Chapter 25: Nutrition, Metabolism, and Temperature Regulation

I. Nutrition

A. Nutrients

1. What are nutrients? _____________________________________________
   __________________________________________________________________
   __________________________________________________________________

2. List the six major classes of nutrients:
   a. ____________________   d. ____________________
   b. ____________________   e. ____________________
   c. ____________________   f. ____________________

3. Which of these are the major organic nutrients? ____________________,
   ____________________, & ____________________

4. Enzymes break organic nutrients into subunits that are:
   a. Broken down ________________________________________
   b. Used as building ________________________________________

5. What are "essential nutrients"? _____________________________
   __________________________________________________________________
   __________________________________________________________________

B. Kilocalories

1. Energy used by the body is stored within _____________________________

2. Define the term calorie: __________________________________________

3. A kilocalorie is equal to ______________________________

4. How many kilocalories in one gram of carbohydrate? __________

5. How many kilocalories in one gram of fat? __________

C. Carbohydrates

1. Sources in the Diet
   a. Carbohydrates include ____________, _____________, & ____________
   b. The most common monosaccharides in the diet are _______________ &
      _______________
   c. Table sugar is a disaccharide called ____________________ and is
      composed of a ____________________ and ____________________
   d. Maltose is a disaccharide composed of ___________________________
e. Lactose is a disaccharide composed of _____________ & ____________
f. The complex carbohydrates are the polysaccharides: ________________, ________________, & ________________
g. Which is the energy storage molecule used in plants? ________________
h. Which is the energy storage molecule used in animals? ______________
i. Which polysaccharide forms cell walls in plants? ________________

2. Uses in the Body
   a. What form of carbohydrate is absorbed into the blood? _______________
b. Which polysaccharide are humans unable to digest? _________________
c. The liver converts all monosaccharides to ________________
d. Most cells use glucose to produce ______________________
e. Excess glucose is converted to ________________ for storage
   1. Additional glucose may be converted to __________ and stored in ________________
f. Other uses of sugar in the body include:
   1. Form part of ________________ & ______________
   2. Combine with proteins to form ______________________

3. Recommended Amounts
   a. The daily kilocalorie intake from carbohydrates should be __________
   b. Why are complex carbohydrates recommended? ________________

D. Lipids
   1. Sources in the Diet
      a. Triglycerides make up about __________ of the lipids in the human diet
      b. Triglycerides are also known as ______________________
      c. A triglyceride molecule consists of ______________________
         attached to a ______________________
      d. Saturated fats have only ______________________
      e. Unsaturated fats have ______________________
      f. The remaining lipids in the diet include ____________ & ____________
2. Uses in the Body
   a. Triglycerides are an important source of __________ used to produce ______________________________
      1. What type of cell gets most of its energy from triglycerides?
         ______________________________
   b. Excess triglycerides are stored in _______________ or the __________
   c. Functionally adipose tissue:
      1. Stores __________________________
      2. Surrounds and __________________________
      3. Under the skin __________________________________________
   d. Functionally cholesterol is a:
      1. Component ______________________________
      2. Modified to form ____________________ & ____________________

3. Recommended Amounts
   a. The daily kilocalorie intake from lipids should be __________________
   b. Which fatty acids must be ingested in the diet? ____________________ & ____________________

