# 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 _____



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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 _____ & _____


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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 _____


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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 _____


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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 _____


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## 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-biphsophate 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 _____,



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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 _____



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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 $FADH_2$ 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


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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 & $FADH_2$
    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 _____


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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


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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 _____


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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 _____


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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 _____


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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 _____


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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? _____


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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 _____



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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?

_____

_____

_____



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