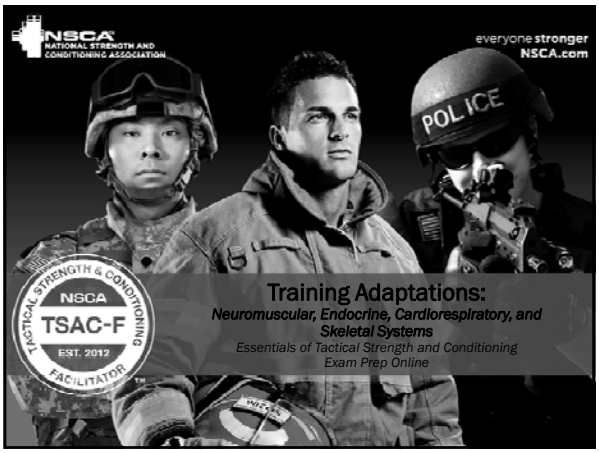

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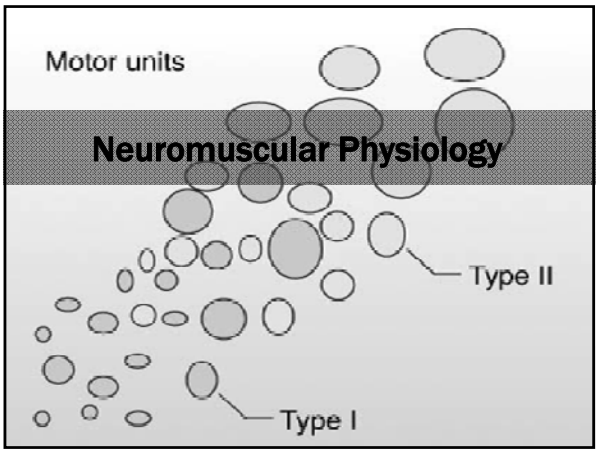
Content Weighting

Training Adaptations Topic Areas	Total	AP	AN	RE
Physiology	2	0	0	2
Neuromuscular Anatomy and Physiology	2	1	0	1
Describe Physiological Adaptations to Exercise	6	4	0	2
Total	10	5	0	5



Topics

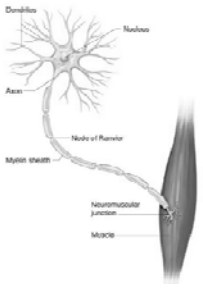
- Neuromuscular anatomy and physiology
- Basic muscle actions

Motor Unit

- Motor unit
  - Motor neuron and all the muscle fibers it innervates
- Muscle activation: All-or-None Principle
  - All the fibers in that motor unit contract at the same time

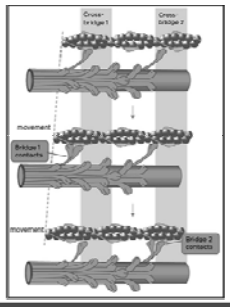
Action potential → ACh → Threshold → Contraction

- Muscle recruitment: Size Principle
  - Lowest threshold motor units first



Sliding Filament Theory

- Muscular contraction
  - Action potential
  - Myosin attaches to actin
  - Actin is pulled towards the midline and the muscle fiber is shortened
- Force production
  - Directly related to the number of cross-bridge attachments at a given time

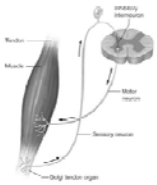


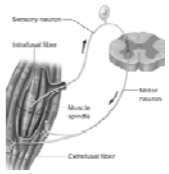
Basic Muscle Actions

- Concentric muscle action
  - Muscle shortens during force production
  - Muscle force > resistive force
- Eccentric muscle action
  - Muscle lengthens during force production
  - Muscle force < resistive force
- Isometric *(*iso means same)* muscle action
  - Muscle exerts force without length change
  - Muscle force = resistive force
- Isokinetic muscle action
  - Constant speed, change in resistive force
- Isotonic muscle action
  - Constant resistance, change in muscle force production

Proprioceptors

- Muscle spindles
  - Muscle length and rate of change in *length*
  - Results in motor unit activation
- Golgi tendon organs (GTO)
  - Activate in response to changes in *tension*
  - Results in motor unit inhibition



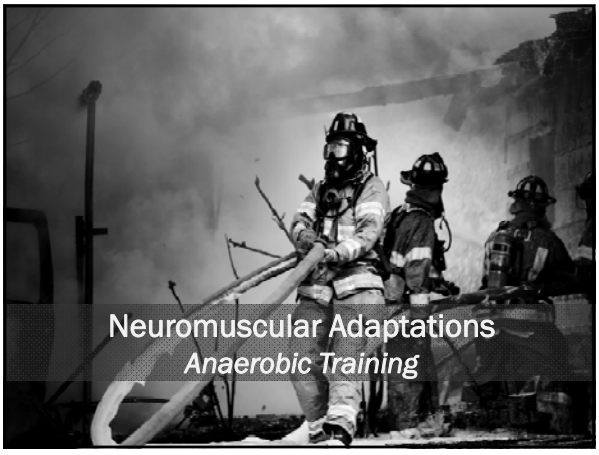


Muscle Fiber Types

- Slow-twitch, Type I (aerobic)
  - Slow force development and relaxation
  - Long twitch time
  - Fatigue resistant
- Fast-twitch, Type IIa and IIx (anaerobic)
  - Rapid force development and relaxation
  - Short twitch time
  - High force development
  - Highly fatigable

