.M., and J.G. Verbalis. **Statement of the Third International Exercise-Associated Hyponatremia Consensus Development Conference, Carlsbad, California, 2015.** Clin J Sport Med. 25(4): 303-20, 2015.

1. What is EAH used to describe?
   - Exercise-associated Hyponatremia is used to describe hyponatremia occurring during or up to 24 hours after physical activity.

2. What is the definition of EAH?

- It is defined by a serum, plasma or blood sodium concentration ([Na+]) below the normal reference range of the laboratory performing the test. **(This is a [Na+] less than 135 mmol/L)**

3. What are the main determinants of serum [Na+]?
   - The main determinants of the serum [Na+] are the total content of **exchangeable body sodium and potassium** relative to total body water and thus hyponatremia can **result from loss of solutes (sodium, potassium)**, a relative excess of total body water or a combination of both.

4. What are 3 ways EAH can occur?
   - **Hypovolemic** hyponatremia: decrease in total body water with greater decrease in total body sodium
   - **Euvolemic** hyponatremia: normal body sodium with increase in total body water
   - **Hypervolemic** hyponatremia: increase in total body sodium with greater increase in total body water

5. What are the two forms of EAH?
   - Asymptomatic
   - Symptomatic

6. What are the main risk factors for the development of both forms of EAH?
   - Overdrinknig water, sports drinks, and other hypotonic beverages
   - Weight gain during exercise
   - Exercise duration >4 h
   - Event inexperience or inadequate training
   - Slow running or performance pace
   - High or low body mass index (BMI)
   - Readily available fluids

7. What is the single most important risk factor for EAH?
   - The single most important risk factor is sustained, **excessive fluid (water, sports drinks or other hypotonic fluids) intake in volumes** greater than loss through sweat, respiratory and renal water excretion so that a positive fluid balance accrues over time.

8. Which form is the most dangerous to an athlete's health?
   - **Dilutional hyponatremia** caused by sustained overdrinking and AVP induced impaired water clearance, which overwhelms the ability of the kidney to excrete the excess water load.

9. What is arginine vasopressin (AVP)?
   - Vasopressin, also known as antidiuretic hormone (ADH), is a peptide hormones secreted by the posterior pituitary gland. Arginine vasopressin is an ADH, which contains arginine (conditionally essential amino acid). AVP will **regulate the body' retention of water**, *it is release when the body is dehydrated and causes the kidneys to conserve water (thus concentrating the urine and reducing urine volume).*

10. What is another name for AVP?
    - **Argipressin**

11. What is SIADH?
    - **Syndrome of inappropriate anti-diuretic hormone secretion**: excessive release of antidiuretic hormone (functions: retain water in the body and to constrict blood vessels) from the posterior pituitary gland or another source.

12. What is EAHE?
    - Exercise-associated hyponatremia encephalopathy

13. In which activities has Symptomatic EAH been reported?
    - Military training exercises, marathons, Ironman triathlons and ultramarathons

14. What are the etiology & pathophysiology of EAH?
    - The primary etiology and pathophysiological mechanism underlying EAH—and all known fatalities—is the **overconsumption of hypotonic fluids** relative to exchangeable sodium in likely combination with non-osmotic AVP secretion (Grade 1A).

15. What are the etiologies of the 3 types of EAH?
    - **Euvolemic** hyponatremia: (total body water expansion without changes in total exchangeable sodium)
    - **Hypervolemic** hyponatremia: (total body water expansion above concomitant increases in total exchangeable sodium)
    - **Hypovolemic** hyponatremia: a loss of total body exchangeable sodium that manifests as volume depletion

16. What is the role of thirst?
    - . Thirst provide adequate stimulus for preventing excess dehydration and markedly reduce the risk of developing EAH in all sports.

17. What is the misconception of thirst as a guide to fluid replacement?
    - Earlier published recommendations to begin drinking before thirst was largely meant for situations where sweating rates were high, above maximal rates of gastric emptying, and dehydration would rapidly accrue over time. Unfortunately, this advice has fostered the misconception that thirst is a poor guide to fluid replacement and **has facilitated inadvertent overdrinking and pathological dilutional EAH**.

18. Is EAH best classified by clinical severity or by the absolute numerical concentration of Na+?
    - EAH is best classified by **clinical severity** (symptoms)

19. What are the signs & symptoms associated with Mild EAH, and Severe EAH & EAHE (Table 5)?
    - **(Mild EAH)** : Lightheadedness, dizziness, nausea, puffiness, body weight gain from baseline
    - **(Severe EAH and EAHE):**Vomiting, headache, altered mental status (confusion, disorientation, agitation, delirium, feelings of impending doom, obtundation), phantom running, seizure, coma, dyspnea, frothy sputum, signs of impeding brain herniation

20. Do the signs & symptoms of EAH overlap with other conditions associated with exercise-associated collapse?
    - EAH **must be differentiated** from other causes of collapse that may present with similar signs and symptoms.

21. What are some of these other causes of collapse?
    - Exertional heat illness, Acute mountain sickness, Hypernatremia, and Exercise associated postural hypotension

22. What is the cause of neurological signs & symptoms of severe symptomatic EAH?
    - It's due to **cerebral edema** that occur when water flows along the osmotic gradient from the extracellular fluid into the intracellular compartment

23. Is severe symptomatic EAH always accompanied by CNS-triggered non-cardiogenic pulmonary edema?
    - Severe symptomatic EAH **may or may not** be accompanied by the respiratory distress of CNS-triggered non-cardiogenic pulmonary edema

24. What are the onsite treatments for Asymptomatic & Symptomatic EAH?

- **Administer oral hypertonic saline solutions** (HTS), to reduce the risk of progression to symptomatic hyponatremia
- There is **no compelling reason** to actively treat asymptomatic EAH

25. What is HTS?
    - IV Hypertonic saline

26. What is the concentration range for HTS?
    - The dose and route of HTS administration should be based upon the severity of clinical symptoms and the available HTS formulations

27. What are the recommended treatments for Mild or Severe EAH (Table 6.)?
    - **(Mild EAH):** Administration of intravenous HTS , Administration of oral HTS (Concentrated bouillon, 3%nacl, equivalent volumes of other solutions of high sodium concentration
    - **(Severe EAH):** Administration of intravenous HTS (100 ml bolus of 3% nacl, comparable amounts of more concentrated Na+ containing solutions (may be an alternative to 3%nacl), (More severe conditions) – administer larger HTS boluses

28. What is the treatment for athletes with signs & symptoms of EAHE?
    - Emergent **intravenous treatment therapy with hypertonic saline** is indicated and should not be delayed pending laboratory measurement or other diagnostic testing (Grade 1B)

29. What are the 3 types of fluids that can worsen the degree of hyponatremia?
    - **IV Hypotonic fluids**
    - **Lactated Ringer's**
    - **Isotonic (normal) saline**

30. How can EAH be prevented?
    - Fluid intake recommendations suggesting that athletes **begin to drink fluids before the onset of the sensation of thirst** were targeting those exercising in situations where high sweat rates were present and **dehydration could evolve rapidly** with known medical and performance outcomes.

31. According to laboratory and field studies, what percentages of normal body mass and total body water can be tolerated without a reduction in endurance performance or muscular power when in cool to temperate temperatures?
    - Laboratory and field studies indicate that fluid deficits less than and up to a volume **approximately equal to 3% of normal body mass (or ~5% total body water)** can be tolerated without a reduction in endurance performance or muscular power when in cool to temperate **(−10°C-20°C) temperatures**

32. In most cases, will drinking to thirst prevent both dilutional EAH & performance decrements due to excessive dehydration?
    - Drinking to thirst will, in most cases, **prevent both dilutional EAH and performance decrements** due to excessive dehydration

.

Chapter 13
Administration, Scoring, & Interpretation of Selected Tests
(Pages 259 to 292)

➢ MEASURING PARAMETERS OF ATHLETIC PERFORMANCE

Physical ability	Test Protocols
Maximum Muscular Strength → Low speed strength	1RM bench press, 1RM back squat 1RM bench pull, maximum isometric force Maximum Isokinetic Force
Anaerobic/Maximum Muscular Power→ High speed strength	1RM power clean, 1RM snatch, 1RM push jerk Standing long jump, vertical jump Static Vertical Jump, reactive strength index Margaria-Kalamen Test
Anaerobic Capacity	300-yd (274-m) Shuttle
Local Muscular Endurance	Partial curl-ups, push-ups, sit-ups, chin-ups, dips, YMCA bench press test, (using a fix load like % 1RM, % Body weight)
Aerobic Capacity	1.5-mile (2.4 km) run, 12-minute run, yo-yo intermittent recovery test, maximal aerobic speed test
Agility	T-test, hexagon test, pro agility test, 505 agility test
Speed	Straight-line sprint tests (10m, 20m, 37m, 40m)
Flexibility	Sit and reach test, goniometers, flexometers, inclinometers, overhead squat
Balance and Stability	Balance error scoring system→BESS Star excursion balance test→ SEBT
Body Composition	Skinfold measurements, bioelectrical impedance analysis, underwater weighing, air displacement plethysmography, DEXA
Anthropometry	Height, weight, girth measurements
Testing Conditions	Similar testing conditions for all athletes being tested

→ Maximum Muscular Strength
- Maximal strength tests
  - For most exercises involve relatively low movement speeds
  - Reflect low-speed muscular strength
- Muscular strength
  - Is the force a muscle or muscle group can exert in 1 maximal effort while maintaining proper form

→ Anaerobic Power/Maximum Muscular Power
- Related to the ability of muscle tissue to exert high force while contracting at a high speed.
- Also called maximal anaerobic muscular power, anaerobic power, or high-speed strength
- Maximum muscular power tests:
  - Very short duration
  - Performed at maximal movement speeds
  - Produce very high power outputs

→ Anaerobic Capacity
  - Is the maximal rate of energy production by the combined phosphagen & anaerobic glycolytic (lactic acid) energy systems for moderate-duration activities
  - Is typically quantified as the maximal amount of work per sec performed in muscular activity between 30 & 90s using a variety of tests for the upper & lower body

→ Local Muscular Endurance

→ Aerobic Capacity
  - Also called aerobic power
  - Is the maximum rate at which an athlete can produce energy through oxidation of energy sources
  - Few S & C professionals have the equipment to measure O consumption, so aerobic capacity is generally estimated by field tests.

→ Agility
  - Traditional definition = is the ability to stop, start & change the direction of the whole body rapidly
  - Recently revised definition = a rapid, whole-body, change of direction or speed in response to a sport-specific stimulus

→ Speed
  - Is displacement per unit time
  - Is typically quantified as the time taken to cover a fixed distance
  - Tests are not usually conducted over distance > 100m
  - Longer distances reflect anaerobic or aerobic capacity more than the absolute ability to propel the body at maximal speed

→ Flexibility

→ Balance & Stability
  - Balance
    - Is the ability to maintain static & dynamic equilibrium or the ability to maintain the body's center of gravity over the base of support
  - Stability
    - Is a measure of the ability to return to a desired position following a disturbance to the system

→ Body Composition

→ Anthropometry

→ Testing Conditions

➢ **Only study the Procedures of the tests that are indicated below. Pay close attention to** the number of trials to be performed, how these tests are **scored** (e.g., to the nearest 1 cm), and **any reasons for disqualification**, if applicable. **Do not study** the equipment and personnel requirements for these tests.

1RM tests

→ Are the maximal strength test of choice for most strength & conditioning professionals because they
  - Do not require expensive equipment &
  - Reflect the kind of dynamic ability necessary in sport

→ Protocol:
1. Instruct the athlete to warm up with a light resistance that easily allows 5 to 10 reps
2. Provide a 1-minute rest period
3. Estimate a warm-up load that will allow the athlete to complete 3 to 5 reps by adding:
   a. 10 to 20 pounds (4-9 kg) or 5% to 10% for upper body exercise or
   b. 30 to 40 pounds (14-18 kg) or 10% to 20% for lower body exercise
4. Provide a 2-minute rest period
5. Estimate a conservative, near-maximal load that will allow the athlete to complete two or three reps by adding:
   a. 10 to 20 pounds (4-9 kg) or 5% to 10% for upper body exercise or

    b. 30 to 40 pounds (14-18 kg) or 10% to 20% for lower body exercise
6. Provide a 2-4 min rest period
7. Make a load increase:
    a. 10 to 20 pounds (4-9 kg) or 5% to 10% for upper body exercise or
    b. 30 to 40 pounds (14-18 kg) or 10% to 20% for lower body exercise
8. Instruct athlete to attempt a 1RM
9. If the athlete was successful, provide a 2-4-minute rest period and go back to step 7. If the athlete failed, provide a 2-4-minute rest period; then decrease the load by subtracting:
    a. 10 to 20 pounds (4-9 kg) or 5% to 10% for upper body exercise or
    b. 30 to 40 pounds (14-18 kg) or 10% to 20% for lower body exercise

- AND then go back to step 8
- Continue increasing or decreasing the load until the athlete can complete one repetition with proper exercise technique. Ideally, the athlete's 1RM will be measured with 3 to 5 testing sets.