E. Proteins
   1. Sources in the Diet
      a. Proteins are chains of __________________________
      b. How many amino acids are in human proteins? __________________________
      c. How many amino acids are essential amino acids? __________________________
      d. A complete protein food contains ______________________________
   2. Uses in the Body
      a. Amino acids are used to ______________________________
      b. Proteins are also used as a ______________________________
      c. Excess proteins can be stored by converting amino acids to __________
         or __________________
   3. Recommended Amounts
      a. The daily kilocalorie intake from protein should be __________________
F. Vitamins
1. What are vitamins? ____________________________________________
2. Essential vitamins must be in the diet because ____________________
   _____________________________________________________________
3. What does the body do with provitamins? ________________________
4. Vitamins are used by the body in _______________________________
5. Many vitamins function as ________________________________________
6. Fat-soluble vitamins dissolve in _________________________________
   a. Absorbed from the intestine along with ________________________
   b. Some of them can be stored for a _____________________________
7. Water-soluble vitamins dissolve in _______________________________
   a. Absorbed from the __________________________________________
   b. Remain in the body __________________________________________
8. What does RDA stand for? _____________________________________
9. The RDA's for vitamins and minerals establish a minimum that should protect
   ________________________________ in a given group
G. Minerals
1. What are minerals? _____________________________________________
2. Functionally minerals are involved in:
   a. Establishing _______________________________________________
   b. Generating ________________________________________________
   c. Adding mechanical __________________________________________
   d. Combining with ____________________________________________
   e. Acting as ____________, ____________, or _______________________
3. Minerals are ingested __________________________________________
H. Daily Values
1. What are daily values? _________________________________________
2. Reference Daily Intakes are based on _____________________________
   a. RDIs are set for four groups: ________________________________,
      ________________________________,
      ________________________________, and _________________________
3. The Daily Reference Values (DRVs) are set for:
   a. ____________________  e. ____________________
   b. ____________________  f. ____________________
   c. ____________________  g. ____________________
   d. ____________________  h. ____________________

4. The Daily Values are a combination of _____________ and ______________

5. The Daily Value for some nutrients is the uppermost limit considered
desirable because of ______________________________________________

II. Metabolism
A. Definitions
   1. What is metabolism? ____________________________________________
   2. What is anabolism? _____________________________________________
   3. What is catabolism? _____________________________________________
   4. The cellular metabolic processes are often referred to as ______________
      ______________ or ______________________________
   5. The food molecules taken into cells are catabolized and the released energy
      is used to ___________________________________________________
   6. What molecule is the "energy currency" of the cell? ________________
   7. Transferring energy from food molecules to ATP molecules involve
      ______________________________ reactions
      a. A molecule is reduced when ______________________________
      b. A molecule is oxidized when ______________________________
   8. Nutrient molecules have many hydrogen atoms covalently bonded to the
      carbon atoms and is therefore highly _________________
      a. When a hydrogen ion and associated electron are lost from the nutrient
         molecule, the molecule ____________________ and __________________
      b. The energy in the electron is used to ___________________________
III. Carbohydrate Metabolism

A. Glycolysis

1. Glycolysis is a series of chemical reactions in the ____________________ that results in the breakdown of ____________ into ____________________

2. Glycolysis is divided into ____________________:
   a. Input of ATP
      1. Phosphate group is transferred from ATP to glucose forming ____________________
         a. What is this process called? ____________________
      2. The atoms are rearranged to form ____________________
      3. Another phosphate group is transferred from a second ATP forming ____________________
   b. Sugar Cleavage
      1. Fructose-1,6-bistrophosphate is cleaved into two molecules each having three carbons:
         a. ____________________
         b. ____________________
      2. Dihydroxyacetone phosphate is rearranged to form ____________________
      3. So the end product is 2 molecules of ____________________
   c. NADH Production
      1. Each glyceraldehyde-3-phosphate molecule is oxidized to form ____________________ and ____________________ is reduced to ____________
      2. Functionally NADH is a carrier molecule with ____________________ that ____________________
   d. ATP and Pyruvic Acid Production
      1. Each 1,3-bisphosphoglyceric acid molecule forms a. Two ____________________ b. One ____________________

3. Summary of Glycolysis
   a. Each glucose molecule that starts glycolysis forms four ____________.
two ____________________, and two ____________________________
b. The start of glycolysis required the input of _________________________
c. Therefore the final yield for each glucose molecule is two _____________,
two ____________________, and two ____________________________

B. Anaerobic Respiration
1. Anaerobic respiration is the breakdown of glucose in the absence of _______
   __________ to produce two ____________________ & two _____________
2. Anaerobic respiration is divided into ____________________:
   a. Glycolysis
      1. Glucose converted to two ____________________ & two __________
         a. Also a net gain of ______________________________
   b. Lactic Acid Formation
      1. Conversion of pyruvic acid to ____________________
      2. Requires input of energy from ______________________________
3. Where does the lactic acid go from the cell? __________________________
4. What is the Cori cycle? _________________________________________
   a. Requires the input of __________________
   b. The oxygen necessary is part of the __________________________