Fiber Type Characteristics

Characteristic	Type I	Type IIa	Type IIx
Motor neuron size	Small	Large	Large
Contraction speed	Slow	Fast	Fast
Fatigue resistance	High	Intermediate/Low	Low
Force production	Low	Intermediate	High
Endurance	High	Intermediate/Low	Low
Capillary density	High	Intermediate	Low
Myoglobin content	High	Low	Low
Mitochondria size/density	High	Intermediate	Low
Fiber diameter	Small	Intermediate	Large
Color	Red	White/Red	White

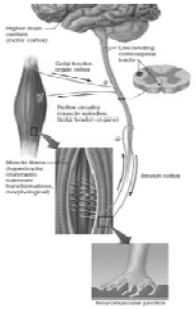


Topics

- Chronic neuromuscular adaptations that occur with training
- Structural adaptations of muscle that occur with training
- Endocrine adaptations that occur with training

Chronic Neuromuscular Adaptations

- Neuromuscular junction
  - End-plate length ↑
  - ACh ↑ and receptor sensitivity
- Reflex potentiation
  - Muscle spindle
    - Enhanced muscle spindle response, ↑ force production
  - Golgi tendon organs
    - ↓ stimulation to allow for greater expression of strength



Chronic Neuromuscular Adaptations

- Motor units
  - Selective recruitment
    - High threshold motor units recruited first
  - Recruitment
    - Greater number of motor units
  - Rate coding
    - ↑ number of action potentials per unit time
  - Synchronization
    - Motor units firing at the same time
  - Co-contraction
    - Agonist and antagonist interaction

Structural Adaptations

- Hypertrophy
  - ↑ in cross-sectional area and volume of existing fibers
  - ↑ synthesis / ↓ in degradation of contractile proteins
- Magnitude of hypertrophy
- Hyperplasia
  - ↑ in number of muscle fibers, *not shown in humans*

Fiber Type Adaptations

- Type I: Slow-twitch
  - Increase in size, but not to the extent of Type II
- Type II: Glycolytic, fast-twitch
  - IIx: Highly powerful, quickly fatigue, "reservoir" fibers
  - IIa: Powerful, fatigue resistant, oxidative properties

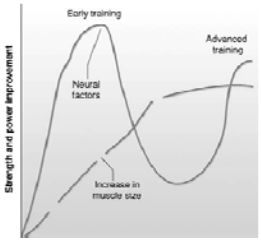
Type I ⇔ Type II

Type IIx → IIa *(any training)*

Type IIa → IIx *(only when detraining)*

- Genetic potential

Initial Training Adaptations



- Neural improvements: 6-10 weeks of training
- Hypertrophy/increased cross-sectional area: >10 weeks

Key Hormones

Anabolic Hormones	Physiological Action
Growth Hormone	Stimulates IGF-1, protein synthesis, growth, and metabolism
Testosterone	Stimulates growth, ↑ in protein anabolism, development of male sex characteristics
Insulin-like growth factors (IGF)	Increase protein synthesis in cells
Insulin	Stores glycogen and promotes glucose entry into cells, involved in protein synthesis
Catecholamines	↑ cardiac output (stimulate the central nervous system and peripheral vasodilators), blood sugar and glycogen breakdown; fat metabolism; stimulate anabolic response

Catabolic Hormones	Physiological Action
Glucocorticoids (cortisol)	Stimulates proteins → carb conversion; maintains normal blood sugar
Glucagon	Increases blood glucose levels

Endocrine Adaptations

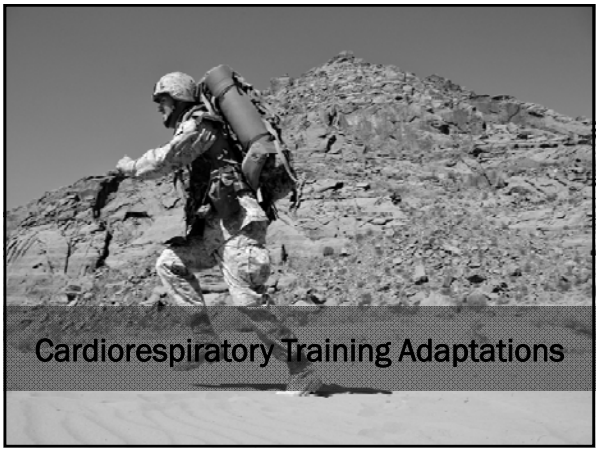
- Acute
  - ↑ testosterone, growth hormone (GH), catecholamines, and cortisol
    - Magnitude depends on the workout variables
    - Why does cortisol increase?
  - IGF and GH; insulin
  - Upregulation of anabolic hormone receptors
- Chronic
  - ↑ GH response to an acute exercise session
  - Resistance training does *not* appear to increase *resting* hormonal levels

Maximizing Endocrine Responses

- Muscle mass
- To increase testosterone response
  - Large muscle groups; 85-95% 1RM; moderate-high volume; short rest intervals (30-60 s)
- To increase growth hormone response
  - Higher lactate concentration workouts; 10RM; rest periods of 60 s
- To optimize adrenal hormone response
  - High volume; large muscle groups; short rest periods; *Be wary of overtraining!*