→ Factors that affect the safety & accuracy of 1RM test results:
- Training status
- Exercise technique experience

→ Typically reserved for:
- Intermediate or advanced resistance-trained athletes who have exercise technique experience in the exercises being tested.

→ Inappropriate for:
- Novice resistance-trained athletes
- Inexperienced athletes
- Untrained athletes
- Injured athletes
- Medically supervised athletes

→ Responsibilities of the S & C professional during 1RM testing:
- Instruct proper lifting technique
- Monitor technique during tests
- Spot the athlete
- Provide motivation to encourage maximal effort

National Football League Combine

- A testing camp that is held by the NFL before the rookie draft
- It is composed of 9 performance measurements

NFL Combine Performance Measurements

- 225-lb bench press to fatigue test
    - Measures the upper-body muscular strength
- 40-yd dash with 10- and 20-yd split times
    - Test anaerobic power, acceleration and speed
- 20-yd shuttle pro-agility test
    - Measures anaerobic power
    - Ability to increase and decrease speed rapidly
    - The ability to change direction rapidly
- 60-yd shuttle
    - Measures speed
    - Body control
    - Small level of endurance
- 3-cone drill
    - Measures agility
    - Change in direction
    - Power
- Vertical jump
    - Measures leg strength
    - Anaerobic power
- Standing broad jump

- Measure leg strength
- Power

TESTS

1RM back squat

- # Of trials→
- Scoring→
- Disqualifications:
  - Losing balance during lifting
  - Failure to descend deeply enough
  - Spotter helping with lift
  - Failure to stand up completely

1RM bench press

- # Of trials→
- Scoring→
- Disqualifications:
  - Bouncing the barbell off chest
  - Lifting the hips off the bench anytime during the movement
  - Spotter helping with lift
  - Failure to extend both arms

1RM bench pull

Start Position

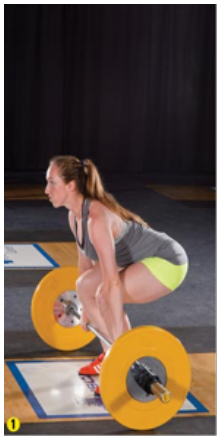
Top Position

- # Of trials→
- Scoring→
- Disqualifications→

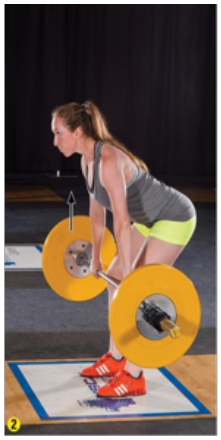
<u>Maximum Muscular Power</u>

- Related to the ability of muscle tissue to exert <u>high force</u> while contracting at <u>high speed</u>
- Also called→ anaerobic muscular power, anaerobic power or high speed strength
- Maximum muscular power tests
  - Very short duration
  - Performed at maximal movement speeds
  - Produce very high power output

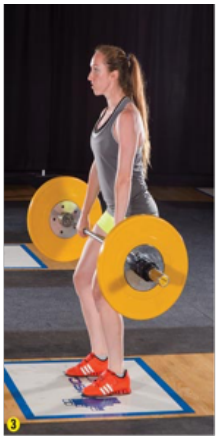
1RM power clean



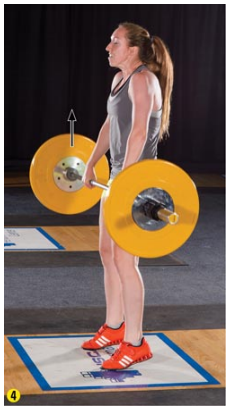
Start Position / Beginning of 1st Pull



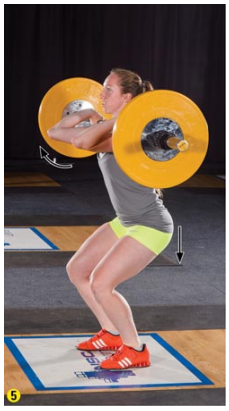
End of 1st Pull / Beginning of Transition



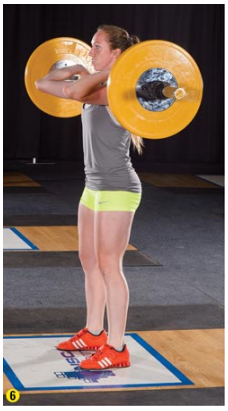
End of transition / Beginning of 2nd Pull



End of 2nd Pull



Catch



End Position

- # Of trials→
- Scoring→
- Disqualification:
  - Stopping during the lift
  - Cleaning the bar to a location other than the shoulders
  - Inability to hold on the barbell while attempting to stand up
  - Loss of balance during lift
- Procedure:
  - Beginning of 1st pull = start position
  - End of 1st pull = beginning of transition
  - Beginning of 2nd pull = end of transition
  - End of 2nd pull
  - Catch
  - End position

1RM snatch

Start Position /
Beginning of 1st Pull

End of 1st Pull /
Beginning of Transition

End of transition /
Beginning of 2nd Pull

End of 2nd Pull

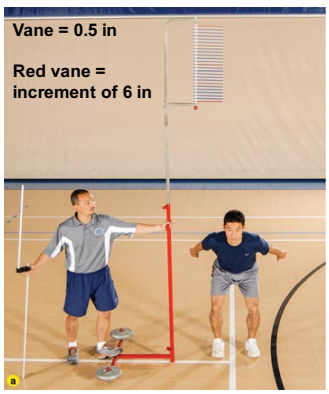
Catch

End Position

- # Of trials→
- Scoring→
- Disqualifications:
  - Stopping during lift
  - Failure to keep both arms extended
  - Loss of balance during the lift

Vertical jump

- # Of trials→ 3, best of 3 is recorded to the nearest 1.0cm
- Disqualifications:



The best of 3 trials is recorded to the nearest 1.0 cm.

Static vertical jump

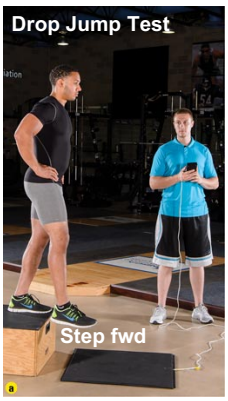
Starting position: no countermovement
Knee angle = 110 degrees, hold 2-3s

Maximum height: measured by contact mat system
Eccentric utilization ratio = VJCM Ht/SVJ Ht

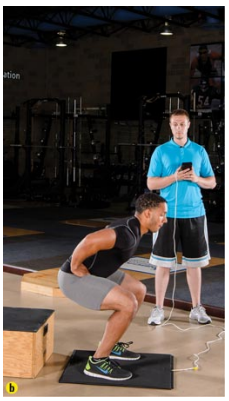
- # Of trials→ 3, best out of three is recorded
- Disqualifications:
- What is the Eccentric Utilization Ratio?
    - Is the ratio of countermovement jump (CMJ) to static jump (SJ) performance
    - EUR = VJCM height/ SVJ height
    - VJCM = eccentric
    - SVJ = concentric

Reactive strength index

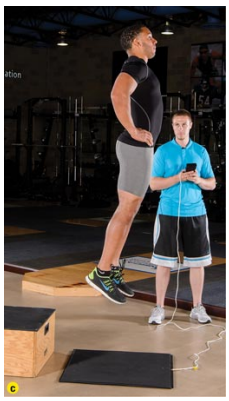
- Box heights→ 20cm, 30cm, 40cm
- A commercial measuring device that provides jump height and contact time→
    - Jump mat
    - Contact mat
- Reactive strength index (RSI) = jump Ht/ Contact time



Starting Position



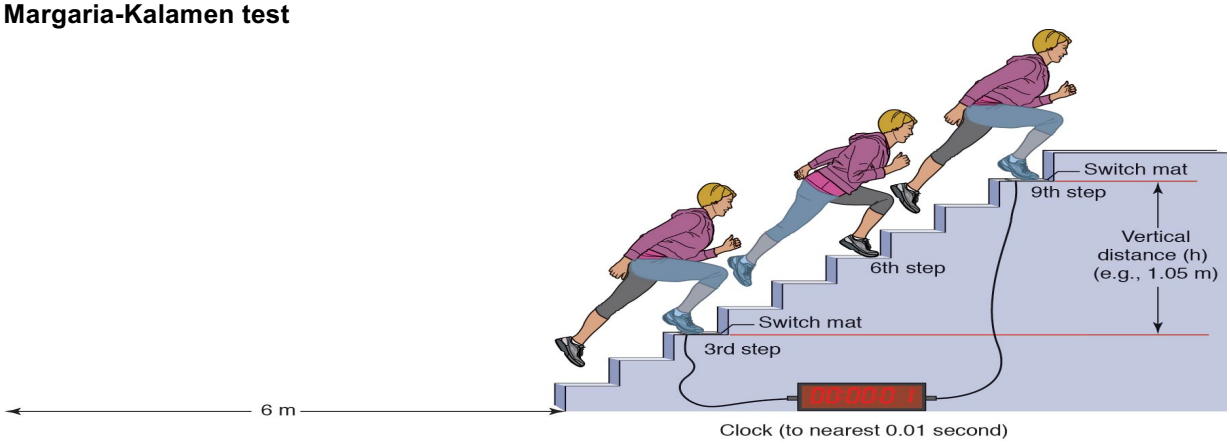
Mat Contact



Maximum Ht

- Mat = at least 0.2m in front of box
- # Of Trials→3, best of 3 trails is recorded

Margaria-Kalamen test

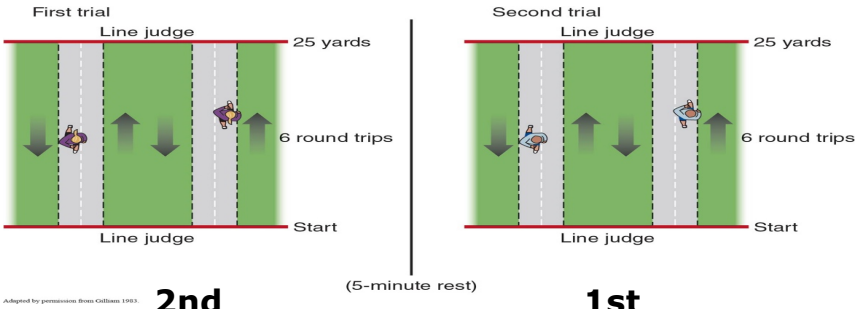


Reprinted by permission from Fox, Bowers, and Foss 1993.

- The time from the 3rd to the 9th step contact is determined to the nearest 0.01 seconds using an electronic timing system
- # Of trials→ 3, best of 3 trials is used in the calculations
- Time of recovery between trials→ 2-3 minutes
- The power output for a 65kg woman who traverses 6 steps in 0.52 seconds computes as follows:
    - F= 65kg
    - D= 1.05m (from 3rd to 9th step), 6 stairs x 17.5cm per stair =105cm =1.05m
    - T= 0.52s (time interval from 3rd to 9th step)
- Power output (watts) = (F x D)/T →(Wt x Ht)/T
    - Power = (65kg x 1.05m)/ 0.52s
    - Power= 131.25 $kgms^{-1}$
    - Power= 131.25 $kgms^{-1}$ x 9.807 = 1287.17 $N\text{-}mÿs^{-1}$ (convert weight to newtons)
    - Power = 1287 Watts

Anaerobic Capacity

→ 300-Yard Shuttle
- Time is recorded to the nearest 0.1 s.
- Record the average of both time trials to the nearest 0.1 s.
- 2 trials
- 25 yards
- 6 round trips (12 in total) per trial
- 5-minute rest between trials
- Foot contact must be made with each line

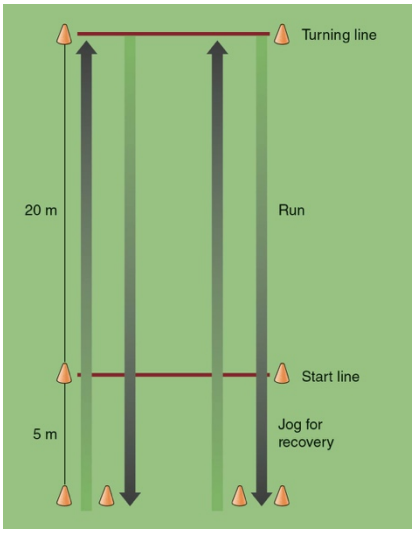


Adapted by permission from Gilliam 1993.

Aerobic Capacity

→ 12-Minute Run

→ Yo-Yo Intermittent Recovery Test



- Common place in field testing protocols for team sports
- Intermittent exercise pattern more
- Performed at 2 different levels:
  - IRT1 = start at 10 km/h
    - Recommendation: S & C professional use IRT1
  - IRT2 = start at 13 km/h
- Correlated to VO_2max: r = 0.71.
- Jog for recovery = 5m
- Run = 20m
- Repeated running bouts with each bout = 2 x 20-m runs = 40 m.
- A 10-s active rest period (2 x 5-m jogging) is performed between each running bout.
- Speed is progressively increased during the test (audio bleeps).
- **Disqualification:** Test is terminated if athlete cannot maintain required pace for two trials
- Final speed & interval score can be used to calculate the total distance covered by the athlete.
- Level 1
  - 4 running bouts at 10.0-13.0 km/h.
  - 7 running bouts at 13.5-14.0 km/h.
  - Continues with stepwise 0.5 km/h speed increments after every 8 running bouts until exhaustion.