C. Aerobic Respiration
1. Aerobic respiration is the breakdown of glucose in the presence of _______
to produce ____________________, __________, & ___________________
   a. The four phases are:
      1. ______________________________
      2. ______________________________
      3. ______________________________
      4. ______________________________
2. Glycolysis is the first phase in ______________________________ and
   ______________________________
3. Acetyl-CoA Formation
   a. Pyruvic acid molecules move from the __________ into a _____________
b. Within the inner compartment of the mitochondrion enzymes remove a ___________ and two ___________ from the three-carbon pyruvic acid molecule to form _______________ & ________________________

1. Energy is released in the process and is used ________________________________

2. The acetyl group joins with coenzyme-A to form __________________

c. Summary

1. From each 2 pyruvic acid molecules from glycolysis (1 glucose) get:
   a. Two ______________________________
   b. Two ______________________________
   c. Two ______________________________

4. Citric Acid Cycle

a. Begins with a citric acid molecule that forms from the combination of __________________ and ______________________________

b. Through a series of reactions another ____________________ is formed which can start the cycle again by joining with ______________________

c. Three important events occur during the citric acid cycle:

1. ATP Production
   a. Each citric acid molecule produces __________________

2. NADH and FADH₂ Production
   a. For each citric acid molecule:
      1. Three ____________________ are converted to ____________
      2. One ____________________________ is converted to _______

3. Carbon Dioxide Production
   a. Each six-carbon citric acid molecule becomes a ________________________________
   b. Two ____________________ and four ____________________
      from the citric acid molecule form _______________________

d. Summary for each glucose that begins aerobic respiration, produce:

1. Two ____________________ in glycolysis
2. Converted into two ____________________ that enter Kreb's cycle
3. In the citric acid cycle (Kreb's cycle) two turns of the cycle occur:
   a. Two ______________________________
   b. Six ______________________________
   c. Two ______________________________ &
   d. Four ______________________________

5. Electron-Transport Chain
   a. The electron-transport chain is a series of electron carriers in the ____________________________
   b. Electrons from __________ & __________ are transferred to the electron-transport carriers and ________________ released from NADH & FADH₂
   c. The now oxidized NAD⁺ and FAD are reused to________________________

   d. The released electrons pass from one electron carrier to the next in a series of ____________________________
   e. Three of the electron carriers also function as proton pumps that move hydrogen ions from ________________ to the ________________
      1. The proton pump accepts an ________________
      2. Uses some of the electron's energy to ________________
      3. Passes the electron to the ________________
   f. The last electron carrier in the series:
      1. Collects the ________________
      2. Combines them with __________ & ___________ to form ________
   g. Without oxygen to accept the electrons ___________________________
   h. As the proton pumps move hydrogen ions into the outer compartment:
      1. The concentration of hydrogen ions in the outer compartment ____________________________
      2. Hydrogen ions diffuse ____________________________
      3. The hydrogen ions diffuse through channels called ________________
      4. As each hydrogen ion diffuses through the channel it loses _________ which is used to produce ___________________________
         a. This is called the ____________________________
6. Summary of ATP Production
   a. For each glucose molecule, aerobic respiration produces a net gain of
      ________________________________
      1. ________ from glycolysis
      2. ________ from the citric acid cycle
      3. ________ from the electron-transport chain
         a. Each NADH molecule formed produces ________ ATP molecules
         b. Each FADH$_2$ molecule formed produces ________ ATP molecules
   b. The number of ATP molecules produced per glucose is also reported as a
      net gain of ________________________________
      1. The two NADH molecules produced by glycolysis cannot cross the
         ________________________________
         a. They donate their electrons to a shuttle molecule that carries the
            electrons to the ________________________________
               1. Depending on the shuttle molecule ________ ATP's are made
         2. In skeletal muscle and brain, ________ molecules are produced for
            each NADH from glycolysis for a net gain of _________________
         3. In liver, kidneys, and heart, ________ molecules are produced for
            each NADH from glycolysis for a net gain of _________________
   c. How many carbon dioxide molecules are produced? _________________
   d. In aerobic respiration water molecules are both ___________________ &
      ________________________________
         1. ________ water molecules are used, but ________ are formed
            for a net gain of ________ water molecules
   e. Aerobic respiration for one glucose molecule is summarized chemically:
      ___________________________________________________________