Other Adaptation Key Points

- Training local muscular endurance
  - ↑ oxidative and buffering capacity
- Flexibility
  - Must be part of a training program
- Aerobic capacity
  - Anaerobic training does not negatively affect aerobic capacity
  - Aerobic training may negatively impact strength, power, and hypertrophy
  - Circuit training may improve VO_2max



Topics

- Basic structure and function of the cardiovascular system
- Acute and chronic responses of the cardiovascular system to training
- Basic structure and function of the respiratory system
- Responses of the respiratory and endocrine systems to training

Cardiovascular Basics

- Myocardium
- Blood vessels
  - Arterial system
  - Venous system
- Blood pressure (BP)
  - Systolic (systole = ventricular contraction)
  - Diastolic (diastole = relaxation)
- Cardiac output (Q)
  - Heart rate (bpm) x stroke volume (ml/min)

Acute Cardiovascular *Response*

Variable	Cardiovascular Response: Acute (single) Session	
	Resistance Training	Aerobic Training
Heart Rate	↑ (variable)	↑
Blood Pressure	↑↑↑	↑
Systolic Blood Pressure	↑↑↑	↑
Diastolic Blood Pressure	↑	Resting level or slight ↓
Cardiac Output *(heart rate x stroke volume)*	↑	↑
Stroke Volume	↑	↑

Chronic Cardiovascular *Adaptations*

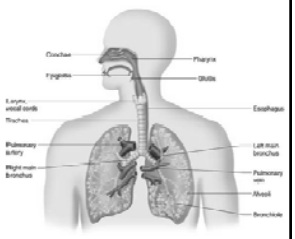
Variable	Cardiovascular Adaptations: Resting	
	Resistance Training	Aerobic Training
Blood Pressure	↓	↓↓
Heart Rate	↓	↓↓
Cardiac Output *(heart rate x stroke volume)*	↑	↑↑↑
Stroke Volume	↑	↑↑
Left Ventricle	↑ ventricular wall thickness	↑ left ventricular chamber volume and wall thickness

Other Adaptations: Aerobic Training

- Capillary density
  - Increases to allow for greater blood flow to working muscles (greater diffusion)
- Mitochondria
  - Procure adenosine triphosphate (ATP) aerobically
  - Increase in number
- Myoglobin
  - Protein that transports O_2 in the cell; increases

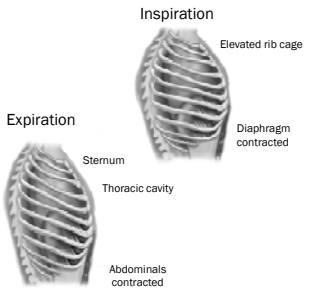
Anatomy of the Respiratory System

- Respiratory passages
  - Trachea
  - Bronchi
  - Bronchioles
- Alveoli
  - Site of gas exchange



Function of the Respiratory System

- Respiration
  - Exchange of O_2 and carbon dioxide
- Inspiration
  - Diaphragm
  - Ribs
- Expiration
  - Elastic recoil
  - Abdominals



Respiratory Responses: Aerobic

- During maximal aerobic exercise
  - Tidal volume increases
  - Breathing frequency increases
- During submaximal aerobic exercise
  - Tidal volume increases
  - Breathing frequency decreases

Endocrine Responses: Aerobic

- Catecholamines
  - Increase with high-intensity training
  - Decrease with submaximal/low-intensity training
- Cortisol
  - Increases, especially with high-volume running
  - Causes protein degradation

Topics

- Basic structure and function of connective tissues
- Adaptations of connective tissue that occur with training

Connective Tissues

- Bones
  - Basis of human movement and internal organ protection
  - Cartilage is found on the ends of bone and provides a smooth articulating surface, absorbs shock, and aids in the attachment of connective tissue to the skeleton
- Tendons
  - Connect muscles to bone and are inelastic
- Ligaments
  - Connect bone to bone and contain elastin (elastic properties)
- Fascia

How Does Bone Form?

- Mechanical loading
  - Osteoblasts
    - Collagen
      - Bone matrix
        - Periosteum

Osteoporosis

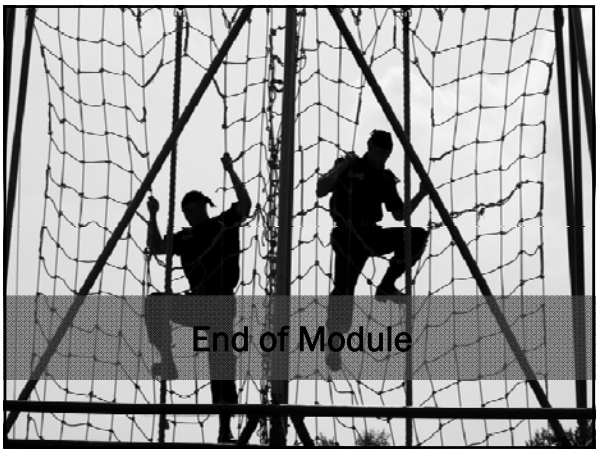
- Osteoporosis
  - Disease in which bone mineral density and bone mass are reduced to critically low levels
- Bone mineral density (BMD)
  - Quantity of mineral deposited in a given area of bone
- Peak bone mass
  - Maximum bone mass during a lifetime; occurs during early adulthood
  - BMD decreases when bones are immobilized and/or not stressed


