Name: _____ Date: _____

AP Biology Exam Review: Cell Structure, Communication, and Division

Helpful Videos and Animations:

1. Bozeman Biology: Cell Membranes
2. Bozeman Biology: Transport Across Cell Membranes
3. Bozeman Biology: Compartmentalization
4. Bozeman Biology: Cellular Organelles
5. Bozeman Biology: Cell Communication
6. Bozeman Biology: Signal Transduction Pathways
7. Bozeman Biology: Signal Transmission and Gene Expression
8. Bozeman Biology: Effects of Changes in Pathways
9. Bozeman Biology: Evolutionary Significance of Cell Communication
10. Bozeman Biology: The Cell Cycle, Mitosis, and Meiosis

Relevant Objectives:

9. Explain why cells are so small
10. Relate surface area to volume ratio to cell size
11. Know the organelles of a cell and their functions
12. Explain the fluid-mosaic model of a cell membrane
13. Explain the difference between passive and active transport
14. Define hypertonic, hypotonic, and isotonic
15. Make predictions about what will happen to cells in certain solutions due to diffusion
16. Explain how cells communicate over long and short distances
17. Explain how cells receive signals (2 ways)
18. Explain the advantages of signal transduction pathways (2)
19. Know the phases of the cell cycle
20. Know the phases of mitosis in depth
21. Explain how cells influence each-other in the cell cycle
22. Explain what happens when there is an error in the cell cycle
23. Know approximately how long a cell spends in each phase of the cell cycle, and why
24. Know the steps of meiosis and what happens in each
25. Explain how meiosis reduces the chromosome number by half, and why this is essential to sexual reproduction
26. Explain how meiosis produces genetic variability (3 ways)
99. Explain how water potential effects the movement of water

Topic Outline:

1. Structure of the Cell Membrane (understand the fluid mosaic model and identify the structure and function of molecules found within it – phospholipids, integral proteins, peripheral proteins, glycolipids, and glycoproteins)

2. Semi/Selective Permeability – which molecules can move through the phospholipid bilayer and which molecules must move with the help of a transport protein?

3. Passive Transport vs. Active Transport – up vs. down concentration gradient, use of energy?

4. Types of Passive Transport
   - Simple Diffusion
   - Facilitated Diffusion using channel or carrier proteins (what is the difference between these two types transport proteins?)
   - Osmosis (hypertonic, hypotonic, isotonic) – be able to predict the movement of water across a semi-permeable membrane based on solute OR water concentration (Hint: you must know how to analyze a "U-tube" problem) and water potential
   - Associated Vocabulary: lysis (animal cells), flaccid (plant cell), plasmolyzed (plant cell), turgid / turgo pressure (plant cell)

5. Types of Active Transport
   - Protein pumps (know how the sodium (Na+) / potassium (K+) pump works!)
   - Co-transport
   - Bulk Transport: Exocytosis vs. Endocytosis

6. Importance of having a large membrane surface area → efficient transport of materials into and out of the cell (Note: this is why cells of the small intestine—an organ used for absorption—have many membrane folds called microvilli or why the mitochondria has many folds)

7. Be able to perform cell surface area to volume ratio calculations to compare the efficiency of membrane transport in cells of various shapes and sizes

8. The Difference between Prokaryotic and Eukaryotic Cells (organelles present, size, organization of DNA, etc.)

9. Structures and Functions of Eukaryotic Organelles (make sure you understand how the structure and molecular composition of each cell part gives it its unique functions)
    - Nucleus (with nuclear membrane, nuclear pores, nucleolus, and chromatin)
    - Ribosomes (free vs. bound… what kinds of proteins does each type create?)
    - Endoplasmic Reticulum (smooth vs. rough)
    - Golgi Apparatus
    - Vacuoles (compare plant vs. animal vacuoles)
    - Mitochondria
    - Chloroplasts
    - Cytoskeleton
    - Centrosomes + Centrioles
    - Cilia and Flagella
    - Extracellular Matrix
    - Intercellular Junctions: three types in animal cells (tight junctions, desmosomes, and gap junctions); one type in plant cells (plasmodesmata)

10. Identify which organelles are found in plant vs. animal cells and identify each in an image

11. Describe the function of the endomembrane system in protein synthesis and secretion (be able to list / sequence all structures and processes involved)

12. The Cell Cycle
    - Reason for division- as cells increase in volume, the surface area decreases and demand for material resources increases which limits cell size
    - Smaller cells have a more favorable surface area-to-volume ratio for exchange of materials with the environment (diffusion, etc.). High SA:V ratio is favorable. Ex. 6:1 is better than 6:5
    - Mitosis = creation of new body cells (somatic cells) with 46 chromosomes each (diploid cells/2n = two sets of chromosomes
    - Organization of DNA in eukaryotic cells = multiple linear chromosomes vs. organization of DNA in prokaryotic cells = single circular chromosome
    - Interphase (normal life of the cell, 90% of cell's life)… : growth (G1), synthesis of DNA (S) and preparation for mitosis (G2); G0 is when a cell exits the cell cycle for a period of time – can still perform life processes
    - Be able to describe the events that take place in the following steps of mitosis: prophase, prometaphase, metaphase, anaphase and telophase (+ cytokinesis, division of the cytoplasm by a cleavage furrow in animals or cell plate in plants)
    - Be able to explain how/why eukaryotic cell division is different from binary fission
    - Vocabulary: chromosome, sister chromatids, centromere, nuclear envelope, mitotic spindle, microtubules, kinetochore, centrioles / centrosome, metaphase plate, cleavage furrow, cell plate

