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)
- androstenedione
- creatine

Steroids

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

Physiological effects/benefits
- Increased muscle size & strength

Side effects or possible health risks
- Cosmetic-related
- Psychological
- Reproductive
- Cardiovascular risk factors
- Liver function
- Athletic injuries
- AIDS

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

Psychological side effects
- Increased aggression
- Possible violent behavior
- Depression
Androgenic-Anabolic Steroids
- 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

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

Androgenic-Anabolic Steroids
- Liver dysfunction
  - Jaundice
  - Liver tumors

Androgenic-Anabolic Steroids
- Athletic injuries
  - Delay in healing
  - Tendon rupture

Androgenic-Anabolic Steroids
- 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
  - popularized by Mark McGuire
  - Banned by NFL and IOC
  - Not banned by MLB or the NBA
- Creatine
17  ☐  **Androstenedione**
- Steroid hormone
  - 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)

18  ☐  **Androstenedione**
- Metabolized or broken down into testosterone in both males and females

19  ☐  **Androstenedione – Theory for Supplementation**
- Androstenedione itself has minimal androgenic activity
- Effects are produced when it is broken down into testosterone

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

21  ☐  **Androstenedione – Banned**
- IOC
- NCAA
- World Natural Body Building Federation
- NFL

22  ☐  **Androstenedione**
- Also see class notes from Monday 2/9/04

23  ☐  **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)

24  ☐  **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

**Creatine – Pharmacokinetics**

**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)

- 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 #1 for Supplementation**
- High levels of ATP minimize dependence on glucose breakdown (glycolysis) which
leads to:
- lactic acid build-up
- muscle pain & burning
- eventual muscle inactivity

33 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 weigh, which in turn builds more muscle mass

34 Creatine – Side Effects
- Known only through anecdotal reports
- No longitudinal studies

35 Creatine – Side Effects
- 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

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

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

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

39 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)

40️⃣ Creatine – Dosage

• 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

41️⃣ 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

42️⃣ What questions do you have?