Increasing Bone Mineral Density

- Principles
  - Specificity and exercise selection
    - Only the specific skeletal regions that experience mechanical loading undergo adaptation
    - Select structural exercises that load specific regions of the skeleton at a variety of angles
  - Progressive overload
    - Minimal essential strain (MES); 1/10 force required to fracture a bone
    - Progressively increase load to meet the new MES


Training Adaptations and Connective Tissue

- Tendons and ligaments
  - Respond to heavier loads; >80% 1RM
    - Tissue adaptation proportional to training intensity
- Cartilage
  - Weight-bearing forces through complete range of motion
  - Moderate aerobic exercise increases cartilage thickness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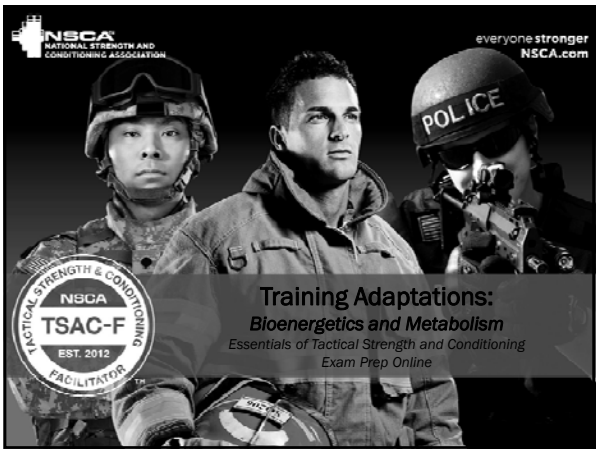

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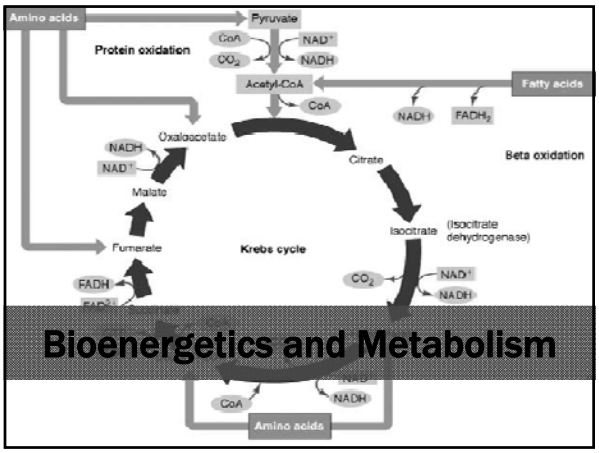
Training Adaptations Topic Areas	Total	AP	AN	RE
Bioenergetics and Metabolism	5	3	0	2



Topics

- Energy systems that function to replenish ATP
- Relationship between exercise duration, rest periods, and the energy systems
- Oxygen consumption
- Relationship between lactate production and fatigue

Basic Bioenergetics

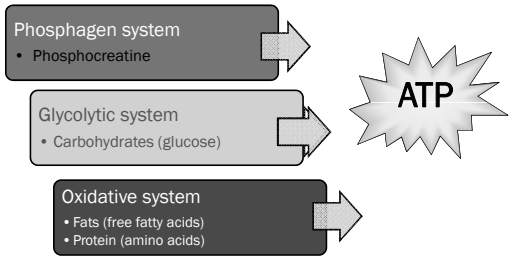
- Bioenergetics
  - Breakdown of the chemical bonds in macronutrients; provides the energy to do work
- Catabolism
  - Breakdown of large molecules into smaller molecules; associated with the release of energy (exergonic reactions)
- Anabolism
  - Synthesis of larger molecules from smaller molecules (endergonic reactions)

Basic Bioenergetics

- Metabolism
  - Total of all catabolic and anabolic reactions
- Adenosine triphosphate (ATP)
  - Chemical created in the body; required for all muscular work
- ATP hydrolysis
  - The breakdown of one molecule of ATP to yield energy

Biological Energy Systems

- ATP replenishment



Phosphagen Energy System

- Phosphagen system
  - Anaerobic, short-term, high-intensity
    - Anaerobic refers to the absence of oxygen
  - Active at the start of all exercise: 0-6 s

$$ADP + CP \underset{\leftarrow \text{Myosin ATPase}}{\overset{\text{Creatine Kinase} \rightarrow}{\longleftrightarrow}} ATP + \text{Creatine}$$

  - Skeletal muscles concentrations of creatine phosphate (CP) are 4-6 times higher than ATP concentrations
  - Type II muscle fibers contain higher concentrations of CP than Type I muscle fibers

Glycolytic Energy System

- Glycolytic system *(also known as glycolysis)*
  - Breakdown of carbohydrates (stored glycogen or blood glucose) to resynthesize ATP
    - End result of glycolysis: pyruvate
- *Anaerobic glycolysis (fast glycolysis)*
  - Pyruvate converted to lactate
- *Aerobic glycolysis (slow glycolysis)*
  - Pyruvate shuttled into mitochondria and oxidized

