Performance Enhancing Drugs

Objectives
- Discuss the routes of administration, dosage patterns, physiological effects and harmful side-effects associated with the following performance enhancing drugs:
  - androgenic-anabolic steroids
  - human growth hormone
  - erythropoietin (epoietin alfa)
  - androstenodione
  - creatine

Steroids
- A derivative of testosterone
- Technically androgenic-anabolic steroids
  - produce both masculinizing (androgenic) AND tissue building (anabolic) effects

Androgenic-Anabolic Steroids
- Physiological effects/benefits
  - Increased muscle size & strength

Androgenic-Anabolic Steroids
- Side effects or possible health risks
  - Cosmetic-related
  - Psychological
  - Reproductive
  - Cardiovascular risk factors
  - Liver function
  - Athletic injuries
  - AIDs

Androgenic-Anabolic Steroids
- Cosmetic-related side effects
  - Facial & body acne
  - Female-like breast enlargement in males
  - Premature baldness
  - Masculinization in females
  - Premature closure of growth centers in adolescents, leading to stunted growth
  - Deepening of the voice in females
Androgenic-Anabolic Steroids

- Psychological side effects
  - Increased aggression
  - Possible violent behavior
  - Depression

- Reproductive side effects
  - Reduction of testicular size
  - Reduction of sperm production
  - Decreased libido
  - Impotence in males
  - Enlargement of the prostate gland
  - Enlargement of the clitoris

- Cardiovascular risk factors
  - Increase in cholesterol
  - High blood pressure
  - Stroke
  - Heart disease

- Liver dysfunction
  - Jaundice
  - Liver tumors

- Athletic injuries
  - Delay in healing
  - Tendon rupture

- AIDS related side effects
  - Use of contaminated needles
Androgenic-Anabolic Steroids
- Potential for side effects far outweigh the benefits!

Human Growth Hormone
- See class notes from Monday 2/9/04

Erythropoietin (EPO)
- See class notes from Monday 2/9/04

Nutritional Supplements
- Androstenedione
  - Promoted as a natural alternative to steroids
  - Endogenous substance made in the adrenal glands and gonads
  - Found in small amounts within some plants
  - Synthetic substance (exogenous)

Androstenedione
- Steroid hormone
- Metabolized or broken down into testosterone in both males and females
### Androstenedione – Theory for Supplementation
- Androstenedione itself has minimal androgenic activity
- Effects are produced when it is broken down into testosterone

### Androstenedione – Dosage
- Ranges from 50 to 100 mg once or twice/day, usually 1 hour before exercise

### Androstenedione – Banned
- IOC
- NCAA
- World Natural Body Building Federation
- NFL

### Androstenedione
- Also see class notes from Monday 2/9/04

### Creatine
- Water soluble amino acid made naturally in the body within the liver, kidneys, and pancreas (endogenous)
  - Formed by the binding of 3 amino acids
    - L-arginine
    - L-Methionine
    - Glycine
- Obtain in diet (animal products & some plants)
- Obtained through supplementation (exogenous)

### Creatine – Indications
- Used to enhance performance during brief, high intensity exercising requiring sudden bursts of energy
- Ineffective in improving performance in endurance sports
- Some evidence to support that it is effective in building muscle
Creatine – Indications
- Used therapeutically to increase strength or muscle function in patients with:
  - Muscular dystrophy
  - Amyotrophic lateral sclerosis (ALS; Lou Gehrig’s Disease)

Creatine – Trade Names
- Muscle Power
- Creatine Fuel
- Creatine Booster
- Creatigen
- CreaVate
- Perfect Creatine
- Extra Advantage
- Creatine Serum
- Creavescent
- Power Creatine
- Phophagen
- Crea-Tek
- Effervescent Creatine Elite

Creatine – Pharmacokinetics
- Creatine synthesized in the liver is transported to the circulatory system and muscles.

Creatine – Pharmacokinetics
- Creatine is converted to creatine phosphate (stored until needed for energy).

Creatine -- Effects
- Muscles need energy to contract
  - ATP is the main source of energy
  - ATP is broken down into ADP during production of energy
  - Creatine phosphate is used to convert ADP back to ATP (it donates a phosphate, becoming creatinine)

Creatine – Effects
- After being used for energy, creatine phosphate is transformed to creatinine & released back into the bloodstream.
- Creatinine is filtered out of the bloodstream by the kidneys
- Excreted in urine
Creatine – Theory #1 for Supplementation

- ↑ amount of creatine phosphate in the muscle helps to ↑ the rate at which ATP can be regenerated from ADP
- Regeneration of ATP results in ↓ fatigue, allowing the muscle to work for longer periods of time

Creatine – Theory #2 for Supplementation

- ↑ muscle cell volume (↑ creatine within muscle cell draws in fluid)
- Produces a larger cross-sectional area of the muscle
  - Muscle strength is dependent on the cross-sectional area
- Muscles will be able to lift more weight, which in turn builds more muscle mass

Creatine – Side Effects

- Known only through anecdotal reports
- No longitudinal studies

- Dehydration (fluid retention within muscle cells)
- Electrolyte imbalance
- Heat related illness
- Muscle injury (muscle cramping & strains)
- Gastrointestinal (nausea, diarrhea, indigestion)
- Weight gain (fluid retention within muscle cells)
- Rash

Creatine – Cautions

- Not controlled by the FDA
  - Product quality & purity are suspect
Creatine – Precautions

- Should be avoided by children, adolescents, pregnant women, nursing mothers and anyone at risk for renal disorders (diabetics)

Creatine – Interactions

- None known at this time
- Caffeine appears to interfere with the beneficial effects of creatine supplementation

Creatine – Dosage

- Available in the following forms
  - Capsules (700 mg, 725 mg, 1200 mg)
  - Effervescent tablets (5 gm)
  - Effervescent powder (27 gm/packet)
  - Powder (5 gm/tsp)
  - Wafers (1000 mg)

- Typically ingested in the form of creatine monohydrate powder
- Initial loading dose of 20 grams (or 0.3 grams/kilogram) divided into four doses/day for 2-5 days

Creatine – Dosage

- Maintenance dose of 5-10 grams (or 0.03 grams/kilogram) daily
- Should be taken with adequate water (6-8 glasses/day)
- Recommended for taking before and/or immediately after a workout

What questions do you have?