IV. Lipid Metabolism
   A. Storage
      1. What is the body's main energy-storage molecule? _________________
      2. Glycogen accounts for about ________ of energy-storage
3. Lipids are stored primarily as ____________________ in ________________

4. Between meals, when blood nutrient levels are low, adipose tissue
________________________________________

5. What are "free fatty acids"? ________________________________
   a. What cells use them for energy? ________________________________

B. Beta-oxidation
   1. Beta-oxidation refers to the metabolism of ________________________________
      a. A series of reactions remove _________ carbon atoms at a time from the
         end of a fatty acid chain to form ________________________________
   2. Acetyl-CoA can then enter the ____________________ and be used to
      ________________________________

C. Ketogenesis
   1. Two molecules of acetyl-CoA combine to form ________________________________
      which is converted mainly to ________________ and ________________
      a. The three molecules formed are referred to as ________________________________
   2. Ketone bodies are released in the blood and travel to other tissues where
      they are converted back into ________________________________ & enter the
      ________________________________ to produce __________

V. Protein Metabolism
   A. Synthesis of Nonessential Amino Acids
      1. The process usually begins with ________________________________
      2. How is a keto acid converted to an amino acid? ________________________________
      3. What is transamination? ________________________________
      4. Most amino acids can undergo transamination to produce ________________________________
      5. What is used as a source of an amine group to construct most of the
         nonessential amino acids? ________________________________
   B. Amino Acids as an Energy Source
      1. In oxidative deamination:
         a. An amino group is ________________________________
b. Leaving ____________________ and a ____________________

c. In the process _________ is reduced to ___________ which can enter ______________________________ to produce ___________

2. Ammonia is toxic to cells:
   a. The liver converts it to ______________
   b. Carried by the blood to the ____________ where it is ______________

3. Keto acid can also enter the ______________________________ cycle or be converted into ______________________ or ______________________

VI. Interconversion of Nutrient Molecules

A. Carbohydrate Storage
   1. Blood glucose enters most cells by ______________________________
   2. Inside the cell it is converted to ______________________________ and used in cellular respiration to produce __________________
   3. When excess glucose is present it is converted to ______________
      a. The process is known as __________________
      b. Most of the body's glycogen is in ______________ & __________

B. Lipid Synthesis
   1. When the limited glycogen stores are filled, glucose and amino acids are used to synthesize ______________
      a. The process is known as ______________________________
         1. Glucose molecules form:
            a. ______________________________ and __________________
         2. Amino acids are converted to ______________________________
         3. Glyceraldehyde-3-phosphate is converted to __________________
         4. Fatty acid chains are formed by joining together __________________
         5. Finally triglycerides are formed by joining together ______________ 
            & ______________________________

C. Carbohydrate Mobilization
   1. When glucose is needed glycogen is broken down into ______________
      a. The process is called ______________________________
2. What happens to glucose-6-phosphate in skeletal muscle? ______________ 
   ____________________________________________________________________

3. What happens to glucose-6-phosphate in the liver? ________________ 
   ____________________________________________________________________
   a. This is necessary to maintain ________________ between meals
   b. For what organ is this most important? ________________

4. Amino acids and glycerol can be used to produce ________________
   a. The process is called ________________
      1. Amino acids are converted to ________________ or ________________
         a. These molecules are then converted to ________________
      2. Glycerol is converted to ________________ which then enters ________________

VII. Metabolic States
A. Absorptive State
   1. Period immediately after a meal when ________________
   2. Most of the glucose that enters circulation is used ________________
   3. Remainder of the glucose is converted to ________________ or __________
   4. Most of the absorbed fats are deposited in ________________
   5. Many of the absorbed amino acids are used ________________
      a. Some are used for ________________
      b. Others enter the liver and are converted into ________________ or ________________

B. Postabsorptive State
   1. Blood glucose levels are maintained by conversion of ________________
      ________________ to ________________
      a. The first source is ________________ stored in the liver
      b. Next fats are used as an energy source:
         1. Glycerol from triglycerides can be converted to ________________
         2. Fatty acids from triglycerides can be converted to ________________
            a. Moves into the ________________ & used ________________
b. In the liver they are used to produce ________________________ that other tissues use for energy