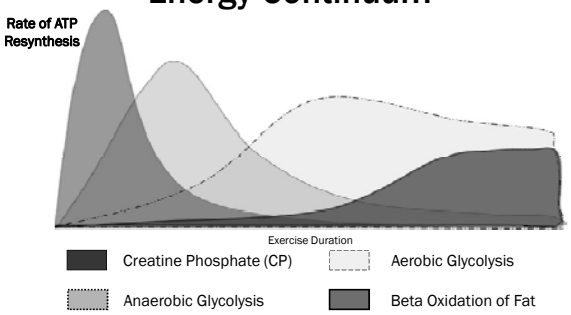
Lactate and Fatigue

- Lactate is an energy substrate that contributes to gluconeogenesis
  - Gluconeogenesis: Glucose is created from another substance
- Accumulation signifies the onset of anaerobic energy metabolism
- Muscular fatigue is most likely a result of H^+ accumulation from ATP hydrolysis, not lactate

Oxidative Energy System

- Primary energy source of ATP at rest and during low-intensity activities
  - > 3 min of activity
- Fuel
  - Combination of carbohydrates and fats
  - At rest
    - 70% fat to 30% carbohydrate
  - At maximal aerobic exercise
    - 100% carbohydrate

Energy Continuum



Effects of Duration and Intensity

Duration	Intensity*	Primary System
0-6 s	Extremely High	Phosphagen
6-30 s	Very High	Phosphagen and Fast Glycolysis
30 s-2 min	High	Fast Glycolysis
2-3 min	Moderate	Slow Glycolysis and Oxidative
>3 min	Low	Oxidative

**Intensity dictates duration and primary energy system used*

Work-to-Rest Ratio

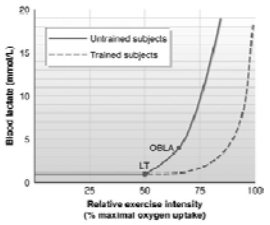
% Max Power	Primary System	Typical Exercise Times	Work-to-Rest Ratio
90-100%	Phosphagen	5-10 s	1:12 to 1:20
75-90%	Fast Glycolysis	15-30 s	1:3 to 1:5
30-75%	Slow Glycolysis	1-3 min	1:3 to 1:4
20-30%	Oxidative	>3 min	1:1 to 1:3

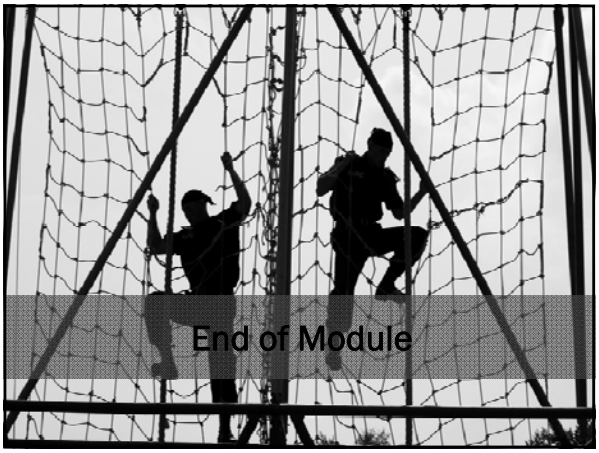
Oxygen Uptake

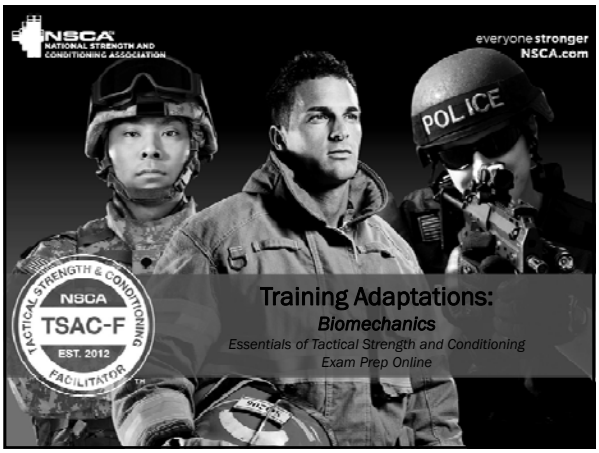
- Volume of oxygen (VO_2)
  - Measure of oxygen intake and use
- Oxygen uptake factors
  - Muscle mass, intensity, metabolic efficiency
- Oxygen deficit
  - Total energy contributions from anaerobic mechanisms
- Excess post-exercise oxygen consumption *(also called oxygen debt)*
  - Oxygen uptake above resting values used to restore the body to the pre-exercise condition

Lactate Threshold

- Lactate threshold shift
  - Glycogen sparing
  - ↑ fat utilization
  - ↓ La^- production
  - ↑ La^- clearance