Yo-Yo Intermittent Recovery Test Level 1

#	# Bouts	Distance/Bout (m)	Total Distance (m)	Distance Range (m)	Speed (km/h)
1	4	40	160	0-160	10.0-13.0
2	7	40	280	160-440	13.5-14.0
3	8	40	320	440-760	14.5
4	8	40	320	760-1080	15.0
5	8	40	320	1080-1400	15.5
6	8	40	320	1400-1720	16.0

Maximal Aerobic Speed Test

- Marker cones placed 25 m intervals around a running track of at least 200 m

Procedure of Maximal Aerobic Speed Test

- Initial Speed of test: Set between 8-12 km/h depending on fitness level of athlete
- Recommended to start at 10 km/h
- Speed increased by: 1 km/h every 2 minutes until the athlete cannot maintain the speed
- Speed at the last completed stage is increased by 0.5 km/h if athlete is able to run a half-stage

Scoring:

- The last speed maintained for at least 2 minutes, is the speed associated with VO_2 max or MAS (Maximal Aerobic Speed)
- VO_2max= 3.5 X MAS (km/h)

Test Termination:

- If athlete fails to reach the next cone on 2 consecutive occasions in the required time

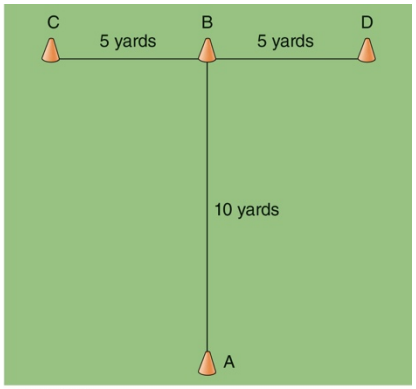
Procedure of 12-minute Run

1. Athletes line up at the starting line
2. On an auditory signal, the athletes travel by foot as far as possible in 12 minutes, preferably by running, but if necessary by walking part or all of the time (Ideal to use 400-meter track if possible)
3. At 12 minutes, on an auditory signal, all the athletes stop in place
4. The distance run by each athlete (laps x 400 m, e.g., 5.25 laps x 400 m = 2,100 m) is calculated and recorded

Agility

→ T-Test

- 1: Sprint fwd to B – right hand.
- 2: Shuffle to C – left hand.
- 3: Shuffle to D – right hand.
- 4: Shuffle to B – left hand.
- 5: Sprint backward.
- Touch base of cone with handfrom 1 to 4.
- Test Score: Best time of 2 trials, to the nearest 0.1s.
-



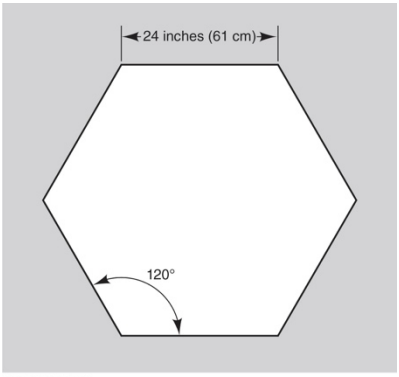
1. Arrange four cones as seen in figure 12.7 (points A, B, C, and D)
2. Have the athlete warm up and stretch prior to the test. The athlete may run the course with a submaximal effort for practice
3. The test begins with the athlete standing at point A
4. On an auditory signal, the athlete sprints forward to point B and touches the base of the cone with the right hand
5. Then, while facing forward and not crossing the feet, the athlete shuffles to the left 5 yards (4.6 m) and touches the base of the cone at point C with the left hand
6. The athlete then shuffles to the right 10 yards (9.1 m) and touches the base of the cone at point D with the right hand
7. The athlete then shuffles to the left 5 yards and touches the base of the cone at point B with the left hand, and next runs backward yards past point A, at which time the watch is stopped
8. For safety, a spotter and gym mat should be positioned several feet behind point A to catch an athlete who falls while running backward

→ **Scoring:** The best time of two trials is recorded to the nearest 0.1 second

→ **Disqualification of a trial:** The athlete fails to touch the base of any cone, crosses one foot in front of the other instead of shuffling the feet, or fails to face forward for the entire test

→ Hexagon Test

- Double-leg hopping.
- Clockwise direction.
- 3 revolutions:
  - 3 revs x 6 j/rev = 18 jumps.
- Start: center.
- End: center.
- Always facing forward.
- Best time of 3 trials is recorded to the nearest 0.1 s.



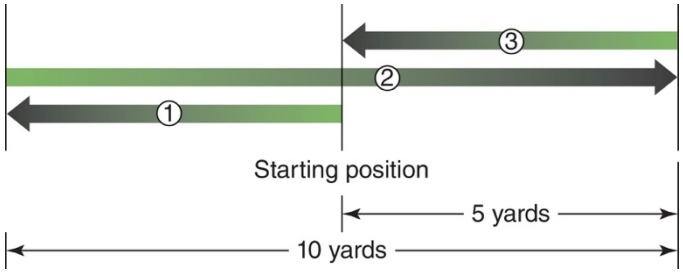
Procedure

1. Using the adhesive tape, create a hexagon on the floor with 24-inch (61 cm) sides meeting to form 120° angles
2. The athlete warms up and practices performance of the test at submaximal speed
3. The test begins with the athlete standing in the middle of the hexagon
4. On an auditory signal, the athlete begins double-leg hopping from the center of the hexagon over each side and back to the center, starting with the side directly in front of the athlete, in a continuous clockwise

sequence until all six sides are covered three times (three revolutions around the hexagon for a total of 18 jumps) and the athlete is again standing at the center. The athlete remains facing the same direction throughout the test.

Disqualification: If the athlete lands on a side of the hexagon rather than over it, or loses balance and takes an extra step or changes the direction he or she is facing, the trial is stopped and restarted after the athlete is allowed time for full recovery.

→ Pro Agility Test (20-Yard Shuttle)



Procedure

1. Stand at the start line
2. On an auditory signal, spring forward 10 m to the first set of timing lights
3. Next, sprint a further 5 m to the turning line with one foot on or over this line
4. Turn and accelerate to the finish line (5 m)

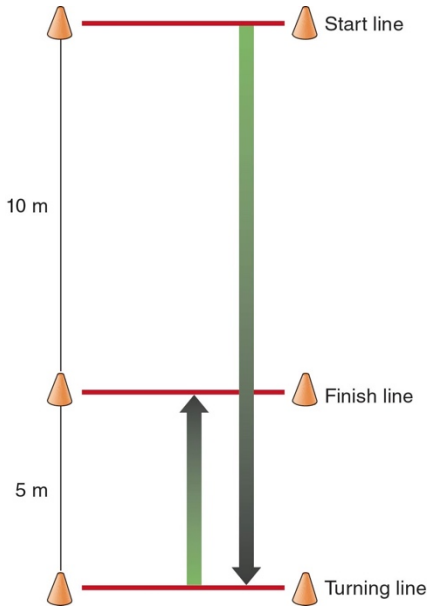
Scoring: Best of 2 trials is recorded to the nearest 0.1 s

→ 505 Agility Test

Procedure:

1. Stand at the start line.
2. On an auditory signal, sprint forward 10 m to the first set of timing lights.
3. Next, sprint a further 5 m to the turning line with one foot on or over this line.
4. Turn and accelerate to the finish line (5 m).

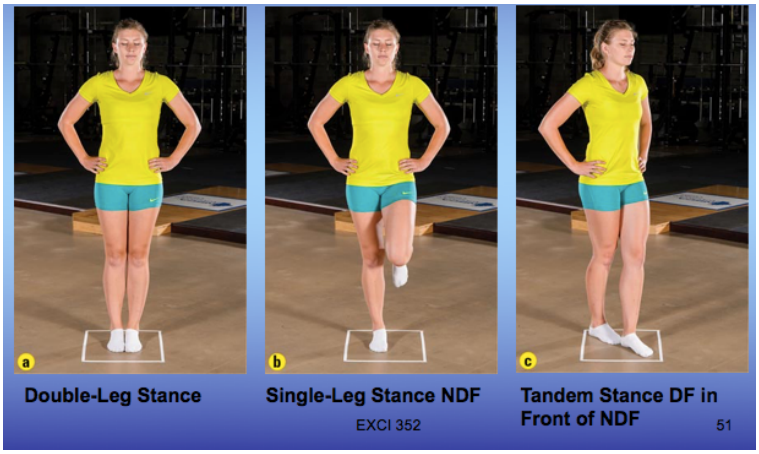
Scoring: Best time of 2 trials is recorded to the nearest 0.1 s.



Balance and Stability
On Firm Surface

Stand on surface, hold stances 20 seconds each, eyes closed and hands on hips

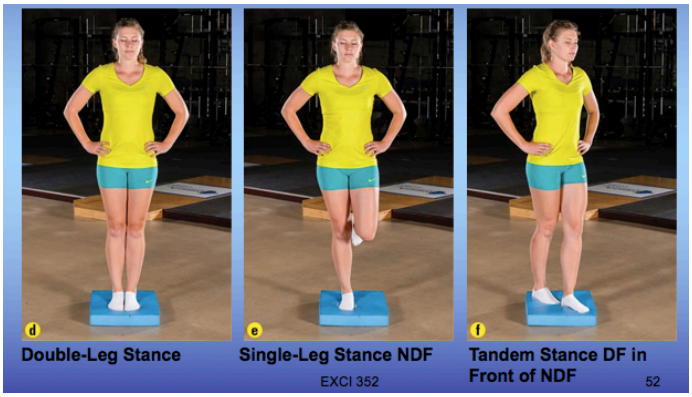
1. Double-leg stance
2. Single leg stance standing on non-dominant foot
3. Tandem stance dominant foot in front of non-dominant foot



On Soft Surface- Foam Balance Pad

Hold stances 20 seconds each, eyes closed and hands on hips

1. Double-leg stance
2. Single leg stance standing on non-dominant foot
3. Tandem stance dominant foot in front of non-dominant foot



Errors worth noting for performing test on firm or soft surface, the following errors are worth deducing 1 point for each stance condition:

- Opening eyes, lifting hands from hips, touchdown of non-stance foot
- Step, hop or other movement on the stance foot/feet
- Lifting forefoot or heel
- Moving hip into more than 30 degrees of hip flexion or abduction
- Remaining out of position for more than 5 seconds

→ Star Excursion Balance Test (SEBT)

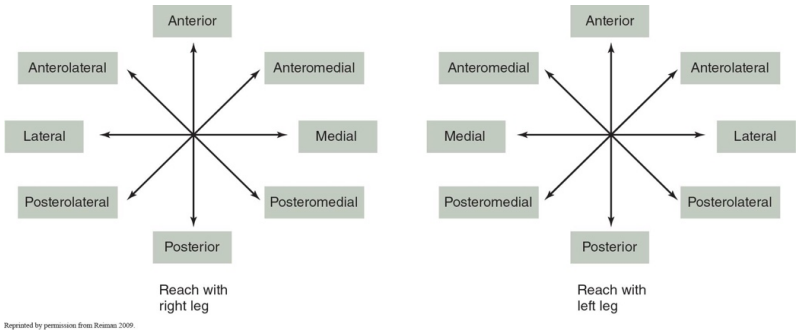
Starting direction and support leg are chosen randomly

- 3 trials are performed for each condition & averaged
- It has been suggested that testing the following positions is sufficient for most situations:
  - Anteromedial position
  - Medial position
  - Posteromedial position

1. Athlete are given a minimum of 4 practice trials before being tested
2. Stand in the center of a grid with 8, 120 cm lines extending out at 45 degree increments
3. Maintain a single-leg stance facing in 1 direction while reaching with the contra-lateral leg as far as possible for each taped line, touching the farthest point possible & then returning to the bilateral position
4. Within a single trial, the athlete remains facing in the beginning direction and the stance leg remains the same, with the other leg doing all of the reaching
5. The distance from the center of the start to the touch position is measured
6. **15 seconds** of rest is allowed between each of the reaches

Disqualification: trials are discarded if the athlete

- Does not touch the line
- Lifts stance foot from the center grid
- Loses balance
- Does not maintain start & return positions for 1 full second



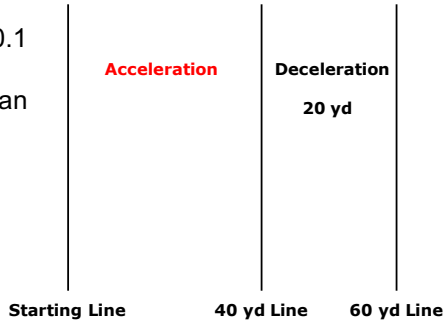
Speed

→ Straight-Line Sprint Tests (40-Yard Sprint)

Procedure:

1. Have the athlete warm up and stretch for several minutes
2. Allow at least two practice runs at submaximal speed
3. The athlete assumes a starting position using a three- or four-point stance
4. On an auditory signal, the athlete sprints 40 yards at maximal speed.
5. Perform a second trial after an active recovery or rest period between trials = at least 2 minutes

Scoring: The average of two trials is recorded to the nearest 0.1 second.
Infra-red light devices for timing (more accurate/precise than human error when manually starting the timer)



- **Read the material on the soccer tests in the review article on the physiology of soccer. You are not responsible for the material regarding soccer referees.**
  - **Stolen, T., Chamari, K., Castagna, C., & Wisloff, U. Physiology of soccer: An Update. (2005). Sports Medicine 35(6): 501-536.**

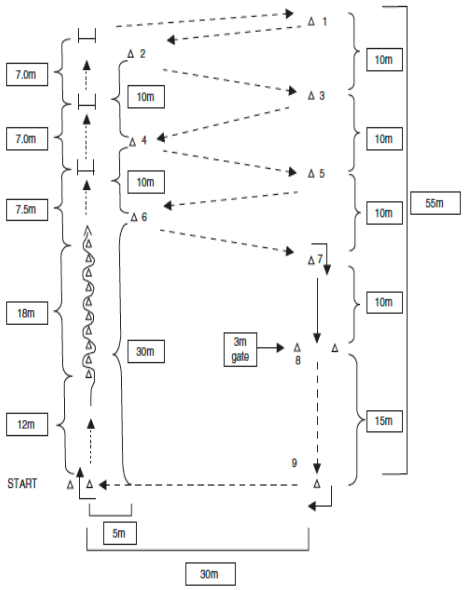
Soccer endurance tests:

→ Field tests

- Continuous multistage fitness test
  - Run back & forth between 2 lines, 20 m apart with an increasing running speed.
  - Exercise intensity is controlled by a series of bleeps or beeps.
  - Involves a circuit.
  - Starting speed = 8 km/hr.
  - The test result is expressed as distance, not as estimated VO_2max.
  - Correlated to VO_2max: r = 0.92.
  - Accuracy = +/-15%.
- Yo-Yo intermittent recovery test
- Soccer-specific testing of VO_2max
  - Gradually increase running intensity to ~ 95% hrmax, which is maintained for 3 min.
  - Then running speed is increased to a level leading to exhaustion after ~ 6 min.
  - Equipped with a portable metabolic test system.
  - Most advanced & most useful test to monitor a soccer player's on-field aerobic capacity.
  - Test circuit includes:

- Dribbling,
- Repetitive jumping,
- Accelerations,
- Decelerations,
- Turning,
- Backwards running with the ball through a 55-m long & 30-m wide circuit.
- Player is equipped with a portable metabolic test system.

- Hoff test: aerobic testing with the ball
  - Circuit training with the soccer ball
  - Ie. Dribbling the ball through cones, running and stopping the ball, running with the ball in a zig-zag pattern (all interpreted through the picture- not in Panenic's notes)



→ Laboratory tests

➢ **STATISTICAL EVALUATION OF TEST DATA**

Useful for evaluating physical abilities & the improvement of a group & the individuals within the group

Statistical measure of:

- Central tendency
- Variability
- Percentile rank
- Smallest worthwhile change
- Effect size
- Standard scores

Descriptive Statistics

- Summarizes or describes a large group of data
- Used when all the information about a population is known
- Three categories of numerical measurement in descriptive statistics: central tendency, variability, percentile rank
- **Central Tendency**
  - Values about which the data tend to cluster
    - **Mean:** Average of the scores. Most commonly used measure of central tendency

        - **Median:** Middlemost score when a set of scores is arranged in order of magnitude. With an even amount of scores, the median is the average of the two middlemost scores
            - More accurate than mean when very high or very low scores of one or a few members of the group tested raise or lower the group mean to an extent that does not adequately describe the ability of most group members
        - **Mode:** Score that occurs with the greatest frequency. Usually regarded as least useful measure of central tendency
- **Variability**
    - Degree of dispersion of scores within a group.
        - **Range:** Interval from the lowest and highest score
            - Advantage of range: Easy to understand
            - Disadvantage: Use two extreme scores so may not be an accurate measure of variability
        - **Standard Deviation (SD):** Measure of variability of a set of scores about the mean
- **Percentile Rank:**
    - Percentage of a test takers scoring below that individual
        - For example, if an athlete is ranked in the 75th percentile, 75% of the group produced scores below the athlete's score

- **Inferential Statistics**
- Allows one to draw general conclusions about a population from information collected in a population sample.
    - I.e. If a boy's 9th grade gym class is put through a battery of tests and it is assumed that the class is representative of all 9th grade boys in the school
        - Results of these tests are used to make inferences about the population as a whole

- **Magnitude Statistics**
- Allow practitioners to interpret clinical significance of fitness testing
- Smallest worthwhile change & effect size are:
    - Magnitude statistics used to describe & evaluate the magnitude change in a fitness test

- **Smallest Worthwhile Change (SWC)**
    - Refers to the ability of a test to detect the smallest practically important chance in performance
    - Typically, SWC = 0.2 x SD (Standard Deviation) between Subjects
- **Effect Size**
    - Useful for calculating group performance following a training program or comparing between groups of athletes
    - ES= (x posttest- x pretest)/ SD pretest

Small ES	0.2
Moderate ES	0.6
Large ES	1.2
Very large ES	2.0

- **Developing an Athletic Profile.**
    - Select tests that will measure the specific parameters most closely related to the characteristics of the sport or sports in question.
    - Choose valid & reliable tests to measure these parameters & arrange the testing battery in an appropriate order with sufficient rest between tests to promote test reliability.
    - Administer the test battery to as many athletes as possible.
    - Determine the smallest worthwhile change for the tests.
    - Compare to normative data where appropriate.

- Develop own norms when standardized procedures are used.
- Conduct repeat testing & use the results to present a visual profile with figures.
- Identify the strengths & weaknesses of the athletes to design the athlete's training program.

Chapter 21
Periodization
(Pages 583 to 604)

➢ GOALS OF PERIODIZATION

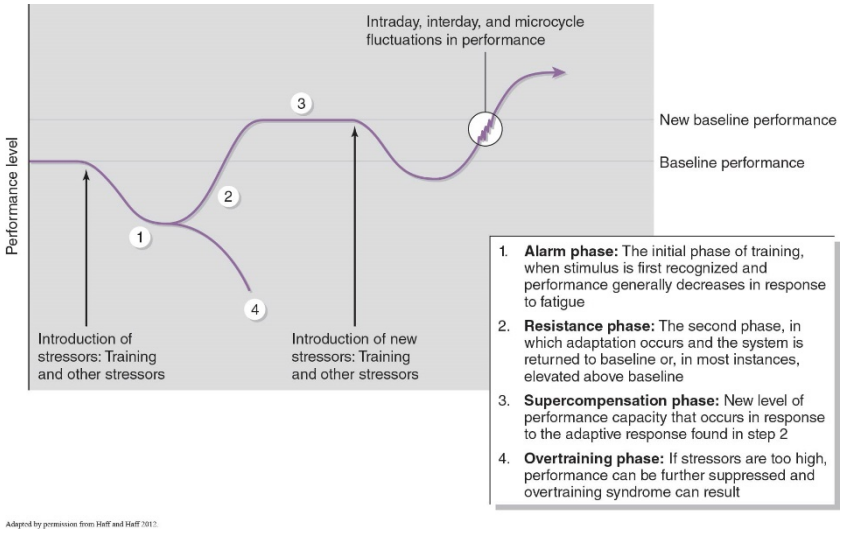
- Optimizing performance at predetermined points or maintaining performance capacity.
- Structure training interventions to target development of specific physiological & performance outcomes.
- Managing the training stressors to reduce the potential of developing the overtraining syndrome (OTS).
- Promoting an athlete's long-term development.

➢ CENTRAL CONCEPTS RELATED TO PERIODIZATION

- **General Adaptation Syndrome**

1. Alarm Phase

- Is the 1st response to a new or more intense stress experienced by the body.
  - E.g., lifting a heavier resistance-training load.
- Is an accumulation of fatigue, soreness, stiffness, or reduction in energetic stores.
- Is characterized by a temporary decrement in performance capacity.
- May last several hours, days, or weeks depending on the magnitude of the encountered stress.



Adapted by permission from Haff and Haff 2012.

2. Resistance Phase

- The body adapts to the stimulus & returns to a normal functional capacity.
- The body is able to demonstrate its ability to withstand the stress
  - Attribute that may continue for an extended period, depending on the health & training status of the athlete.
- If the training stress is appropriately structured & not excessive
  - Adaptive responses occurring during this phase can further elevate an athlete's performance capacity, resulting in what is termed *supercompensation*.
  - Phase is sometimes called the *supercompensation phase.*

3. Exhaustion Phase

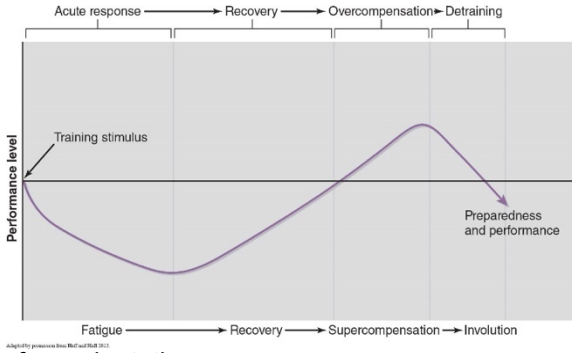
- Is reached if the stress persists for an extended period of time.
- Is characterized by an inability to adapt to the imposed stressors.
- Will present some of the same symptoms experienced during the alarm phase.
- Is most likely experiencing overreaching or overtraining responses.

- Can occur due to monotonous training, overly varied training, & overtraining.
- Non-training-related stress can contribute to the overall stress level & lead to this phase.
- The S & C professional should strive to avoid the occurrence of this phase of the GAS

- **Stimulus-Fatigue-Recovery-Adaptation Theory**
  - Is an extension of the GAS.
  - Suggests that training stimuli produce a general response that is influenced by the overall magnitude of the training stressor.
  - Is also referred to as the *supercompensation cycle*.
    - *Supercompensation* is an adaptation to an appropriate stimulus.

4 Phases

1. **Stimulus Phase (or exercise)**
   - Homeostasis is disturbed.
2. **Fatigue Phase**
   - 1st phase(!) Of the SFRA Theory.
   - The greater the overall magnitude of the workload encountered, the more fatigue accumulates.
3. **Recovery Phase**
   - 2nd phase of the SFRA or *compensation phase*.
   - Homeostasis must be restored.
   - The more fatigue accumulates, the longer delay before complete recovery.
   - It is not always necessary to reach a state of complete recovery before engaging in a new training bout or session.
4. **Adaptation Phase**
   - 3rd phase of the SFRA or *supercompensation phase*.
   - New, higher level of homeostasis.
   - The more fatigue accumulates, the longer the delay before adaptation can occur.



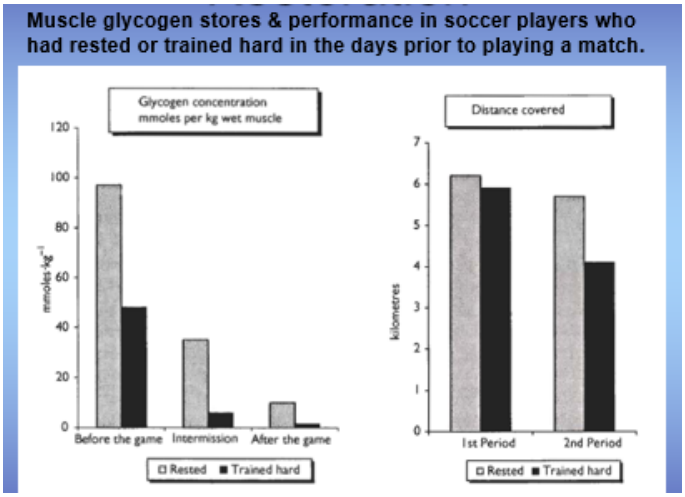
- **Supercompensation Cycle**
  - Is the **direct** transposition of the GAS into the theory & methodology of training & deals with the association between training load & regeneration as the biological basis for physical arousal (Bompa, 1999).
- **Glycogen Supercompensation: Carbohydrate Loading**

Training Status	Diet	Muscle Glycogen Level (mmol/kg wet weight)
Untrained	Balanced	80
Trained	-	~ 125
Trained & Tapering	CHO Loading	175-200

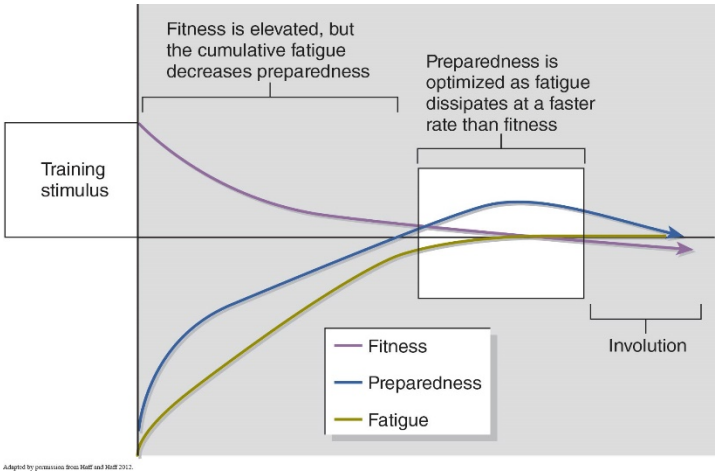
	Classic Method		Modified Method	
DBE	Diet	Exercise	Diet	Exercise
0	High CHO meal BE	Event lasts 60-90 min	High CHO meal BE	Event lasts 60-90 min
1	> 10-12 g CHO/kg/day	Rest	8-10 g CHO/kg/day	Rest
2	> 10-12 g CHO/kg/day	Rest	8-10 g CHO/kg/day	20 min at 75% VO_2max
3	> 10-12 g CHO/kg/day	Rest	8-10 g CHO/kg/day	20 min at 75% VO_2max
4	> 2 g CHO/kg/day	90-120 min at 65-85% VO_2max	4.5 g CHO/kg/day	40 min at 75% VO_2max
5	> 2 g CHO/kg/day	90-120 min at 65-85% VO_2max	4.5 g CHO/kg/day	40 min at 75% VO_2max
6	> 2 g CHO/kg/day	90-120 min at 65-85% VO_2max	4.5 g CHO/kg/day	90 min at 75% VO_2max
7	50% CHO mixed diet	Exercise to exhaustion	4.5 g CHO/kg/day	90 min at 75% VO_2max

DBE = Days Before the Event.