2. The use of fatty acids as an energy source:
   a. Partly eliminates ________________________________
   b. Resulting in ________________________________
   c. Maintenance of ________________________________

3. What other molecule can be used as a source of glucose or for energy production? ______________________________

VIII. Metabolic Rate

A. Metabolic Rate
   1. Metabolic rate is the total ______________________ produced and used by the body ______________________
   2. Metabolic rate is usually estimated by measuring ______________________
   3. One liter of oxygen consumed by the body is assumed to produce ______________________

B. Basal Metabolic Rate (BMR)
   1. The basal metabolic rate is the metabolic rate calculated in ______________
      ______________ per ______________________ per ____________
   2. How is BMR determined? ________________________________
      ________________________________
   3. BMR is the energy needed to ________________________________
   4. Basal metabolism accounts for about __________ of energy expenditure
   5. Factors that affect the BMR include:
      a. Muscle tissue is ________________________________
      b. Younger people ________________________________
      c. Fever ________________________________
      d. Reduced kilocaloric input ________________________________
      e. Thyroid hormones ________________________________
      f. Epinephrine ________________________________
      g. Males ________________________________
h. During pregnancy ____________________________________________

C. Thermic Effect of Food
1. Assimilating ingested food consumes energy when:
   a. Accessory digestive organs and the intestinal lining ________________
   b. Motility of the digestive tract ________________
   c. Liver is involved in ________________
2. The energy cost of these activities is called the ______________________
   a. They account for about __________ of the body's energy expenditure

D. Muscular Activity
1. Muscular activity consumes about __________ of the body's energy
2. Increased physical activity using skeletal muscle requires more energy for:
   a. Skeletal muscle ________________
   b. Increased contraction of the ___________ & ______________________
3. Energy loss through muscular activity is the only component of energy
expenditure that ______________________________________________

IX. Body Temperature Regulation
A. Homeotherms
1. What does the term homeotherm or being warm-blooded animals mean for
   humans? ______________________________________________________
2. Maintenance of a constant body temperature is important to _____________
3. Most enzymes are very temperature sensitive and only function ___________
   ______________________________
   a. Environmental temperatures ______________________________
   b. Heat produced by metabolism ________________________________
      ___________________________________________________________

B. Free Energy
1. Define the term "free energy": _______________________________________
   ______________________________________________________
   a. Usually expressed in terms of ____________ per ______________
2. How much of the energy released by catabolism is used to do work? ______
3. What happens to the rest of the energy? _____________________________

C. Heat Exchange

1. What is radiation? _______________________________________________
   ______________________________________________________________

2. What is conduction? _____________________________________________
   ______________________________________________________________

3. What is convection? _____________________________________________
   ______________________________________________________________

4. What is evaporation? ____________________________________________
   ______________________________________________________________

5. Body temperature is maintained by _________________________________
   a. If heat gain exceeds heat loss _________________________________
   b. If heat loss exceeds heat gain _________________________________

6. Heat gain occurs through ______________ & _________________________

7. Heat loss occurs through ______________________________

8. Radiation, conduction, and convection can result in heat gain or loss
depending on __________________________________________________

9. What determines the amount of heat exchanged between the environment
and the body? _________________________________
   a. The greater the temperature difference __________________________

10. Temperature difference can be controlled physiologically through ________
    ______________________________________________________________ in the skin
    a. Warm blood is brought to the surface by __________________________
    b. Skin temperature is lowered by _________________________________

11. When environmental temperature is greater than body temperature:
    a. Vasodilation _________________________________________________
    b. Causing ____________________________________________________ that
    c. Decreases __________________________________________________
    d. Evaporation _________________________________________________

12. Regulation of body temperature is an example of a _________________
    controlled by a ____________________
a. Increases in blood temperature are detected by _____________________
   __________________________________________
   1. Activates mechanisms that ________________________________

b. Decreases in blood temperature are detected by ______________
   _______________________________________________________
   1. Initiate heat gain by ________________________________

c. Under what conditions can the set point of the hypothalamus be changed?
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________