

Incoming Human Anatomy & Physiology I (Biol 2401)
Student Knowledge Expectations for Basic Chemistry and Cell Biology
Effective Fall 2015

Prior to enrolling in Human Anatomy & Physiology I (Biol 2401), students should understand the following basic chemistry and cell biology learning objectives.

Students are expected to have a firm understanding of these objectives *before* enrolling. These objectives are commonly covered in a high school biology course and/or college introductory biology course. Because of time restrictions in Biol 2401, these topics will not be covered in detail in class. A fundamental understanding of these topics is crucial to the successful understanding and completion of both Anatomy & Physiology I (BIOL 2401) and Anatomy & Physiology II (BIOL 2402). Instructors will assume that students come into the class with a strong understanding of these topics.

There are two paths to gain the necessary knowledge regarding these objectives:

- 1) self-preparation – these topics are discussed in the first few chapters of textbook.
- 2) BIOL 1308 Biology Fundamentals – a one-semester lecture course designed to be a preparatory course for A&P; topics include basic chemistry and cell biology for A&P, study skills, and an introduction to the body systems.

Incoming A&P I students should have a strong understanding of the following objectives:

Atoms, Molecules, Bonds and Properties of Matter

- ✓ Define the term *element*.
- ✓ Identify the common chemical symbols and be able to read the periodic table.
- ✓ Define the term *atom*.
- ✓ Describe the basic structure of an atom (protons, neutrons, and electrons).
- ✓ Identify the charge and the location in an atom of protons, neutrons and electrons.
- ✓ Define the term *isotope*.
- ✓ Define the terms *molecule* and *ion*.
- ✓ Explain the role of electrons in chemical bonding.
- ✓ Compare how covalent and ionic bonds hold atoms together and how each type of bond is shown in a diagram.
- ✓ Discuss the relative strengths of covalent and ionic bonds (how easily the bonds can be broken).
- ✓ Compare polar and nonpolar bonds.
- ✓ Compare and contrast the characteristics of polar and nonpolar molecules.
- ✓ Define the term hydrogen bond.
- ✓ Describe the characteristics of hydrogen bonds.
- ✓ Identify how hydrogen bonds are shown in a diagram.

Water

- ✓ Describe the polarity of water.
- ✓ List and describe the properties of water and how they benefit organisms.
- ✓ Explain the biological importance of hydrogen bonds between water molecules and between other polar covalent molecules.

- ✓ Distinguish between hydrophilic & hydrophobic substances and describe their interactions.

Acids, Bases, pH, and Buffers

- ✓ Define the terms *acid*, *base*, and *hydrogen ion* (also called a *proton*).
- ✓ Define pH and relate pH to the concentration of hydrogen ions/protons.
- ✓ Read a pH scale and determine whether the solution is acid, basic, or neutral.
- ✓ Compare the properties of salts, acids, and bases.
- ✓ Define the term *buffer*.
- ✓ Describe how buffers work to keep the pH within a narrow range to maintain homeostasis.
- ✓ Define the term *dissociation*.
- ✓ Describe the effect of dissociation in producing anions and cations.
- ✓ Describe the effect of dissociation on the strength of an acid or base.

Chemical Reactions

- ✓ Differentiate between kinetic energy and potential energy and know their characteristics.
- ✓ Recognize examples of kinetic energy and potential energy.
- ✓ Explain how organisms use chemical reactions to capture and release energy and to make new compounds and break down compounds.
- ✓ Recognize that in a reaction at equilibrium the forward and reverse reactions are occurring at the same rate.
- ✓ Define the following terms: *catalyst*, *enzyme*, *substrate*, *products*, *activation energy*, and *active site*.
- ✓ Explain the characteristics of enzymes, including their specificity and that enzymes are not altered or used up in a reaction.
- ✓ Describe how enzymes work, including how they affect the activation energy of a reaction and the rate of a reaction.
- ✓ Identify the factors that affect enzyme activity (pH and temperature).

Biomolecules

- ✓ Describe why carbon is a versatile element and found in the structure of all biomolecules.
- ✓ Define the terms *monomer* (also called *subunit* or *building block*) and *polymer*.
- ✓ Describe the reactions (dehydration/synthesis or condensation/hydrolysis) used to make and break down polymers.

Carbohydrates:

- ✓ Define the terms *monosaccharide*, *disaccharide*, and *polysaccharide*.
- ✓ Identify monosaccharides as the monomers/subunits joined to make disaccharides and polysaccharides.
- ✓ Name and classify the following common carbohydrates as either *monosaccharides*, *disaccharides*, or *polysaccharides*: glucose, fructose, galactose, ribose, deoxyribose, sucrose, lactose, glycogen, starch, and cellulose.

Proteins:

- ✓ Identify amino acids as the monomers/subunits joined to make proteins/polypeptides.
- ✓ Name the parts of an amino acid: (central carbon, amino group, carboxyl group, R group, and H atom).
- ✓ Describe the four levels of a protein's structure.
- ✓ Describe the importance of shape to protein function.

- ✓ Define the term *denaturation*.
- ✓ Explain how denaturation affects the function of a protein.
- ✓ Describe how pH and temperature affect protein function.
- ✓ List examples of the functions of proteins in cells.

Nucleic acids:

- ✓ Name the two major nucleic acids found in cells.
- ✓ Identify nucleotides as the monomers/subunits joined to make nucleic acids.
- ✓ Identify the three main parts of a nucleotide.
- ✓ Distinguish between the four nucleotides used to make RNA and the four nucleotides used to make DNA.
- ✓ Identify genes as pieces of DNA with the instructions for making a specific protein.
- ✓ Describe how two DNA strands are complementary to each other.
- ✓ Identify ATP (adenosine triphosphate).