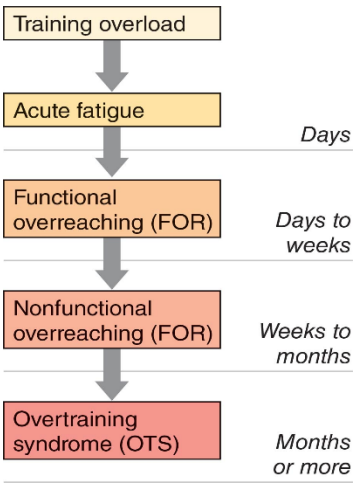
- **Restoration**
  - Is a process of returning to normal or elevated functional capacity after training-induced fatigue.
  - Is related to the need for rest & recovery over a training cycle.
  - For resistance training this is achieved with:
    - Decreased frequency of lifting,
    - Lower volumes of exercise,
    - Passive or active rest,
    - Restoration techniques,
      - Sleep, massage, & hydrotherapy.



- **Peaking**
  - Is the attempt to achieve maximum performance at a specific time, usually a major competition.
  - Is related to a composite aggregation of all conditioning stimuli & sports practice that result in optimal or record performance in the athlete's sport at a specific point in time.
  - Design Considerations
    1. Frequency
    2. Timing
    3. Duration of peaking.
- **Fitness-Fatigue Pradigm**
  - Partially explains the relationships among fitness, fatigue, & preparedness.
    - Fitness & fatigue, the 2 aftereffects of training in this paradigm, summate & exert an influence on the preparedness of the athlete.
      - **Fitness + Fatigue = influence on Preparedness**
  - High training loads result
    - In both elevated fatigue & fitness levels, & a reduction in preparedness.
  - Low training loads result
    - In minimal fitness & fatigue, & a low level of preparedness.
  - Fatigue dissipates
    - Faster than fitness & therefore allows for elevated preparedness with use of appropriate training strategies.
  - The sequencing of training loads
    - Becomes important in that it allows for training workloads to be varied in a systematic manner.



- **Overtraining**
  - Is an excessive frequency, volume, and/or intensity of training without sufficient rest, recovery, & nutrient intake
    - Results in conditions of extreme fatigue, illness, &/or injury.
  - Is an accumulation of training stress
    - Result in long-term decrements in performance with or without associated physiological & psychological signs & symptoms of maladaptation.
- **Overreaching**
  - An increase in the training stimuli to create a decrease in performance that is followed by a supercompensation response
    - A rebound with an increase in performance at some point in the future after the **OR phase** has been completed.
  - The athlete returns to his or her normal training after the **OR phase** while awaiting the improvement in performance.



- **Overtraining Continuum**
  - **Overreaching or FOR**
    - Excessive training that leads to short-term decrements in performance.
- **NFOR**
  - A state of extreme overreaching that an athlete can evolve into when the intensification of a training stimulus continues without adequate recovery & regeneration.
- **OTS**
  - Involves a prolonged maladaptation.
  - Sympathetic OTS – at rest.
  - Parasympathetic OTS – at rest & with exercise.

Signs & Symptoms of Overtraining

→ Excessive sweating.
→ Inability to recover optimally following intensive exercise.
→ Loss of desire & enthusiasm for exercise training (feelings of helplessness).
→ Breakdown of technique.
→ Poor concentration.
→ Loss of appetite.
→ Loss of body weight.
→ Disturbed sleep often with nightmares or vivid dreams.
→ Increased susceptibility to injuries.
→ Menstrual irregularities, even cessation of menstruation.
→ Susceptibility to infections, especially of the skin & upper respiratory tract.
→ Increased rates of allergies.
→ Minor scratches may heal more slowly.

➢ **PERIODIZATION HIERARCHY**

- **Periodization Cycles (Table 21.1)**

Period	Duration	Description
Multiyear plan	2-4 yrs.	• A 4-yr training plan = quadrennial plan.
Annual training plan	1 year.	• Can contain single or multiple macrocycles. • Divided into preparatory, competitive, & transition periods of training.
Macrocycle	Typically, several months to 1 yr.	• Referred to as an annual plan by some authors. • Divided into preparatory, competitive, & transition periods of training.
Mesocycle	Can last several wks to months. Most typical = 2-6 wks.	• Medium-sized training cycle. • A block of training. • Most common duration = 4 wks. • Consists of microcycles linked together.
Microcycle	Several days to 2 wks.	• Small-sized training cycle. • Can range from several days to 2 wks. • Most common duration = 1 wk (7 days). • Composed of multiple workouts.
Training day	1 day	• 1 training day that can include multiple training sessions is designed in the context of the particular microcycle it is in.
Training session	Several hrs	• Generally consists of several hrs of training. • Multiple sessions = if the workout includes > 30 min of rest between bouts of training.

- **Periodization Periods**
  - Periodized training plans systematically shift training foci from
    - General nonspecific activities of high volume & low intensity toward (sport-specific) activities of lower volume & higher intensities over a period of many weeks or months to help reduce the potential for overtraining while optimizing performance capacities.
  - The planned implementation of the mesocycles & microcycles within an overall macrocycle is the basis for varying the program design variables.
  - Predominantly, it is the intensity & volume assignments of the training & conditioning programs that are manipulated to the greatest extent.

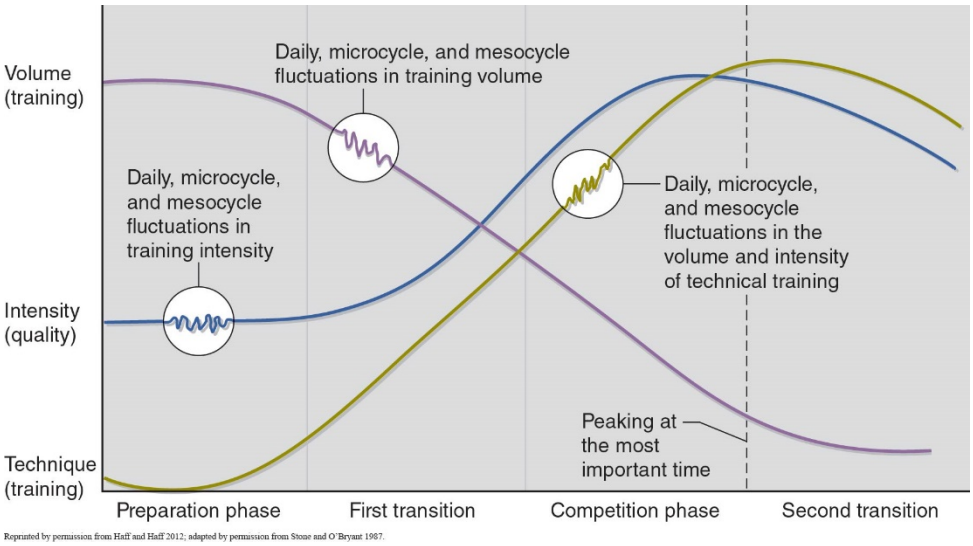


Figure 1 : Modification of Matveyev's Model of Periodization
*Appropriate for **Novice Athletes***

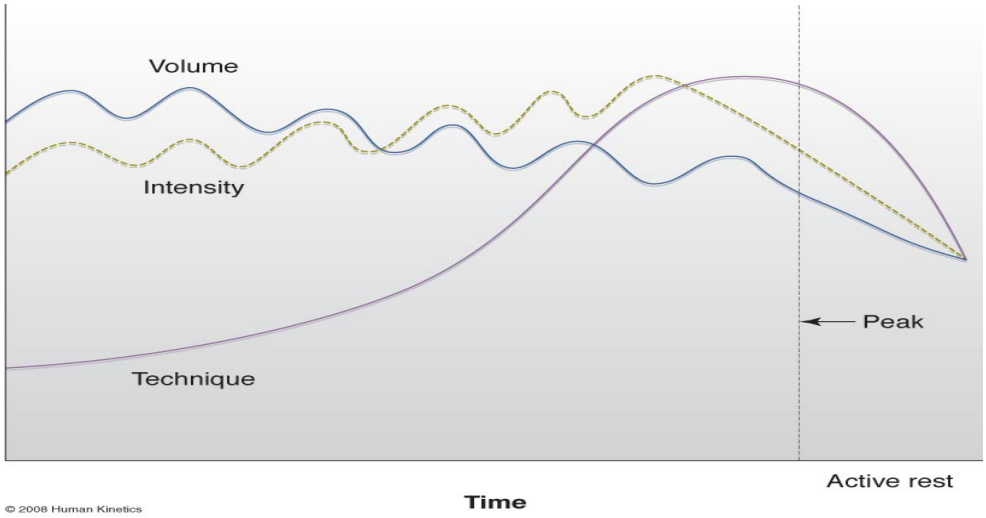


Figure 2 : Modification of Matveyev's Model of Periodization
*Appropriate for **Advanced** **Athletes***

- **Preparatory Period**
  - Is usually the starting point of a periodized training plan.
  - Is usually the longest period.
  - Occurs when there are no competitions & a limited amount of technical, tactical, or sport-specific work.
  - Often corresponds to the off-season of a sport.
  - Conditioning activities begin at relatively low intensities & high volumes.
  - **Central Objective:**
    - Develop a base level of conditioning to increase the athlete's tolerance for more intense training.
  - Divided into 2 phases:
    1. **General Preparatory Phase (Hypertrophy/Strength Endurance Phase)**
       - Typically, occurs early.
       - Often targets development of a general physical base.

- High training volumes, low training intensities.
- Larger variety of training means structured to develop general motor abilities & skills.

2. **Specific Preparatory Phase (Basic Strength Phase)**
   - Expands the athlete's training base.
   - Increased emphasis on sport-specific training activities that prepare the athlete for the competitive period.

Factors	Resistance Training Phase	
	Hypertrophy/Strength Endurance	Basic Strength
Preparatory Phase	General	Specific
Training Intensity	Low to Moderate	Higher
Training Volume	High	Lower
Sport-Specific Activities	No	Yes (more)
Primary Objectives	1. Increase lean body mass, 2. Develop an endurance (muscular & metabolic) base, or 3. 1 and 2.	1. Increase strength of the muscles that are essential to the primary sport movements.

- **First Transition Period**
  - Is a link between the Preparatory & Competitive periods.
  - Classically the resistance training in this period focuses on the development of strength & power.
  - **Central Objective**
    - Shift the training focus toward the elevation of strength & its translation into power development.
  - **Last Week of this Period**
    - Reduced volume, intensity, or both to achieve recovery before the beginning of the competition period.
  - **Strength/Power Phase**: is the main phase within the First Transition period.
  - **Resistance Training Program**
    - Involves the performance of power explosive exercises at low to very high loads with low volumes.
    - Load assignments for power exercises do not follow the typical %RM-repetition relationship, but their relative intensities are elevated during this phase.
    - Exercises selected in this phase can dictate the loading that is used.
    - Mixed training (heavy- & low-load training) is warranted.

- **Competition Period**
  - **Central Training Target**
    - During the competitive period is preparing the athlete for competition by further increasing strength & power via additional increases in training intensity while decreasing volume.
  - **Optimum Performance**
    - Balance between an adequate volume & intensity of exercise, and reductions in volume, intensity, or both.
  - **During this period,**
    - Time spent practicing sport-specific skills & tactics increases dramatically, whereas time spent performing physical conditioning activities decrease.
  - **Program Type**
    - **Peaking Program**
      - For sports with competition periods lasting 1 or 2 weeks.