13. Meiosis
    - Cell division to create gametes (sex cells) with half the number of chromosomes (23) of a somatic cell (haploid cell/n = one set of chromosomes)
    - Understand the difference between sexual vs. asexual reproduction
    - There are 23 pairs of homologous chromosomes in a body cell (what are homologous chromosomes?) that divide during meiosis
    - 22 pairs are autosomes and 1 pair consists of sex chromosomes (XX for females and XY for males)
    - Fertilization = the fusion of haploid gametes (egg + sperm) to create a diploid zygote
    - Meiosis includes two rounds of division to produce four daughter cells

- Be able to explain how Meiosis I is different from Meiosis II and describe what occurs in each of the stages of meiosis: Prophase I, Metaphase I, Anaphase I, Telophase I / Cytokinesis, Prophase II, Metaphase II, Anaphase II, Telophase II / Cytokinesis
- During meiosis, homologous chromosomes are paired (one from mom and one from dad) and line up in the center of the cell randomly. The homologues are pulled apart and separated in meiosis I. A second division occurs in which the duplicated chromosomes are pulled apart.
- Variation occurs in gametes during crossing over; during random fertilization, because of separation of alleles (leading to new combinations during fertilization (law of segregation); because of all the possible combinations of homologous chromosomes aligning during metaphase I (law of independent assortment)

14. Control of the Cell Cycle
    - There are internal checkpoints that tell the cell to continue dividing or stop dividing
    - Major checkpoints = G1 phase checkpoint (after G1 phase), G2 phase checkpoint, and M phase checkpoint
    - If the cell does not receive the "go ahead" signal at the G1 checkpoint, it enters the "G0 phase," a state of semi-dormancy where no cell division is occurring (ex: mature nerve cells)
    - Example: if cyclin molecules bind to Cdk molecules (cyclin dependent kinases), they produce MPF (mitosis/maturation promoting factor,) enough MPF can allow the cell to pass the G2 checkpoint and enter mitosis. To bring mitosis to a close, MPF switches itself off by starting a process that degrades cyclin
    - If checkpoints are normal, cells will show density-dependent inhibition (stop dividing when they are crowded) and anchorage dependency (must be attached to a substrate to divide)
    - If cells divide too frequently, they will not show density-dependent inhibition or anchorage dependency → tumors (know the difference between benign and malignant tumors and be able to define metastasis)

15. There are three main steps in cell signaling
    - Reception (target cell's detection of a signal molecule)
    - Transduction (conversion of the signal to a form that can bring about a particular cell response)
    - Response (the specific cellular response to the signal molecule)

16. Reception
    - Ligand (signal molecule) binds to receptor
        A. Intracellular receptors (for hydrophobic molecules like steroids that can pass through the cell membrane)
        B. Plasma membrane receptors (for hydrophilic molecules that cannot pass through the cell membrane)
           Ex: G protein coupled receptor or receptor tyrosine kinase (see notes to recall how these work)

17. Transduction
    - Transduction involves amplifying the signal (making it stronger) and converting it to a form the cell can respond to
        A. Second messengers (ex: calcium ions – Ca2+ -- or cyclic AMP) carry the signal from the receptor and may be used to activate protein kinases or other key molecules in the transduction process. Second messengers amplify the signal because multiple second messengers are created from one ligand received and these second messengers can activate multiple kinases
        B. Phosphorylation cascade (protein kinases activate molecules by adding a phosphate group, these molecules then activate other molecules, and ultimately you activate a molecule that causes the specific cell response)

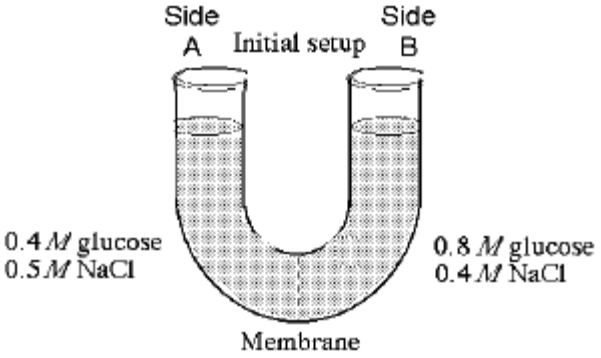
18. Response
    - Regulating Synthesis of Proteins: Transduction may activate transcription factors that initiate transcription of particular genes in the nucleus (by enabling the binding of RNA polymerase to start creating mRNA from DNA)
    - Regulating Activity of Proteins: ex: In the epiphrine pathway in liver cells that initiates breakdown of glycogen to produce blood glucose to fuel the fight or flight response, protein kinases activate the enzyme phosphorylase, which chops apart glycogen

Practice Multiple Choice Questions:

1. Celery stalks that are immersed in fresh water for several hours become stiff and hard. Similar stalks left in a 0.15 M salt solution become limp and soft. From this we can deduce that the cells of the celery stalks are
a. hypotonic to both fresh water and the salt solution.
b. hypertonic to both fresh water and the salt solution.
c. hypertonic to fresh water but hypotonic to the salt solution.
d. hypotonic to fresh water but hypertonic to the salt solution.
e. isotonic with fresh water but hypotonic to the salt solution.

