

Concepts of Scientific Thinking

1. Be able to understand the scientific method and describe all the typical steps.
2. What is a hypothesis?
3. What is a prediction?
4. What needs to occur in order for a hypothesis to become a theory?
5. Be able to describe the common elements found in most experiments.
6. What is the difference between experimental and control groups? Why are control groups essential when doing experiments?
7. What is a variable? Why is sample size so important?
8. Be able to define what an independent variable is. Be able to define what a dependent variable is.

Concepts of Chemistry

1. What is an element? What is an atom? Describe the three subatomic particles of an atom, including where they are found and what kind of charges they have, if any.
2. What is atomic number? What is atomic mass?
3. What determines how an atom will interact with other atoms?
4. What is an ionic bond? Describe how it is formed. What is an ion? How does an anion differ from a cation?
5. What is a covalent bond? Describe how it is formed.
6. Be able to compare and contrast nonpolar covalent bonds with polar covalent bonds. What makes a covalent bond polar?
7. What is a hydrogen bond and how is it formed?
8. Explain what hydrophilic substances are. Explain what hydrophobic substances are.
9. What is a solvent? What is a solute?
10. What is the main difference between organic molecules versus inorganic molecules?
11. How is water able to stabilize temperature? What makes water cohesive? Why is water a great solvent?
12. What does the pH scale measure? Understand how the pH scale works.
13. What is an acid? What is a base?
14. Explain what buffers are, how they work, and why they are important.
15. What is a salt?
16. What are the different classes of carbohydrates? What functions do carbohydrates perform for cells? What kinds of atoms are they typically composed of?
17. What functions can lipids perform for cells?
18. What are fats? What are fatty acids? What are triglycerides? Know the typical components of a fat.
19. What are phospholipids? Know the typical components of a phospholipid.
20. What are sterols? What are the typical components of a sterol?
21. What are proteins? What are their main functions in cells? What are amino acids?
22. Be able to describe the primary, secondary, tertiary, and quaternary structures of proteins and how those structures are formed.
23. How are lipoproteins different from “regular” proteins? How are glycoproteins different from “regular” proteins?
24. What is denaturation? Be able to describe ways to denature a protein.
25. What are enzymes? What is their function? Why are they important for cell metabolism?
26. What is an active site? What is activation energy? Be able to describe the induced fit model of how enzymes and substrates interact.
27. Describe the ways in which enzyme activity can be regulated (HINT: there are four factors: temperature, pH, concentration, and inhibitors/activators).
28. What are nucleotides? Be able to describe their typical components.
29. What is DNA? What does DNA do for a cell? How are the two strands of DNA held together?
30. What is RNA? How is RNA different from DNA? What function does RNA carry out for cells?

Cell Structure and Function

1. What are the three statements of the Cell Theory?
2. What basic properties do all cells have in common?
3. What are the **physical characteristics** ALL cells (regardless of type of cell) share?
4. Explain the structure of a plasma membrane, including what the components are, how the membrane is arranged and the types of movements the components can undergo. Be able to relate the structure of the plasma membrane to the “fluid mosaic” model.
5. What are the different categories of proteins found associated with or embedded in plasma membranes? What main function(s) does each type of protein perform?
6. Be able to describe the typical characteristics and structures of prokaryotic cells. Be able to describe the main functions of prokaryotic cell structures.
7. What is the definition of the term “organelle”?
8. Be able to describe the functions and characteristics of the following organelles: nucleus, rough endoplasmic reticulum, smooth endoplasmic reticulum, golgi apparatus, mitochondria, lysosome, and peroxisome.
9. Be able to describe the function and characteristics ribosomes and of centrioles.
10. Explain what the endomembrane system is and what it does.
11. What are the three components of the cytoskeleton? Be familiar with their structures and functions.
12. What is the basic structure of cilia and flagella? What do they do for cells?
13. What types of substances cross the plasma membrane freely?
14. How are water molecules able to cross the plasma membrane?
15. What types of molecules or ions are not able to cross the plasma membrane on their own?
16. What is diffusion? What is a concentration gradient? What is equilibrium?
17. How does facilitated diffusion differ from active transport?
18. What is osmosis? What is tonicity? Be able to describe how animal cells react when placed in hypertonic, hypotonic or in isotonic environments.
19. What is endocytosis? What are the three endocytic pathways cells may use to take in substances?
20. What is exocytosis? How is it accomplished?