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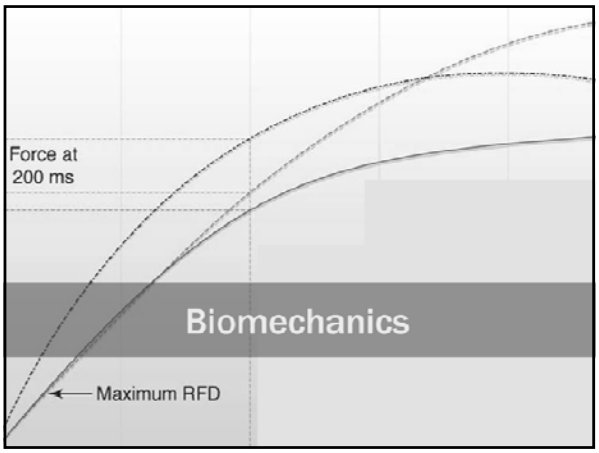
Training Adaptations Topic Areas	Total	AP	AN	RE
Biomechanics	5	2	2	1



Topics

- Basic principles of biomechanics
- Kinematic laws and principles of movement
- Kinetic laws and principles of movement
- Muscle actions and force-velocity relationship
- Application of biomechanics to exercise

Muscle Actions

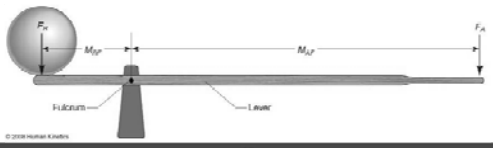
- Agonist
  - Prime mover
- Synergist
  - Assists the agonist
  - Prevents unwanted movement
- Antagonist
  - Opposes the prime mover, assists joint stabilization, and decelerates the limb (tendon and ligament protection)

Biomechanics

- Fulcrum (axis)
  - Pivot point of a lever
- Muscle force
  - Effort applied to cause movement
- Resistive force
  - Force generated by a source external to the body
  - Acts opposite to muscle force

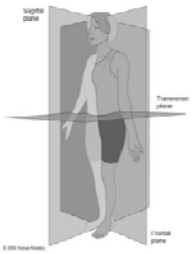
Biomechanics

- Torque (moment)
  - Degree to which a force rotates an object about a fulcrum
- Moment arm
  - Perpendicular distance from the line of action to the fulcrum
- Mechanical advantage
  - Ratio of moment arm through which applied force acts to moment arm through which resistive force acts



Anatomical Planes of Motion

- Anatomical position
  - Reference position used when viewing the body
- Anatomical planes of motion
  - Sagittal
    - Left and right
    - Flexion and extension
  - Frontal
    - Front and back
    - Abduction and adduction; side bending
  - Transverse
    - Upper and lower
    - Internal and external rotation



Major Body Movements

Shoulder adduction-abduction: Transverse

Shoulder adduction-abduction: Frontal

Shoulder flexion-extension: Sagittal

Shoulder internal-external rotation: Transverse

Elbow flexion-extension: Sagittal

Major Body Movements

Hip internal-external rotation: Transverse

Hip flexion-extension: Sagittal

Hip adduction-abduction: Frontal

Hip adduction-abduction: Transverse

Knee flexion-extension: Sagittal

Ankle dorsi-plantar flexion: Sagittal

Lumbar flexion-extension: Sagittal

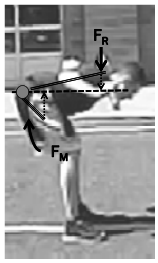
First-Class Levers

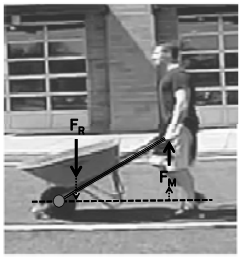
- Muscle force (triceps) and resistive force (cable) act on *opposite sides* of the fulcrum (elbow)
- F_M acting through a moment arm *smaller* than that which the resistance arm acts = mechanical disadvantage
- Examples
  - Triceps extension
  - Good morning

Second-Class Levers

- F_M and F_R act on the *same side* of the fulcrum
- F_M acting through a moment arm *longer* than that which the resistance arm acts
  - Calf raise
  - Wheelbarrow

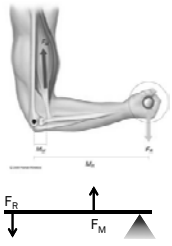
Lever Comparison

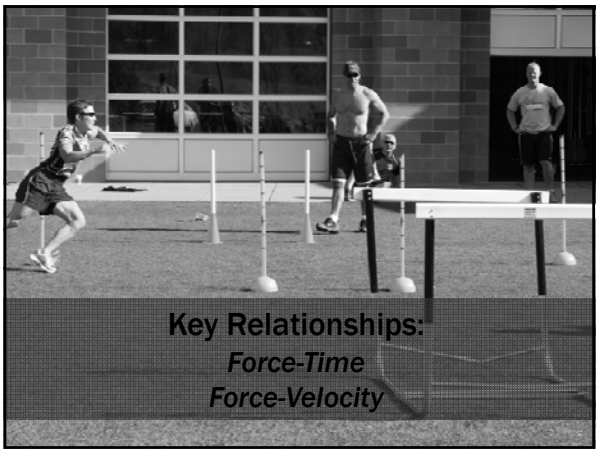




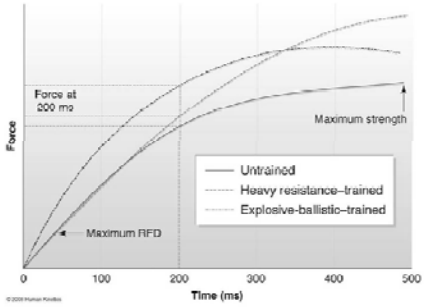
Third-Class Levers

- F_M and F_R act on the *same side* of the fulcrum
- F_M acting through a moment arm *shorter* than that which the resistance arm acts
  - DB biceps curl
  - DB lateral raise