- Sprinting.

– **Maintenance Program**
  - For sports with competition periods lasting many months.
  - Team sports.

- **Second Transition Period (Active Rest)**
  - Between the competitive period (season) & the next macrocycle's preparatory period or next annual training plan.
  - Sometimes referred to as the active rest/restoration period.
  - Generally lasts 1 to 4 weeks.
  - Recommendation: 4-week maximum, unless injured.
  - Focuses on unstructured, non-sport-specific recreational activities performed at low intensities with low volumes.
  - May not involve resistance training.
  - Allows for injury rehabilitation & physical & mental rest.
  - **Secondary Use of the Active Rest Concept**
    – Is the practice of inserting a 1-week break between phases or periods, which is called an *unloading week.*
      - **Purpose of Unloading Week**
        - Prepare the body for the increased demand for the next phase.
        - Many S & C professionals believe that significantly reducing the volume & load assignments will make the athlete less susceptible to overtraining symptoms.

Period	Preparatory		First transition	Competition			Second transition
Subperiod	General preparatory	Specific preparatory	Precompetitive	Main competitive			Postcompetitive
Season	Off-season		Preseason	In-season			Postseason
Phase	Hypertrophy/ strength endurance	Basic strength	Strength/power	Peaking	Or	Maintenance	Active rest
Intensity	Low to moderate	High	Low to very high	Very high to very low		Moderate to high	Recreational activities (may not involve resistance training)
	50-75% of 1RM	80-95% of 1RM	87-95% of 1RM*	50% to ≥93% of 1RM		85-93% of 1RM	
			30-85% of 1RM**				
Volume	High	Moderate to high	Low	Very low		Low to moderate	
	3-6 sets***	2-6 sets***	2-5 sets***	1-3 sets***		~2-5 sets***	
	8-20 repetitions	2-6 repetitions	2-5 repetitions	1-3 repetitions		3-6 repetitions	

*These percentages of 1RM apply to nonpower core exercises.

**These percentages of 1RM apply to power exercises. The actual percentage used to elicit power development depends on the exercise that is used. For more information see Kawamori and Haff (39).

***These recommendations do not include warm-up sets and represent only target sets for core exercises (2); they also do not include lower-intensity recovery days that are often part of a periodized training plan (27).

Adapted from 27, 56, 57, 58, 59.

➢ **APPLYING SPORT SEASONS TO THE PERIODIZATION PERIODS**

- **Offseason**
  - Should be considered the preparatory period.
  - Typically lasts from the end of the postseason to the beginning of the preseason.
  - Subdivided into general & specific preparatory phases.
  - If it is overly long, it can be divided into multiple shorter mesocycles.
  - May complete several rotations of H/SE & BS phases.
- **Preseason**
  - After completion of the off-season.
  - Leads into the 1st major competition.
  - First transition period (Strength/Power phase of RT).
  - Prepare athlete for the subsequent competitive period.
- **In-season**
  - Competition (in-season) period.
  - Contains all of the contests scheduled for that year.
  - Includes any tournament games.

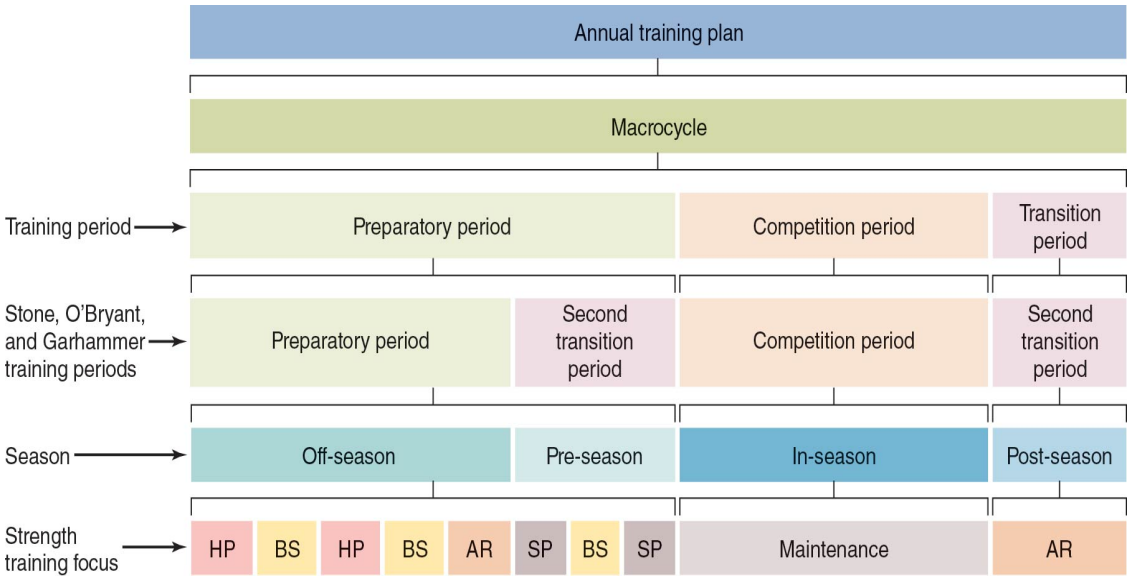
- Most sports have a long in-seasons that requires multiple microcycles arranged around key contests.
- 2 Approaches: Peaking or Maintenance program.

- **Postseason**
  - After the final contest.
  - The second transition period.
  - Active or relative rest before starting next year's off-season or preparatory period.

➢ UNDULATING VS LINEAR PERIODIZATION MODELS

- The degree of undulation depends upon:
  - How the training variables (volume, intensity & exercise selection) are manipulated over time.
  - How many time levels are being manipulated (macrocycle, mesocycles, microcycles).
  - The type of sport (seasonal, climatic).
  - The level of the athlete with the degree of undulation increasing with the advancement of the athlete.

➢ EXAMPLE OF AN ANNUAL TRAINING PLAN



➢ REVIEWING THE ANNUAL PLAN EXAMPLE

➢ MOST COMMON PERIODIZATION MODELS

- **Classic Linear Periodization Model**
  - Is the traditional periodization model.
  - Is falsely referred to as linear due to the gradual & progressive **mesocycle** increases in intensity over time.
  - Contains nonlinear variation in training intensity & volume-load at the **microcycle** level & throughout the **mesocycle**.
  - Is the most common resistance training periodized model used for increasing strength & power.
  - Progression of exercise training over the macrocycle
    - Begins with high training volume & low intensity gradually progressing to lower volume & higher intensity.
- **Reverse Linear Periodization Model**
  - Is the reverse of the classic linear periodization model (CLPM).

- Unlike the CLPM,
  - The main goal of this model is to maximize muscle
    1. Hypertrophy or
    2. Strength endurance.

Training Phase	Strength	Hypertrophy	Strength Endurance
Sets	3-4	3-6	3-6
Reps/Set	2-6	8-12	15-30
Intensity	High	Low	Very Low
Volume	Moderate	High	Very High

Goal: Build strength endurance.

Active rest may be added after the strength endurance phase if the athlete is training for a competition.

Training Phase	Power	Strength	Hypertrophy
Sets	3	3-4	3-6
Reps/Set	2-3	2-6	8-12
Intensity	Very High	High	Low
Volume	Low	Moderate	High

Goal: Build strength & power to optimize gains in muscle mass.

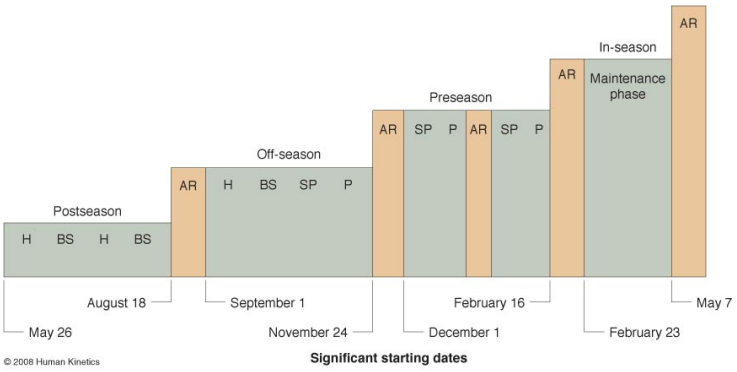
Appropriate for bodybuilding.

- **<u>Undulating Nonlinear Periodization Model</u>**
  - A periodization model alternative that involves <u>large fluctuations in the load & volume</u> assignments for core resistance training exercises.
  - Follows <u>a less linear</u> scheme than the CLPM & the RLPM.
  - Intensity & volume are <u>changed from 1 workout to another</u>.
  - Requires <u>less organization & planning</u> than the other 2 periodization models.
  - Can be applied to <u>sports</u> that have <u>many in-season contests</u>.

Whole-Body Routine					
Wk 1	Monday	Tuesday	Wednesday	Thursday	Friday
	Strength	X	Strength Endurance	X	Hypertrophy
Wk 2	Monday	Tuesday	Wednesday	Thursday	Friday
	Strength Endurance	X	Hypertrophy	X	Strength
Split Routine					
Wk 1	Monday	Tuesday	Wednesday	Thursday	Friday
	UB Hypertrophy	LB Hypertrophy	X	UB Strength	LB Strength
Wk 2	Monday	Tuesday	Wednesday	Thursday	Friday
	UB Endurance	LB Endurance	X	UB Strength	LB Strength

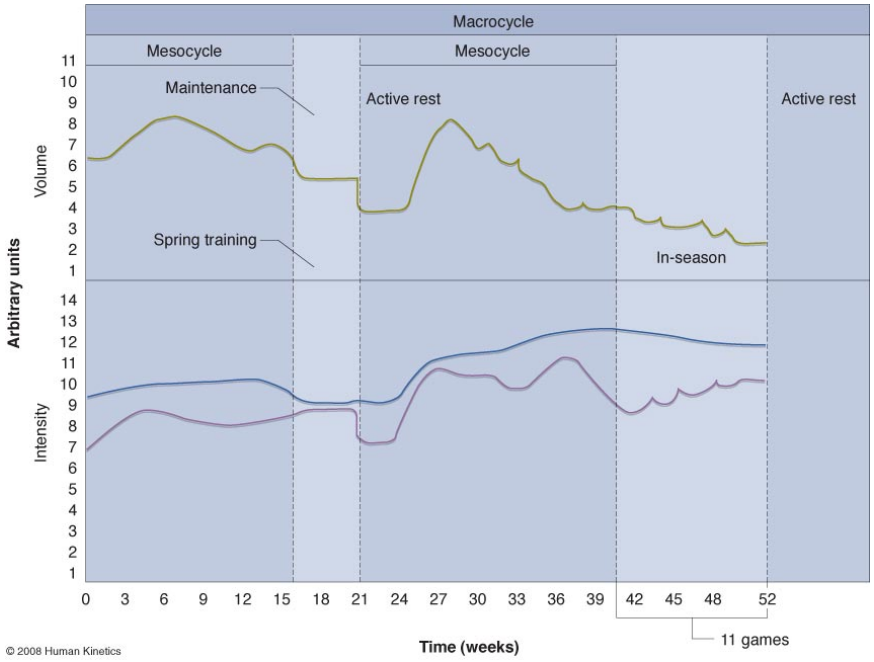
Workout Type	Sets	Reps	Rest Between Sets (min)
Strength	3-5	2-4	4-5
Hypertrophy	3-4	8-12	2-3
Strength Endurance	3-4	15-30	1-2

- **RESEARCH ON PERIODIZATION MODELS**
  - Periodized strength training programs have been shown to be significantly more effective than nonperiodized programs for increasing strength, power & athletic performance in both men & women (Kraemer et al., 2003; Marx et al., 2001, Rhea & Alderman, 2004; Willoughby, 1993).
  - Reverse linear periodization is more effective for increasing endurance strength than the classic linear periodized model (Rhea et al., 2003).
  - Undulating periodized training programs are just as effective as linear periodized models for increasing strength, power, & hypertrophy [muscle mass] (Kraemer et al., 2000; Marx et al., 2001) and more effective than nonperiodized programs.
  - In one study, undulating periodization training was more effective than a linear periodized plan for developing strength (Rhea et al., 2002).
- **MACROCYCLE FOR AN INDIVIDUAL SPORT**