2. Mammalian blood contains the equivalent of 0.15 M NaCl. Seawater contains the equivalent of 0.45 M NaCl. What will happen if red blood cells are transferred to seawater?
a. Water will leave the cells, causing them to shrivel and collapse.
b. NaCl will be exported from the red blood cells by facilitated diffusion.
c. The blood cells will take up water, swell, and eventually burst.
d. NaCl will passively diffuse into the red blood cells.
e. The blood cells will expend ATP for active transport of NaCl into the cytoplasm.

The solutions in the arms of a U-tube are separated at the bottom of the tube by a selectively permeable membrane. The membrane is permeable to sodium chloride and water but not to glucose. Side A is filled with a solution of 0.4 M glucose and 0.5 M sodium chloride (NaCl), and side B is filled with a solution containing 0.8 M glucose and 0.4 M sodium chloride. Initially, the volume in both arms is the same. Refer to the figure to answer the following questions.



3. At the beginning of the experiment,
a. side A is hypertonic to side B.
b. side A is hypotonic to side B.
c. side A is isotonic to side B.
d. side A is hypertonic to side B with respect to glucose.
e. side A is hypotonic to side B with respect to sodium chloride.

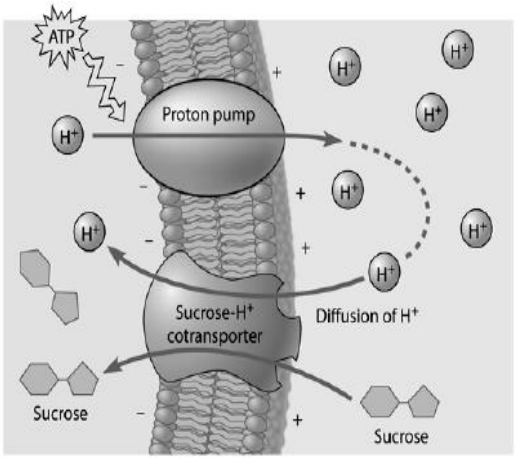
4. If you examine side A after three days, you should find

a. a decrease in the concentration of NaCl and glucose and an increase in the water level.
b. a decrease in the concentration of NaCl, an increase in water level, and no change in the concentration of glucose.
c. no net change in the system.
d. a decrease in the concentration of NaCl and a decrease in the water level.
e. no change in the concentration of NaCl and glucose and an increase in the water level.

5. A patient has had a serious accident and lost a lot of blood. In an attempt to replenish body fluids, distilled water–equal to the volume of blood lost–is transferred directly into one of his veins. What will be the most probable result of this transfusion?
a. It will have no unfavorable effect as long as the water is free of viruses and bacteria.
b. The patient's red blood cells will shrivel up because the blood fluid has become hypotonic compared to the cells.
c. The patient's red blood cells will swell because the blood fluid has become hypotonic compared to the cells.
d. The patient's red blood cells will shrivel up because the blood fluid has become hypertonic compared to the cells.
e. The patient's red blood cells will burst because the blood fluid has become hypertonic compared to the cells.

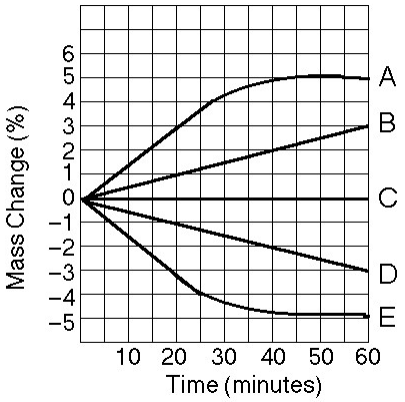
6. Based on the figure to the right, which of these experimental treatments would increase the rate of sucrose transport into the cell?

a. decreasing extracellular sucrose concentration
b. decreasing extracellular pH
c. decreasing cytoplasmic pH
d. adding an inhibitor that blocks the regeneration of ATP
e. adding a substance that makes the membrane more permeable to hydrogen ions



Read the following information and refer to the graph below to answer the following question.

Five dialysis bags, constructed from a semi-permeable membrane that is impermeable to sucrose, were filled with various concentrations of sucrose and then placed in separate beakers containing an initial concentration of 0.6 M sucrose solution. At 10-minute intervals, the bags were massed (weighed) and the percent change in mass of each bag was graphed.



7. Which line represents the bag that contained a solution isotonic to the 0.6 molar solution at the beginning of the experiment?