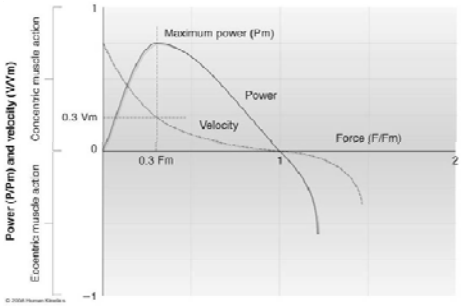




Force-Time Relationship



Force-Velocity Relationship



Application of Biomechanics

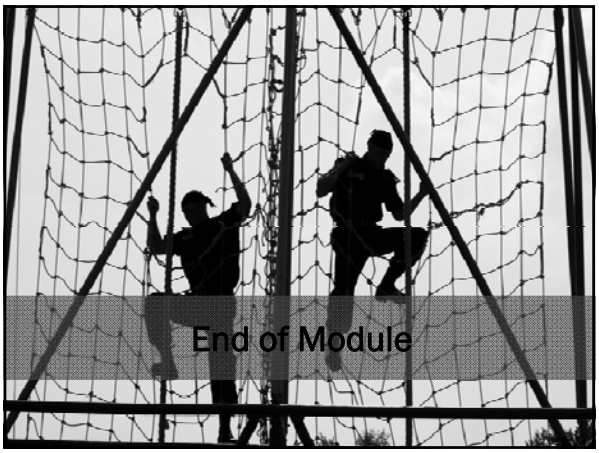
- Specificity and skill transfer
  - Leg press vs. depth jump

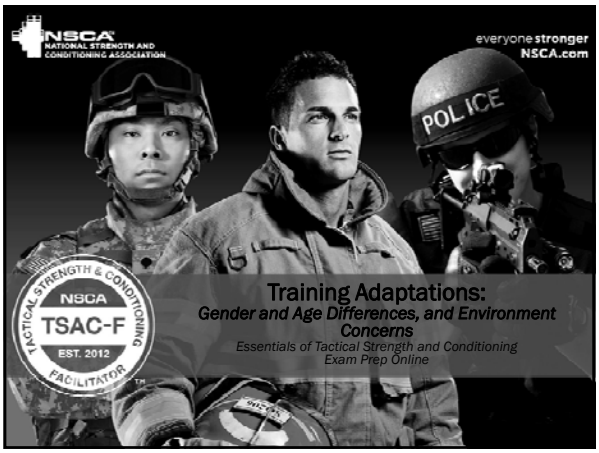
Application of Biomechanics

- Applying lever-related concepts

Application of Biomechanics

- Applying force-time and force-velocity relationships


End of Module



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Content Weighting

Training Adaptations Topic Areas	Total	AP	AN	RE
Anatomical, Physiological, and Biomechanical Differences	1	1	0	0
Identify Environmental Concerns	3	3	0	0
Total	4	4	0	0

Gender and Age Differences

Topics

- Anatomical and physiological differences of males and females
- Effects of aging on the body

Gender Differences

Topic	Males	Females
Hormones	Testosterone	Estrogen
Result	Bone formation, protein synthesis	Fat deposit, breast development
Total bodyweight	Heavier	Lighter
Absolute strength	↑ greater than female	2/3 of male (upper body only)
Relative strength (fat-free mass)	Approximately equal	Approximately equal
Shoulder-to-hip ratio	Higher	Lower
Result	Support ↑ muscle tissue; ↑ mechanical advantage	

Effects of Aging

- Aging (>30 year-old) can result in:
  - Muscle atrophy, loss of bone mineral content, increased body composition
    - Decreasing activity level is a major factor
- Muscle atrophy
  - Most notable in Type II fibers in both genders
    - More pronounced in women
- Aging does not affect musculoskeletal adaptations to resistance exercise

Topics

- Effects of the following environmental concerns on training and performance:
  - Altitude
  - Cold weather
  - Heat
  - Air pollution

Altitude

- Acute physiological response at >3,900 ft
  - O_2 content in arterial blood is reduced
  - Acute response includes
    - Increase in pulmonary ventilation (hyperventilation)
    - Increase in cardiac output (Q) due to increased HR
      - Heart must work harder to compensate for decreased O_2 in the atmosphere

  Results in decreased VO_2max and aerobic performance
- Acclimatization
  - Initial: 10-14 days
  - Complete: 3-6 weeks

Cold Weather Basics

- Physiological responses to cold environments
  - Peripheral vasoconstriction
  - Thermogenesis
    - Increases the energy cost of activity
- Performance effects
  - VO_2max is decreased
  - Anaerobic power is decreased
  - Aerobic capacity is increased (moderately cold weather)

Types of Cold Injuries

Frostbite	
Freezing skin or frostbite can occur when skin is exposed to ≤20° Fahrenheit	
Symptoms	A white or grayish-yellow skin area; skin that feels unusually firm or waxy; numbness in body parts exposed to the cold such as the nose, ears, feet, hands, and skin
Treatments	Keeping susceptible areas covered is the easiest way to prevent frostbite from occurring. If any of the aforementioned symptoms are experienced, immediately stop physical activity and seek treatment and/or medical attention