Significant starting dates

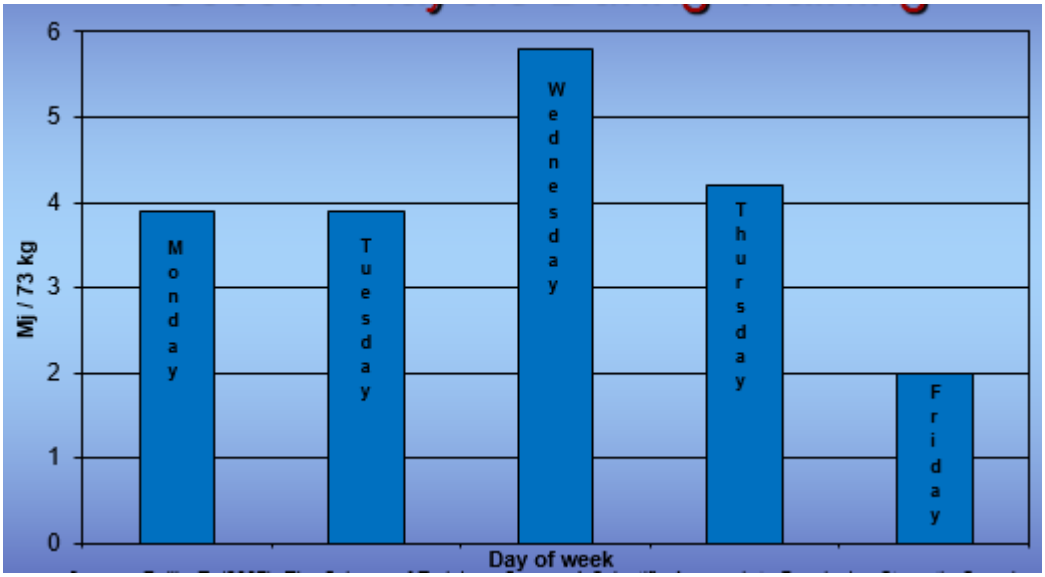
➢ MACROCYCLE FOR A TEAM SPORT



➢ AN OUTLINE OF THE ANNUAL PHASES OF THE SOCCER CALENDAR

Phase	Activity	Weeks
Preseason	General preparation – basic endurance, base conditioning. Specific preparation Friendly matches	1-3 4-6
Early-season	Competition Extend training	 7-20
Mid-season	Competition Consolidate fitness, boost training.	 21-33
Late-season	Competition Maintain fitness, quality training.	 34-46
Off-season	Recuperation – detraining, alternative activity. Transition – cross-training, base conditioning.	47-49 50-52

- **ENERGY EXPENDED BY PROFESSIONAL SOCCER PLAYERS DURING TRAINING**



Chapter 14
Warm-Up & Flexibility Training
(Pages 317 to 350)

➢ WARM-UP

- Temperature Related Effects of Warm-Up
  1. Increased muscle temperature
  2. Increased core temperature
  3. Enhanced neural function
  4. Disruption of transient connective tissue bonds
- Non-Temperature Related Effects of Warm-Up
  1. Increased blood flow to muscles
  2. Elevated baseline O2 consumption
  3. Post-activation potentiation
- Positive Effects of the Warm-Up on Performance
  1. Faster muscle contraction & relaxation of both agonist & antagonist.
  2. Improvements in the rate of force development and reaction time.
  3. Improvements in muscle strength & power.
  4. Lowered viscous resistance in muscles & joints.
  5. Improved oxygen delivery due to the **Bohr Effect** (higher temperatures facilitate oxygen release from hemoglobin & myoglobin)
  6. Increased blood flow to active muscles.
  7. Enhanced metabolic reactions.
  8. An increased psychological preparedness for performance.
- Components of a Warm-Up
  1. General warm up period
     - Goal: increase HR, blood flow, deep muscle temperature, respiration rate, perspiration, & decrease viscosity of joint fluid.
     - Consist of: (1) aerobic activity (usually 5 minutes, low intensity) and (2) stretching
  2. Specific warm up period
     - Consists of: sport specific movements and rehearsal of skills
- Targeted & Structured Warm-Ups
- RAMP Protocol (Raise, Activate & Mobilize, Potentiate)
  - Raise
    - Objective: raise body temp, HR. Respiration rate, blood flow, and joint fluid viscosity using low intensities.
    - Involves: raising physiological parameters and skills
    - Consists of: low intensity movements that simulate movement patterns and skill patterns in activity
    - Analogous to aerobic exercise of general warmup
  - Activate & Mobilize
    - Focus: Mobility and performance of full ROM
    - Consists of: dynamic stretching, mobility drills, movement patterns required for in athlete's performance.
    - Dynamic stretching benefits: maintain temperature related benefits of previous phase, ability to integrate multiple joints, includes sports-specific multi-planar movements, time-efficient.
    - Analogous to stretching of general warmup
  - Potentiate
    - Focus: intensity of activities
    - Consists of: sport-specific activity that progress in intensity till at the same intensity of competition (important with high speed, strength or power activities)
    - Analogous to specific warmup

- Determines optimal length of warmup

➢ STRETCHING & INJURY PREVENTION

- What are the main conclusions of the review article by Witvrouw et al. (2004)? Contradictions in the research literature can be explained by considering the type of sports activity performed by the athlete & the stretch-shortening cycle (SSC) requirements of the sport.
- Witvrouw, E., Mahieu, N., Danneels, L., & mcnair, P. (2004). Stretching and injury prevention: An obscure relationship. Sports Medicine 34(7): 443-449.

➢ FLEXIBILITY

- Flexibility and Performance
  - Main objective: optimize flexibility in relation to specific sport.
- Factors Affecting Flexibility
  - Joint Structure
    - Type of joint, shapes of the joint's articulating surfaces, & soft tissues surrounding the joint
    - Determines joint ROM
  - Age & Sex
    - Older people less flexible than younger people
    - Females more flexible than males
  - Muscle & Connective Tissue
    - Muscle tissue, the musculotendinous unit, tendons, ligaments, fascial sheaths, joint capsules, & skin may limit ROM
    - Elasticity & plasticity of tissues.
  - Stretch Tolerance
    - The ability to tolerate the discomfort of stretching.
    - Individuals with a greater ROM tend to demonstrate a greater level of stretch tolerance.
  - Neural Control
    - CNS & PNS have ultimate control over ROM
    - Afferent & efferent mechanisms influence reflexive & conscious activities
  - Resistance Training
    - Resistance training using full ROM can increase flexibility and develop force capacity
    - Resistance training with limited ROM can decrease flexibility
    - ROM loss prevention: develop agonist and antagonist and use full ROM.
  - Muscle Bulk
    - Large muscles may impede joint movement
  - Activity Level
    - An active person is more flexible than an inactive person
    - Activity level alone does not increase flexibility
- Frequency, Duration, & Intensity of Static Stretching
  1. Program length: 5 weeks min
  2. Frequency: 2 days per week min
  3. Intensity: stretch held till mild discomfort
  4. Duration: 15-30 seconds
- When Should an Athlete Stretch?
  - Following Practice & Competition
    - Facilitates ROM improvements.
    - Should be performed within 5 to 10 minutes after practice.
    - May decrease muscle soreness.
  - As a Separate Session
    - If increased levels of flexibility are required.
    - If a recovery session on the day after a competition is needed.
- Proprioceptors and Stretching

Specialized sensory receptors providing the central nervous system with information needed to maintain muscle tone and perform complex coordinated movements

- Muscle Spindles
  - Location: intrafusal fibers (muscle fibers)
  - Position relative to extrafusal muscle fibers: parallel
  - Sensitive to: muscle length (stretch)
  - Muscle Response: reflexive muscle contraction
  - Activated Reflex: stretch reflex
- Golgi Tendon Organs
  - Location: myotendinous junction
  - Position relative to extrafusal muscle fibers: series
  - Sensitive to: muscle tension (contraction)
  - Muscle Response: reflexive muscle relaxation
  - Activated Reflex: inverse stretch reflex
- Stretch Reflex
  - During a rapid stretch, a sensory neuron from the muscle spindle innervates a motor neuron in the spine. The motor neuron then causes a muscle action (contraction) of the previously stretched extrafusal muscle fibers. (p323)
- Autogenic Inhibition
  - Relaxation that occurs in the same muscle that is experiencing increased tension.
  - Method: active contraction of a muscle immediately before the performance of a passive stretch by the same muscle.
- Reciprocal Inhibition
  - Relaxation that occurs in the muscle opposing the muscle that is experiencing increased tension.
  - Method: contracting the muscle opposing the muscle that is being passively stretched.

➢ TYPES OF STRETCHING

- Active Stretch
  - The person stretching supplies the force of the stretch.
  - Involves voluntary muscle movement.
- Passive Stretch
  - A partner, gravity, or stretching machine provides the external force to cause or enhance a stretch.
  - Involves involuntary muscle movement.
- Static Stretch
  - Slow and constant stretch with end position held for 15 to 30 seconds.
  - Includes relaxation and elongation of stretched muscle.
  - Advantages: does not elicit stretch reflex, low injury likelihood, easy to learn, effectively improves ROM.
- Ballistic Stretch
  - Involves active muscular effort using bouncing-type movement with end position not held.
  - Often used in the pre-exercise warm-up.
  - Disadvantages: may injure muscles or connective tissues, especially when there has been a previous injury and usually triggers the stretch reflex.
- Dynamic Stretch
  - Also known as mobility drills.
  - Type of functionally based stretching exercise that uses sport-generic or sport-specific movements performed in a controlled manner, with muscle active through ROM
  - Focus: movement requirements of the sport rather than individual muscles
  - Advantages: No bouncing movement, promotes dynamic flexibility
  - Disadvantages: less effective at increasing static ROM than static or PNF stretching.
- Proprioceptive Neuromuscular Facilitation Stretch
  - Usually performed with a partner.

- Involves passive movement & active (concentric or isometric) muscle actions
- Advantage: facilitates muscular inhibition.
- Disadvantage: impractical because most of the stretches require a partner & some expertise.
- Terminology: (1) antagonist: muscle being stretched, (2) Hold: Isometric muscle action of the antagonist, (3) Contract: Concentric muscle action of the antagonist muscle, (4) Agonist Contraction: Concentric muscle action of the agonist muscle, (5) Relax: Passive, static stretches that are involved in each PNF stretching technique.

▪ Hold-Relax
  Phase 1: 10 second passive prestretch
  Phase 2: 6 second isometric antagonist contraction (autogenic inhibition)
  Phase 3: 30 second passive stretch

▪ Contract-Relax
  Phase 1: 10 second passive prestretch
  Phase 2: 6 second concentric antagonist contraction – full ROM (autogenic inhibition)
  Phase 3: 30 second passive stretch

▪ Hold-Relax With Agonist Contraction
  Phase 1: 10 second passive prestretch
  Phase 2: 6 second isometric antagonist contraction (autogenic inhibition)
  Phase 3: Concentric agonist contraction (reciprocal inhibition) followed By 30 second passive stretch

➢ Guidelines for Static Stretching (p. 329)
  - Get into a position that facilitates relaxation
  - Move to the point in ROM where you experience mild discomfort
  - Hold stretches for 15-30 seconds
  - Repeat unilateral stretched on both sides

➢ Precautions for Static Stretching (p. 329)
  - Decrease stretch intensity if pain, radiating symptoms, or loss of sensation occurs
  - Use caution when stretching hypermobile joints
  - Avoid combination movements involving spinal extension or lateral flexion
  - Stabilizing muscles should be active to protect other joints and prevent unwanted movements

➢ Static Stretching Techniques (p. 330 - 340)
  - **Only study** which muscles & body areas are affected by these stretches? For example, the Chicken Wing stretches the triceps brachii & latissimus dorsi muscles, & the posterior area of the upper arm. Make a table that summarizes this information.
  - You do not have to study the technical descriptions of the static stretches.

Stretch	Muscles Affected
Look Right and Left	Sternocleidomastoid
Flexion and Extension	Sternocleidomastoid, suboccipitals, splenae
Straight Arms Behind Back	Anterior deltoid, pectoralis major
Seated Lean Back	Deltoids, pectoralis major
Behind Neck Stretch	Triceps brachii, latissimus dorsi
Cross Arm in Front of Chest	Posterior deltoid, rhomboids, middle trapezius
Arms Straight Up Above Head	Latissimus dorsi
Spinal Twist (pretzel)	Internal & external obliques, piriformis, erector spinae
Semi-Leg Straddle	Erector spinae
Forward Lunge	Iliopsoas, rectus femoris
Supine Knee Flex	Hip extensors (gluteus maximus and hamstrings)
Side Bend with Straight Arms	External oblique, latissimus dorsi, serratus anterior
Side Bend with Bent Arm	External oblique, latissimus dorsi, serratus anterior, triceps brachii
Side Quadriceps Stretch	Quadriceps, iliopsoas
Sitting Toe Touch	Hamstrings, erector spinae, gastrocnemius
Semistraddle (figure four)	Gastrocnemius, hamstrings, erector spinae

Straddle	Gastrocnemius, hamstrings, erector spinae, hip adductors, Sartorius
Butterfly	Hip adductors, Sartorius
Wall Stretch	Gastrocnemius, soleus, Achilles tendon
Step Stretch	Gastrocnemius, soleus, Achilles tendon

- Guidelines for Dynamic Stretching (p. 341)
  - Perform 5 to 10 repetitions of the same movement in place or over a given distance
  - Progressively increase ROM with each repetition when possible
  - Increase the speed of motion in subsequent sets when appropriate – always maintaining control of motion
  - Actively control muscular action as you move through ROM
  - Try to replicate movements required for the sport
- Precautions for Dynamic Stretching (p. 341)
  - Move progressively through the ROM
  - Move deliberately through the motion without bouncing
  - Do not forsake good technique for additional ROM
- Dynamic Stretching Techniques (p. 342 - 349)
  - **Only study** which muscles are affected by these stretches?
  - You do not have to study the technical descriptions of the dynamic stretches.