Lipids:

- ✓ Identify lipids as molecules that are hydrophobic or at least partially hydrophobic.
- ✓ List three types of lipids (triglycerides, phospholipids, and steroids).
- ✓ Compare the structure of triglycerides, phospholipids, and steroids.
- ✓ Compare the function of triglycerides, phospholipids and the steroid cholesterol, including the role of cholesterol as a precursor to other steroids.

DNA, RNA, and Protein Synthesis

- ✓ Define the term *DNA replication* and state where in the cell DNA replication occurs.
- ✓ Describe how DNA is replicated using complementary base pairing.
- ✓ Define and describe the relationship between genes, DNA, and chromosomes.
- ✓ Define the term *mutation*. Understand that mutations to a gene (piece of DNA) can change the structure and function of the protein that the gene codes for.
- ✓ Define the terms *transcription* and *translation* and state where in the cell transcription and translation occur.
- ✓ Describe the processes of transcription and translation in the making of proteins.
- ✓ *Briefly* describe the role of mRNA, tRNA, and rRNA in translation.

Structure and Function of Cells

- ✓ State the three tenets of the cell theory.
- ✓ Describe the basic structure of eukaryotic cells: plasma membrane, nucleus, and cytoplasm.
- ✓ Describe the location of intracellular and extracellular fluids and the relationship between the two.
- ✓ Describe the structure and function of the cytoskeleton of the cell.
- ✓ Describe the structure and function of ribosomes, the rough endoplasmic reticulum (RER), and the Golgi apparatus (also called Golgi body or Golgi complex).
- ✓ Describe how ribosomes, the rough endoplasmic reticulum and the Golgi apparatus work together in protein synthesis and packaging.
- ✓ Describe the structure and function of the smooth endoplasmic reticulum (SER).
- ✓ Describe the structure and function of lysosomes.
- ✓ Describe the structure of the mitochondrion and its role in energy capture in the cell.
- ✓ Describe the structure and function of the nucleus.
- ✓ Describe the structure and function of cilia and flagella.

The Plasma Membrane

- ✓ Describe the structure of the plasma membrane (phospholipid bilayer, cholesterol, proteins, and carbohydrates) and its overall functions.
- ✓ Identify the function of each of the following parts of the plasma membrane: phospholipid bilayer, cholesterol, proteins, and carbohydrates.
- ✓ Explain how protein receptors in the plasma membrane allow cells to communicate with each other.
- ✓ Explain how the size, electric charge, and lipid solubility of molecules affect their movement across the plasma membrane.
- ✓ Compare how substances are moved into and out of the cell by each of the following: simple diffusion, osmosis, facilitated diffusion, active transport/solute pumping, endocytosis, and exocytosis.
- ✓ Identify the energy needs of simple diffusion, osmosis, facilitated diffusion, active transport/solute pumping, endocytosis, and exocytosis. Define each of the following terms: *isotonic solution*, *hypotonic solution*, and *hypertonic solution*. Describe the effects on cell volume when cells are exposed to isotonic, hypotonic, and hypertonic solutions.
- ✓ Determine whether a cell's environment is hypotonic, hypertonic, or isotonic with respect to the cell when given the concentration of solutes in the environment and in the cell.
- ✓ Determine which way water will move by osmosis and whether the cell will shrink, stay the same shape, or swell, when given the concentration of solutes in the cell and in the environment.

Energy and Cells

- ✓ Explain the role of ATP (adenosine triphosphate) and ADP (adenosine diphosphate) in energy transfer.
- ✓ Understand each of the following processes: *cellular respiration*, *glycolysis*, *citric acid cycle* (also called *Krebs cycle* or *tricarboxylic acid cycle*), *substrate-level phosphorylation*, *oxidative phosphorylation*, and *electron transport chain*.
- ✓ Recognize that breaking the bonds in glucose and other food molecules releases the energy used to make ATP during cellular respiration.
- ✓ Name the location in the cell where glycolysis occurs.
- ✓ Describe the function of glycolysis and its benefit to cells.
- ✓ Identify the reactants and products of glycolysis.
- ✓ Name the location in the cell where the citric acid cycle occurs.
- ✓ Identify the products of the citric acid cycle.
- ✓ Name the location in the cell where oxidative phosphorylation occurs, including the specific structure (electron transport chain).
- ✓ Identify the products of oxidative phosphorylation.
- ✓ Describe the role of oxygen in oxidative phosphorylation.
- ✓ Compare and contrast the relative amount of ATP production in glycolysis, the citric acid cycle, and oxidative phosphorylation.
- ✓ Recognize that lactic acid fermentation occurs after glycolysis whenever oxygen is not present in the cell's environment.

Mitosis and Meiosis

- ✓ Define the term *mitosis*.
- ✓ Describe the outcome of mitosis in terms of the number of daughter cells that result after the parent cell divides and in terms of the number of chromosomes in each of the resulting daughter cells.

- ✓ Compare when mitosis occurs (during growth and repair) and when meiosis occurs (during gamete production).
- ✓ State the function of mitosis and distinguish it from cell division.
- ✓ Define the term *meiosis*.
- ✓ Describe the outcome of meiosis in terms of the number of daughter cells that result and in terms of the number of chromosomes in each of the resulting daughter cells.
- ✓ Define the term *gamete* and explain why meiosis is necessary to maintain proper chromosome number after fertilization.