Hypothermia	
Body cannot produce heat as fast as it is lost; particularly when wet in cold temperatures	
Symptoms	Shivering, loss of judgement, slurred speech, drowsiness, and muscle weakness
Treatments	Get out of wet clothes, attempt to warm and call for medical attention

Cold Weather Tolerance Factors

- Fitness level
- Skinfold thickness
- Ratio of surface area to mass
- Wind
  - Greater wind velocity increases loss of body heat
- Water immersion

Wind Chill Factor

Wind Speed (mph)	Actual Air Temperature (°F)								
	40°	30°	20°	10°	0°	-10°	-20°	-30°	-40°
10	34	21	9	-4	-16	-28	-41	-53	-66
20	30	17	4	-9	-22	-35	-48	-61	-74
30	28	15	1	-12	-26	-39	-53	-67	-80
40	27	13	-1	-15	-29	-43	-57	-71	-84
50	26	12	-3	-17	-31	-45	-60	-74	-88
60	25	10	-4	-19	-33	-48	-62	-76	-91

Frostbite Times:

30 minutes	10 minutes	5 minutes

Cold Weather Clothing

- Wear three layers
  - Inner layer
    - Moisture-wicking properties: wool or polypropylene
  - Middle layer
    - Insulative properties: wool, down, synthetic materials
  - Outer layer
    - Water and wind resistant: nylon or Gore-Tex®

Types of Heat Illness

Heat Cramps	
Symptoms	Muscle twitching, cramping, spasms in legs, arms, and abdomen
Treatments	Put the tactical athlete in a shaded area, provide water/electrolytes, monitor status

Heat Exhaustion (requires medical attention)	
Symptoms	Excessive thirst, fatigue, lack of coordination, increased sweating, cold/wet skin, dizziness, and/or confusion
Treatments	Same as cramps; apply cold water to head and body, call for medical attention

Heat Stroke (medical emergency, call 9-1-1)	
Symptoms	No sweating, hot/dry skin, rapid pulse, rapid breathing, seizure, dizziness and/or confusion, loss of consciousness
Treatments	Same as exhaustion

Heat Stress Factors

- Environmental factors
  - Ambient/radiant temperature, humidity, wind
- Individual/behavioral factors
  - Metabolic rate, clothing
- Other factors
  - Hydration status, level of acclimatization, age, fitness level, obesity

Temperature/Humidity Limits

Relative Humidity (%)	Temperature Limit
0	95°F (35°C)
1-20	90°F (32°C)
21-50	85°F (29°C)
51-90	80°F (27°C)
91-100	75°F (24°C)

Heat Acclimatization

- Primary adaptations occur in 5 days, full acclimatization occurs in 10-14 days, these include:
  - Reduced heart rate
  - Increased peripheral blood flow and blood volume
  - Reduced metabolic heat production
  - Increased sweat production
  - Decreased loss of electrolytes
- Train at roughly 50% VO_2max for 2 hours per day
- Hot-dry vs. hot-wet environments both require acclimatization

Euhydration and higher aerobic fitness level (VO_2max) correlate with more efficient acclimatization response

Effects of Dehydration

- Bodyweight fluid loss
  - 1% loss
    - Elevated core temperature during exercise
  - 3-5% loss
    - Cardiovascular strain and impaired ability to dissipate heat
    - Loss of body fluid (plasma volume) forces the heart rate to increase during submaximal exercise
  - 7% loss
    - Serious threat of collapse

Thirst is not an accurate indicator of hydration status (thirst sensation typically occurs at 1-2% bodyweight fluid loss)

Training in the Heat

- Allow time to acclimatize
- Hydration recommendations
  - Hydrate in the preceding 24 hours
  - Drink cool beverages, 150-250 ml every 15 minutes during training
- Clothing
  - Light-color, loose-fitting tanks tops and shorts with moisture-wicking properties

Air Pollution

- Carbon monoxide
  - Decreases VO_2max
  - May result in blurred vision and impaired judgement
- Ozone
  - Increases breathing difficulty, especially during maximal activity
- *Adaptation is unknown, but 2-5 days of exposure seems to decrease the detrimental effects*

Review: Altitude

- Physiological effects
  - Decreased VO_2max and aerobic performance
- Training considerations
  - Ascend slowly
  - Maintain hydration
  - Avoid overexertion in the initial days
  - Adaptations are lost after 30 days at sea level

Review: Cold Weather

- Physiological effects
  - Decreased VO_2max; increased energy expenditure at rest and lower exercise intensity
  - Decreased muscle temperature results in decreased strength and power capability
- Training considerations
  - Acclimatization is minimal; wear 3 layers of clothing
    - Inner layer – moisture-wicking properties
    - Middle layer – insulative properties
    - Outer layer – water and wind resistant
- Body composition
  - Body fat acts as insulation (positive effect)

Review: Heat

- Physiological effects
  - Increased sweat rate
    - Decreased plasma volume
    - Increased heart rate for relative exercise intensity
- Training considerations
  - Allow 10-14 days to acclimate
    - Wear light, loose-fitting clothing
    - Monitor heat/humidity index and hydration status; provide fluids and rest periods