Exercise	Muscles Affected
Arm Swings	Latissimus dorsi, teres major, anterior and posterior deltoids, pectoralis major
Inchworm	Erector spinae, gastrocnemius, gluteus maximus, hamstrings, soleus, anterior tibialis
Lunge Walk	Gluteus maximus, hamstrings, iliopsoas, quadriceps
Lunge with Overhead Side Reach	Gluteus maximus, hamstrings, iliopsoas, latissimus dorsi, internal and external oblique, rectus femoris
Walking Knee Lift	Gluteus maximus, hamstrings
Forward Lunge with Elbow Instep	Biceps femoris, erector spinae, gastrocnemius, gluteus maximus, hamstrings, iliopsoas, latissimus dorsi, internal and external oblique, quadriceps, rectus femoris, soleus
Heel to Toe Walk	Gastrocnemius, soleus, anterior tibialis
Walking Over and Under	Hip abductors, adductors, gastrocnemius, gluteus maximus, hamstrings, iliopsoas, rectus femoris, soleus
Inverted Hamstring Stretch	Gluteus maximus, hamstrings, hip abductors, adductors, erector spinae
Straight Leg March	Gluteus maximus, hamstrings, iliopsoas, rectus femoris
Spiderman Crawl	Biceps femoris, erector spinae, gastrocnemius, gluteus maximus, hamstrings, iliopsoas, latissimus dorsi, internal and external oblique, quadriceps, rectus femoris, soleus

EXTRAS

- The goal of a warmup is to mentally and physically prepare the athlete for performance.
- The warmup should last 10 to 20 minutes and should end no more than 15 minutes before the activity.
- Perform Benefit Risk Analysis to determine if static stretching (less than 45 seconds) is appropriate (evidence on subject is equivocal).
- Flexibility Definitions:
  1. Flexibility: measure of ROM that has static and dynamic components.
  2. Static Flexibility: the range of possible movement about a joint and its surrounding muscles during a passive movement
  3. Dynamic Flexibility: available ROM during active movements and therefore requiring voluntary muscle actions
  4. Mobility: the freedom of a limb to move through a desired ROM. (related to balance coordination, postural control coordination, perception, and appropriate motor control)

- Increased risk of injury with: inflexibility, hyper flexibility, or imbalance in flexibility.
- Acute effects of stretching: transient increase in flexibility from 3 minutes to 24 hours after stretching, and then decline.
- Static stretching should always be preceded by general activity and followed by monitoring for radiating pain or loss of sensation
- PNF terminology: (1) **Antagonist**: muscle being stretched, (2) **Hold:** Isometric muscle action of the antagonist, (3) **Contract:** Concentric muscle action of the antagonist muscle, (4) **Agonist Contraction:** Concentric muscle action of the agonist muscle, (5) **Relax:** Passive, static stretches that are involved in each PNF stretching technique.
- Specific Muscle Actions to Facilitate Passive stretch during PNF
  1. **Isometric Muscle Action of the Antagonist**: Used before a passive stretch of the antagonist to achieve autogenic inhibition.
  2. **Concentric Muscle Action of the Antagonist**: Used before a passive stretch of the antagonist to achieve autogenic inhibition.
  3. **Concentric Muscle Action of the Agonist**: Used during a passive stretch of the antagonist to achieve reciprocal inhibition.

Chapter 14
Exercise Technique for Free Weight & Machine Training
(Pages 351 to 408)

DB = dumbbell and BB = Barbell

➢ FUNDAMENTALS OF EXERCISE TECHNIQUE

- Hand Grips

A. Type of Grips

- Pronated Grip
  - Overhand grip.
- Supinated Grip
  - Underhand grip.
- Neutral Grip:
  - Knuckles point laterally, like a handshake.
- Alternated Grip
  - Pronated grip + supinated grip. (Both)
- Hook Grip
  - Is similar to the pronated grip.
  - The thumb is positioned under the index & middle fingers.
- Closed Grip
  - The thumb is wrapped around the bar.
- Open or False Grip
  - Thumb does not wrap around the bar. (aka suicide grip)
- Clean Grip
  - A closed, pronated grip that is slightly wider than shoulder-width apart, outside of the knees.
- Snatch Grip
  - A wide, closed, pronated grip that is *measured using either the fist-to-opposite shoulder or elbow-to-elbow* method.

B. Exercise and grips used

- Closed, Pronated Grip:
  - Bent-over Row (can also be done closed supinated)
  - Barbell Bench press
  - Snatch
- Closed, Supinated:
  - Biceps Curl
- Closed Neutral:
  - Hammer Curl, Flat DB fly
- Closed, Pronated or Alt:
  - Deadlift (all barbell 3 variations)
- Open Grips
  - Front Squat (*Crossed arm position* - See slide 13, note Front squat also has a parallel arm position)
- Back Squats
  - High bar & Low Bar positions
    - Closed Pronated

- Stable Body & Limb Positioning
  - Enables the athlete to *maintain* proper body alignment during exercise
    - Places an appropriate stress on muscles & joints.
  - Standing Position:
    - Feet are positioned slightly wider than hip width,
    - Heels & balls of feet in contact with the floor
  - Seated or Supine exercises
    - Five-point body contact position
      - Head is placed firmly on the bench or back pad.

        - Shoulders & upper back are placed firmly & evenly on the bench or back pad.
        - Buttocks are placed evenly on the bench or seat.
        - Right foot is flat on the floor.
        - Left foot is flat on the floor.
    - Machines:
        - Before starting exercise on machine aligne body joint of the prime mover with the machines axis of rotations
- Range of Motion & Speed
    - Full ROM
        - Maximizes the value of an exercise
        - Maintains or improves flexibility
        - Achieved via - Slow, controlled movements
    - High Speed
        - Appropriate for *power exercise*
- Breathing Considerations
    - Exhale: through the sticking point of the concentric phase
    - Inhale: During the less stressful eccentric phase of the repetition
    - Valsalva Maneuver
        - Expiring against a closed glottis
        - Contracting the abdomen & rib cage muscles,
        - Will assist in maintaining proper vertebral alignment & support
        - Helps to establish the "flat-back" & erect upper torso position in many exercises
        - Only use if EXPERIENCE and WELL TRAINED
            - When performing structural Exercise
            - Used During 1-RM Testing (Often)
        - Risk of the Valsalva Maneuver:
            - Dizziness
            - Disorientation
            - Excessively high blood pressure can quickly rise to 3x resting levels.
            - Blackouts
- Weight Belts
    - May help maintain *intra-abdominal pressure* during lifting
    - Appropriateness depends on:
        - Type of exercise performed
        - Relative load lifted
    - Recommended for:
        - Exercises
            - That place stress on the lower back.
            - Near-maximal or maximal loads (1-3RM?)
            - Have to meet both criteria. Not recomended (or rather not needed) Otherwise

- Lifting a Bar off the Floor
    - Squat down behind the bar
    - Feet between hip- and shoulder-width apart
    - Position the bar close to the shins & over the balls of the feet & grasp the bar with a closed grip that is shoulder-width (or slightly wider) apart
- If lifting dbs
    - Stand directly between them & grasp the handles with a closed grip & a neutral arm or hand position
    - For both:
    - Position the arms outside the knees with the elbows extended
- What is the correct preparatory body position before lifting a weight off the floor?
    - The **back** is neutral or slightly arched.
    - The **scapulae** are depressed & retracted.
    - The **chest** is held up & out.
    - The **head** is in line with the vertebral column or slightly hyperextended.
    - The **feet** are flat on the floor.

- The **shoulders** are over or slightly in front of the bar.
- The **eyes** are focused straight ahead or slightly upward

➢ **SPOTTING FREE WEIGHT EXERCISES**

- Types of Exercises Performed & Equipment Involved
  - Overhead Exercises
  - Exercises With the Bar on the Back or Front Shoulders
  - Over-the-Face Exercises
  - Do Not Spot Power Exercises
  - Typically require 1 or more spotters (for the aforementioned type of exercises)
- Spotting Overhead Exercises & Those With the Bar on the Back or Front Shoulders
  - Ideally, to promote the safety of the lifter, the spotters, & others nearby, these exercises should be performed inside a power rack with the crossbars in place at an appropriate height
    - (Note crossbars are safety bars which run on either side of the Powerrack)
  - **Spotter(s)** should be at least as strong and as tall as the **athlete**
- Spotting Over-the-Face Exercises
  - Grasp the bar with an alternated grip
    - With a grip is narrower than the athlete's grip.
  - *Exceptions due to the bar's curved trajectory in the*:
    - **Lying triceps extension**, & **the barbell pullover**.
    - The spotter uses an alternated grip to pick up the bar & return it to the floor.
    - The spotter uses a supinated grip to spot the bar.
- Do Not Spot Power Exercises
  - Too Dangerous
    - Athlete should just DROP the bar and move away from it
- Number of Spotters
  - Depends on:
    - Load being lifted.
    - The experience & ability of the athlete & spotters.
    - The physical strength of the spotters.
- Communication Between Athlete & Spotter
  - Use of a Liftoff
  - Amount & Timing of Spotting Assistance
  - Initial handling of the bar,
  - How many reps will be performed, &
  - When the athlete is ready to move the bar into position (related to liftoff).

➢ **Answer the following questions based on the RESISTANCE TRAINING EXERCISES described on pages 359 to 407 in your textbook.**

- Which resistance exercises use:
  - A closed, pronated grip,
    - Lat Pulldown
    - Seated Row (as well as low pulley)
    - Flat Barbell Bench Press
    - Incline Dumbbell Bench Press
    - Vertical Chest Press
    - Wrist Extension
    - Back Squat
    - Forward Step Lunge (with barbell)
    - Step-Up(barbell)
    - Good Morning
    - Shoulder Press (Machine)
    - Seated Barbell Shoulder Press (and Dumbbell Variation)

        - Starting Position
        - Lying Barbell Triceps Extension
        - Triceps Pushdown (Machine)
        - Push Press (and Push Jerk Variation)
        - Power Clean (and Hang Clean Variation)
        - Snatch
    - A closed, supinated grip,
        - Barbell Biceps Curl
        - Starting Position
    - A closed, neutral grip,
        - Grip,
        - Seated Row (As well as low pulley seated row)
        - Hammer Curl
        - Flat Dumbbell Fly
        - Forward Step Lunge (with Dumbell)
        - Step-Up (Dumbbells)
        - Lateral Shoulder Raise
    - A closed, alternated grip,
        - Deadlift (all barbell variations)
    - A closed, hook grip,
    - An open or false grip,
    - A Clean grip, &
    - A Snatch grip?

- Which free weight exercises require a spotter?
    - Flat & Incline Dumbbell Fly
    - Squats (front and back)
    - Chest press, All variations
    - Lying Triceps extention
    - Forward Lung
    - Seated Shoulder Press
    - Step Up

- Which resistance exercises are spotted overhead, with the bar on the back or front shoulders, and over the face?

- Which resistance exercises do not require a spotter?
    - Power exercises
    - All back Exercise
    - Biceps exercise
    - Deadlifts, all variations
    - Good Mornings
    - Abs and low back
    - Calves and Forearm Exercise
    - Leg press/ Hip Sled

- How are dumbbell exercises spotted?
    - From the posterior lateral aspect of the wrist

- Study the spotting techniques in depth for the following exercises:
    - Flat Barbell Bench Press

    - Back Squat
    - Front Squat
    - Forward Step Lunge
    - Step-Up
    - Seated Barbell Shoulder Press
    - Lying Barbell Triceps Extension

- Which resistance exercises should be performed inside a power rack?
    - Deadlifts, squats, and power exercise

- Which resistance exercises require a liftoff?

- Which resistance exercises involve the use of the 5-point body contact position?
    - Flat Dumbbell Fly

- What types of grips do spotters use for the various resistance exercises?
    - Supinated
    - Pronated
    - Alternated

- What are the grip widths for the following resistance exercises?
    - Barbell Biceps Curl
    - Flat Barbell Bench Press
    - Back Squat
    - Front Squat
    - Forward Step Lunge
    - Step-Up
    - Deadlift
    - Stiff-Leg Deadlift
    - Romanian Deadlift
    - Seated Barbell Shoulder Press
    - Push Press
    - Push Jerk
    - Power Clean
    - Hang Power Clean
    - Snatch
    - Hang Power Snatch

- It is suggested that you make tables for the previous questions.

- It is very important that you study the following Power exercises in detail:
  - Push Press
  - Push Jerk
  - Power Clean
  - Hang Power Clean
  - Snatch
  - Hang Power Snatch

- For the previously indicated Power exercises, create a table that includes the following information:
  - Beginning Position
  - Initial bar position
  - Grip type
  - Grip width
  - Feet position
  - Final Bar Position
  - Phases (e.g., Dip, Drive, Catch, First Pull, Second Pull, Scoop)
  - Exercise Actions (e.g., hip extension, knee extension)