8. Cells of the pancreas will incorporate radioactively labeled amino acids into proteins. This "tagging" of newly synthesized proteins enables a researcher to track their location. In this case, we are tracking an enzyme secreted by pancreatic cells. What is its most likely pathway?

a. ER → Golgi → nucleus
b. Golgi → ER → lysosome
c. nucleus → ER → Golgi
d. ER → Golgi → vesicles that fuse with plasma membrane
e. ER → lysosomes → vesicles that fuse with plasma membrane

9. Which of the following is one of the ways that the membranes of winter wheat are able to remain fluid when it is extremely cold?

a. by increasing the percentage of unsaturated phospholipids in the membrane
b. by increasing the percentage of cholesterol molecules in the membrane
c. by decreasing the number of hydrophobic proteins in the membrane
d. by co-transport of glucose and hydrogen
e. by using active transport

10. Tay–Sachs disease is a human genetic abnormality that results in cells accumulating and becoming clogged with very large, complex, and undigested lipids. Which cellular organelle must be involved in this condition?
a. the endoplasmic reticulum
b. the Golgi apparatus
c. the lysosome
d. mitochondrion
e. membrane–bound ribosomes

11. A cell has the following molecules and structures: enzymes, DNA, ribosomes, plasma membrane, and mitochondria. It could be from:
a. A bacterium.
b. An animal, but not a plant.
c. A plant, but not an animal.
d. A plant or an animal.
e. Any kind of organism.

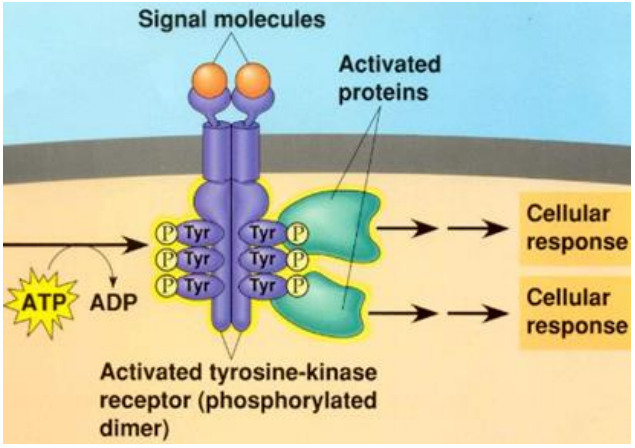
12. In a plant cell, DNA may be found
a. only in the nucleus.
b. only in the nucleus and mitochondria.
c. only in the nucleus and chloroplasts.
d. in the nucleus, mitochondria, and chloroplasts.

13. All of the following are part of a prokaryotic cell except
a. DNA.
b. a cell wall.
c. a plasma membrane.
d. ribosomes.
e. an endoplasmic reticulum.

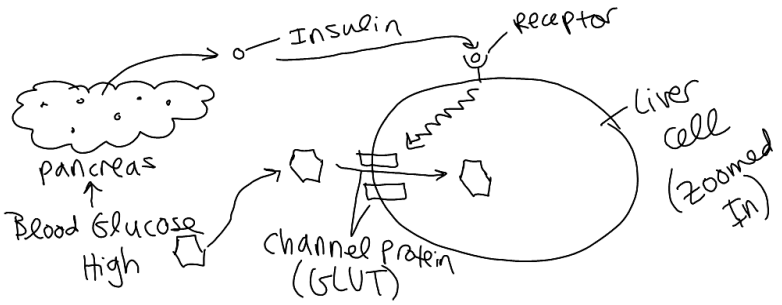
14. A gland cell capable of producing large quantities of a protein hormone would have well-developed:
a. Cilia.
b. Centrioles.
c. Rough Endoplasmic Reticulum.
d. Smooth Endoplasmic Reticulum

15. A toxin that destroys adenylyl cyclase, the enzyme responsible for creating cyclic AMP—a second messenger molecule in the cell – is injected into a cell. What will be the final effect on the signaling pathway?
a. The initial messenger molecule (ex: epinephrine) will be unable to bind to its plasma membrane receptor.
b. The initial messenger molecule (ex: epinephrine) will bind more easily to the plasma membrane receptor.
c. The transduction step will be inhibited, resulting in a smaller response.
d. The transduction step will be more efficient, resulting in a larger response.

16. If ATP is not present in the cell pictured to the right, what would be the most immediate effect on the receptor tyrosine kinase pathway?
a. The signal molecules will not be able to bind to the receptor.
b. The tyrosine molecules will be unable to detach from the receptor.
c. The tyrosine molecules will not be able to "steal" phosphate groups from ATP and use these phosphate groups to activate other proteins.
d. The two parts to the receptor will not be able to come together as a dimer.



17. The pathway below shows the effect of insulin, a hormone released in response to high blood glucose, on liver cells. In Type 1 diabetes, cells in the pancreas cannot create and secrete insulin. How will this affect blood glucose levels?



a. Blood glucose levels will remain high because glucose will not be removed from the blood by the GLUT channels in liver cells.
b. Blood glucose levels will decrease because glucose will be successfully removed from the blood by the GLUT channels in liver cells.
c. Blood glucose levels will remain high because the pancreas will never receive the signal to create insulin.
d. Blood glucose levels will decrease because the receptor will be activated by another hormone.

18. Of the following, a receptor protein in a membrane that recognizes a chemical signal is most similar to
a. the active site of an enzyme in the cytoplasm that binds to a specific substrate.
b. RNA specifying the amino acids in a polypeptide.
c. a particular metabolic pathway operating within a specific organelle.
d. an enzyme with an optimum pH and temperature for activity.
e. genes making up a chromosome.

19. At puberty, an adolescent female body changes in both structure and function of several organ systems, primarily under the influence of changing concentrations of estrogens and other steroid hormones. How can one hormone, such as estrogen, mediate so many effects?
a. Estrogen is produced in very large concentration and therefore diffuses widely.
b. Estrogen has specific receptors inside several cell types, but each cell responds in the same way to its binding.
c. Estrogen is kept away from the surface of any cells not able to bind it at the surface.
d. Estrogen binds to specific receptors inside many kinds of cells, each of which have different responses to its binding.
e. Estrogen has different shaped receptors for each of several cell types.