Concepts of Energy and Cell Metabolism

1. What is cellular respiration?
2. What is energy? What is work?
3. What is potential energy? What is kinetic energy? What is thermal energy? What is light energy? What is chemical energy?
4. What is the First Law of Thermodynamics? Why is heat considered lost energy for cells?
5. What is the Second Law of Thermodynamics? What is entropy?
6. Explain why ATP is such a good source of energy.
7. What is the definition of aerobic cellular respiration?
8. What happens during glycolysis? Where does it take place within cells? What are the starting reactants and end products of glycolysis?
9. What happens during the preparatory steps to the citric acid cycle (Krebs cycle)? In what organelle do the preparatory steps occur? In what the specific area of that organelle do the preparatory steps occur?
10. What is the citric acid cycle (Krebs cycle)? In what organelle does it take place? Where in that organelle does the citric acid cycle (Krebs cycle) occur? What are the starting reactants and end products of the citric acid cycle (Krebs cycle)?
11. What occurs during electron transport chain stage of aerobic cellular respiration? In what organelle does it take place? Where in that organelle does the electron transport chain occur? What are the starting reactants and end products of electron transport chain stage?
12. What is ATP synthase? How does it work?
13. What serves as the final electron acceptor during aerobic cellular respiration?

14. What is anaerobic cellular respiration? Be familiar with lactate (lactic acid) fermentation pathway. How does the amount of ATP generated during anaerobic cellular respiration pathways compare to that generated during aerobic cellular respiration?
15. How are fats and proteins broken down for energy? Do fats give off more or less energy (make more or less ATP) when broken down, compared to carbohydrates?

Concepts of DNA and RNA

1. What is DNA? What is its main function in cells? Be familiar with its overall structure.
2. What is a nucleotide? Be familiar with a nucleotide's general structure. Which nucleotides are found in DNA?
3. What is the pattern of base pairing in DNA? (In other words, which nucleotides can bind to each other?)
4. What is RNA? What are the three classes of RNA? What is the function of each class? Be familiar with the overall structure of each class of RNA.
5. How do the bases (nucleotides) of DNA differ from those in RNA?
6. What is transcription? Where does it occur in prokaryotic cells? Where does it occur in eukaryotic cells?
7. Describe the steps/events that occur during transcription.
8. Describe the modifications an mRNA transcript (in eukaryotic cells) undergoes before it can leave the nucleus. What is the difference between an intron and an exon?
9. What is translation? Where does translation occur in prokaryotic cells? Where does it occur in eukaryotic cells?
10. What are codons?
11. What is the genetic code?
12. What are anticodons? Where are they found?
13. Be familiar with the structure of ribosomes and how they carry out the process of translation.
14. Know the events of the three stages of translation.
15. What does the term "mutation" mean? Be able to differentiate among the terms "neutral mutation", "beneficial mutation" and "harmful mutation".
16. What is base-pair substitution? How may this affect the sequence of a protein?
17. What are frameshift mutations? What are the two ways they can be caused?
18. Describe how events of duplication, deletion, relocation (also known as translocation), and inversion can change the overall structure and organization of a chromosome.

Concepts of Chromosomes and the Cell Cycle

1. Describe overall chromosome structure.
2. What are histones? What do they do?
3. What are the major stages of the cell cycle?
4. What happens during interphase? Describe what occurs during G₁, S, and G₂ stages of interphase.
5. What is the purpose of mitosis?
6. Be very familiar with all the events happening in cells during the prophase, metaphase, anaphase, and telophase stages of mitosis.
7. What is the spindle apparatus? What is it made of? What purpose does it serve?
8. How do animal cells undergo cytokinesis? What is a cleavage furrow?
9. What is the main purpose of meiosis?
10. What are genes? What is an allele?
11. What is sexual reproduction? What is asexual reproduction? What similarities do the two processes of reproduction share? What are the differences between the two processes?
12. What are homologous chromosomes?
13. Describe the events that occur during the first division of meiosis (meaning prophase I through telophase I).
14. What is crossing over? How does it help contribute to the genetic diversity of haploid cells, and therefore of potential offspring? When does it occur during Meiosis I?

15. What is random alignment (this is also called “independent assortment”)? How does it contribute to the genetic diversity of haploid cells, and therefore of potential offspring? When does it occur during Meiosis I?
16. Describe the events that occur during the second division of meiosis (meaning prophase II through telophase II). What is the result of second meiotic division?
17. How is gender (sex) determined in humans? Be able to describe differences found when comparing the X chromosome with the Y chromosome.

Concepts of Genes and Inheritance

1. What is a gene? What is an allele? What is meant by “gene locus”?
2. What is a dominant allele? What is a recessive allele? What is meant by homozygous dominant and homozygous recessive? What is meant by heterozygous?
3. What is a genotype? What is a phenotype?
4. What is incomplete dominance?
5. What is codominance?
6. What is a multiple allele system?
7. What does it mean when a trait is said to be “polygenic”?
8. What is pleiotropy?
9. In what ways are phenotypes sometimes affected by environmental conditions?