20. How would you expect the length of interphase to differ in a skin cell (which has to be continuously replaced) vs. a mature nerve cell (which is never replaced)?
a. Interphase is longer in the skin cell because a long interphase corresponds to a faster rate of cell division.
b. Interphase is shorter in the skin cell because a short interphase corresponds to a faster rate of cell division.
c. Interphase is longer in the skin cell because a long interphase corresponds to a slower rate of cell division.
d. Interphase is shorter in the skin cell because a short interphase corresponds to a slower rate of cell division.

21. In some organisms such as certain fungi and algae, cells undergo mitosis repeatedly without subsequently undergoing cytokinesis. What would result from this?
a. A rapid rate of sexual reproduction
b. A decrease in chromosome number
c. Division of the organism into many cells, most lacking nuclei
d. Large cells containing many nuclei

22. A cell containing 92 chromatids at metaphase of mitosis would, at its completion, produce two nuclei each containing how many chromosomes?
a. 12
b. 16
c. 23
d. 46
e. 92

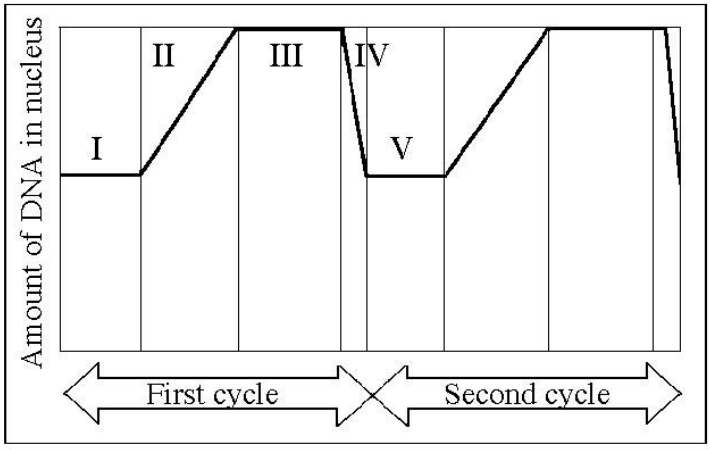
23. The karyotype of one species of primate has 48 chromosomes. In a particular female, cell division goes awry and she produces one of her eggs with an extra chromosome. The most probable source of this error would be a mistake in which of the following?
a. Mitosis in her ovary
b. Metaphase I of one meiotic event
c. Telophase II of one meiotic event
d. Telophase I of one meiotic event
e. Either anaphase I or II

24. Which of the steps below take place in both mitosis and meiosis?

1. Formation of four new nuclei, each with half the chromosomes present in the parental nucleus
2. Alignment of tetrads at the metaphase plate
3. Separation of sister chromatids
4. Separation of the homologues; no uncoupling of the centromere
5. Synapsis; chromosomes moving to the middle of the cell in pairs

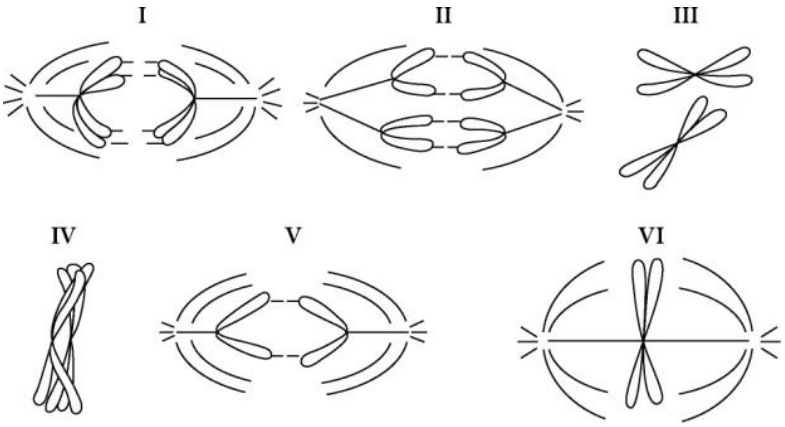
a. 2
b. 3
c. 5
d. 2 and 3 only
e. 2, 3, and 5

25. How do cells at the completion of meiosis compare with cells that have replicated their DNA and are just about to begin meiosis?
a. They have twice the amount of cytoplasm and half the amount of DNA.
b. They have half the number of chromosomes and half the amount of DNA.
c. They have the same number of chromosomes and half the amount of DNA.
d. They have half the number of chromosomes and one-fourth the amount of DNA.
e. They have half the amount of cytoplasm and twice the amount of DNA.



26. Which number above represents the point in the cell cycle during which the chromosomes are replicated?
a. I
b. II
c. III
d. IV
e. V

27. In multicellular organisms, mitosis is
a. the means of tissue growth and repair.
b. a way of generating increasing genetic variation in members of the next generation
c. the means of sexual reproduction.
d. able to occur in only a few cells of specialized tissues.



28. Which diagram represents prophase I of meiosis?
a. I
b. II
c. IV
d. V
e. VI

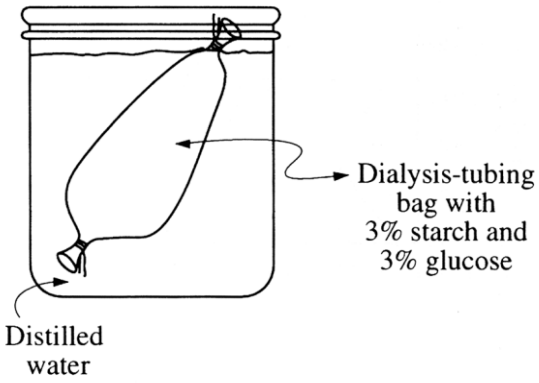
29. Natural selection and recombination due to crossing over during meiosis I are related in which of the following ways?
a. Recombinants are usually selected against.
b. Non-recombinant organisms are usually favored by natural selection if there is environmental change.
c. Most recombinants reproduce less frequently than do non-recombinants.
d. Recombinants may have combinations of traits that are favored by natural selection.
e. Recombination does not affect natural selection.

30. For a chemotherapeutic drug to be useful for treating cancer cells, which of the following is most desirable?
a. It only attacks cells that are large in size.
b. It only attacks cells that are highly specialized.
c. It interferes with cells entering G_0.
d. It interferes with rapidly dividing cells.

31. The organelle that is the major producer of ATP and is found in both heterotrophs and autotrophs is the
a. chloroplast
b. nucleus
c. ribosome
d. Golgi apparatus
e. mitochondrion

32. If plant cells are immersed in distilled water, the resulting movement of water into the cells is called
a. conduction
b. active transport
c. transpiration
d. osmosis
e. facilitated diffusion

Questions 33-35. The following questions refer to an experiment in which a dialysis-tubing bag is filled with a mixture of 3% starch and 3% glucose and placed in a beaker of distilled water, as shown at right. After 3 hours, glucose can be detected in the water outside the dialysis-tubing bag, but starch cannot.



33. From the initial conditions and results described which of the following is a logical conclusion?
a. The initial concentration of glucose in the bag is higher than the initial concentration of starch in the bag.
b. The pores of the bag are larger than the glucose molecules but smaller than the starch molecules.
c. The bag is not selectively permeable.
d. A net movement of water into the beaker has occurred.
e. The molarity of the solution in the bag and the molarity of the solution in the surrounding beaker are the same.

34. Which of the following best describes the conditions expected after 24 hours?
a. The bag will contain more water than it did in the original condition.
b. The contents of the bag will have the same osmotic concentration as the surrounding solution.
c. Water potential in the bag will be greater than water potential in the surrounding solution.
d. Starch molecules will continue to pass through the bag.
e. A glucose test on the solution in the bag will be negative.

35. If, instead of the bag, a potato slice were placed in the beaker of distilled water, which of the following would be true of the potato slice?
a. It would gain mass.
b. It would neither gain nor lose mass.
c. It would absorb solutes from the surrounding liquid.
d. It would lose water until water potential inside the cells is equal to zero.
e. The cells of the potato would increase their metabolic activity.

Practice Long Response Questions: Make an outline of the information you would include in each of these essays.

1. A laboratory assistant prepared solution of 0.8 M, 0.6 M, 0.4 M, and 0.2 M sucrose, but forgot to label them. After realizing the error, the assistant randomly labeled the flasks containing these four unknown solutions as flask A, flask B, flask C, and flask D.

Design an experiment, based on the principles of diffusion and osmosis, that the assistant could use to determine which of the flasks contains each of the four unknown solutions. Include in your answer
(a) a description of how you would set up and perform the experiment
(b) the results you would expect from your experiments
(c) an explanation of those results

2. Membranes are essential components of all cells.
a. Identify TWO macromolecules that are components of the plasma membrane in a eukaryotic cell and discuss the structure and function of each.
b. Explain how membranes participate in TWO of the following biological processes.

- muscle contraction
- fertilization of an egg
- chemiosmotic production of ATP
- intercellular signaling

3. A major distinction between prokaryotes and eukaryotes is the presence of membrane-bound organelles in eukaryotes.
a. Describe the structure and function of TWO eukaryotic membrane-bound organelles other than the nucleus.
b. Prokaryotic and eukaryotic cells have some non-membrane-bound components in common. Describe the function of TWO of the following and discuss how each differs in prokaryotes and eukaryotes.

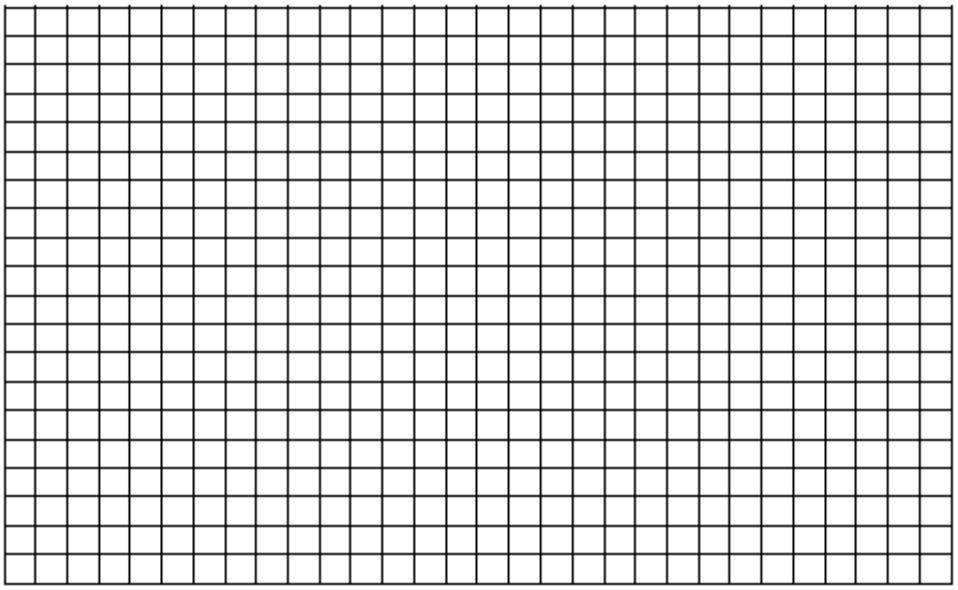
- DNA
- cell wall
- ribosomes

c. Explain the endosymbiotic theory of the origin of eukaryotic cell and discuss an example of evidence supporting this theory.

4. The following experiment was designed to test whether different concentration gradients affect the rate of diffusion. In this experiment, four solutions (0% NaCl, 1% NaCl, 5% NaCl, and 10% NaCl) were tested under identical conditions. Fifteen milliliters (mL) of 0% NaCl were put into a bag formed of dialysis tubing that is permeable to Na^+, Cl^-, and water. The same was done for each NaCl solution. Each bag was submerged in a separate beaker containing 300 mL of distilled water. The concentration of NaCl in mg/L in the water outside the bag was measured at 40-second intervals. The results from the 5% bag are shown in the table below.

CONCENTRATION IN mg/L OF NaCl OUTSIDE THE 5% NaCl BAG	
Time (seconds)	NaCl (mg/L)
0	0
40	130
80	220
120	320
160	400

a. On the axes provided, graph the data for the 5% NaCl solution
b. Using the same set of axes, draw and label three additional lines representing the results that you would predict for the 0% NaCl, 1% NaCl, and 10% NaCl solutions. Explain your predictions.
c. Farmlands located near coastal regions are being threatened by encroaching seawater seeping into the soil. In terms of water movement into or out of plant cells, explain why seawater could decrease crop production. Include a discussion of water potential in your answer.

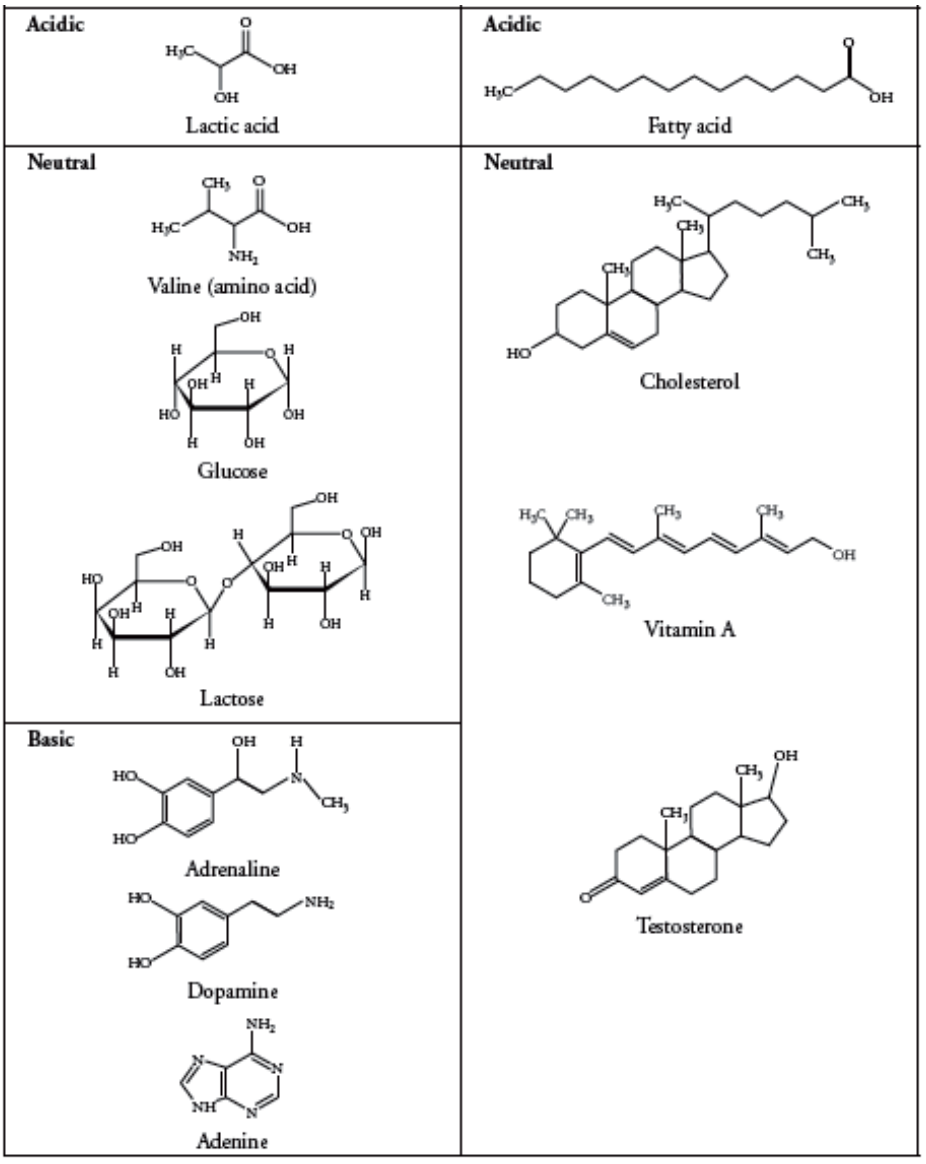


5. The value for Ψ in root tissue was found to be -3.3 bars.
a. If you place the root tissue in a 0.1 M solution of sucrose at 20°C in an open beaker, what is the Ψ of the solution, and in which direction would the net flow of water be?
b. If the solution in question 4 contained 0.1 M NaCl instead of 0.1 M sucrose, what is the Ψ of the solution, and in which direction would the net flow of water be?

6. Paclitaxel is a chemotherapy drug used to treat a variety of cancers. Paclitaxel inhibits both assembly and disassembly of microtubules.
a. Which phases in the cell cycle are affected by Paclitaxel? How does this drug inhibit the growth of cancer?
b. Paclitaxel affects not only cancer cells, but normal cells as well. Would the effects of Paclitaxel be seen first in organs that have quickly dividing cells (like the intestine and hair follicles) or in organs that have slow or nondividing cells (like muscles and the nervous system). Justify your reasoning.

Thinking Practice Questions:

1. For each molecule shown to the right, answer the following, providing justifications for each:
a. Is it polar or nonpolar?
b. Is it hydrophobic or hydrophilic?
c. In order to be transferred into a cell, would the molecule require a protein channel?

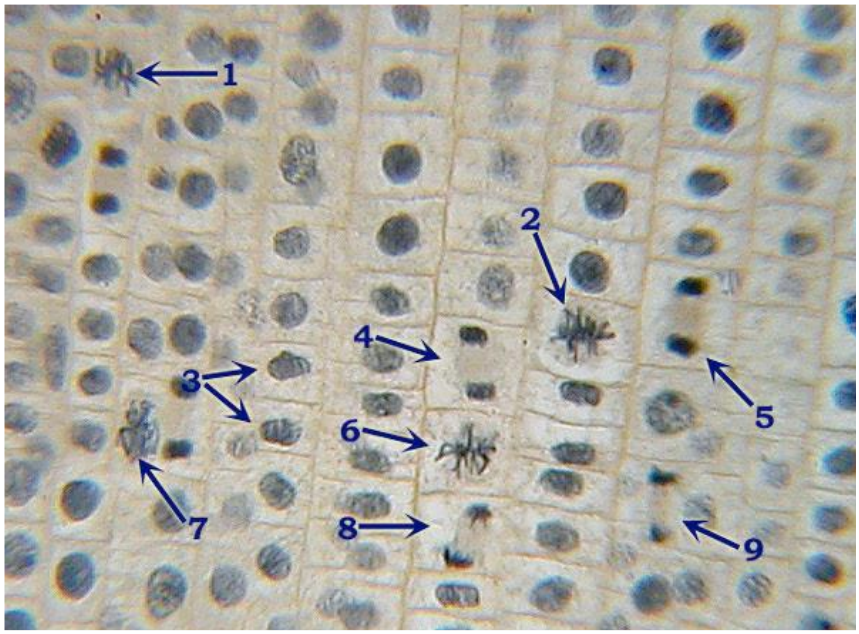


2. Biological systems rely heavily on the properties of water movement. Excretion, digestion, and blood pressure are just a few examples of situations where water balance is important. Suppose you have a semi-permeable membrane that ONLY water can pass. On one side of the membrane you have 0.1 M $CaCl_2$. On the other side of the membrane, you have 0.1 M Glucose. $CaCl_2$ ionizes in water to produce 3 ions. Glucose does not ionize in water.
a. Calculate the water potential for each side of the membrane, assume room temperature (25 ^{O}C or 298 K).
b. Describe which direction the water will flow and explain your answer.

3. Embedded proteins, as shown below, are often found spanning the membrane of a cell or organelle. These proteins serve as channels for specific molecules to travel through the membrane, either into or out of the cell.

a. What sections of the embedded protein chain are most likely to contain amino acids with hydrophobic R-groups? Explain your reasoning.
b. What sections of the embedded protein chain are most likely to contain amino acids with hydrophilic R-groups? Explain your reasoning.

4. Refer to the figure to the right.
a. What process is being shown in this picture?
b. What type of organism are these cells from? How do you know?
c. Identify a numbered cell for each of the four major stages of mitosis?
d. In what stage are most of the cells in this image? What does this indicate about the amount of time spent in each phase of the cell cycle?



5. Two students debate about proteins that regulate the cell cycle. One argues that MPF triggers the production of cyclin, while the other argues that cyclin triggers the production of MPF.
a. Based on the figure shown below, which statement is correct and why?
b. Propose a possible function of MPF, based on when it is produced in the cell cycle.