Supplemental Material

CBE—Life Sciences Education

Shaffer ***et al.***

Fall 2015 Bio 93 (section A)

Exam 1 (10.12.15)

Version A

Instructions: Write your name, and bubble in your version and student ID on your scantron (see front of the room for more details).

Write your name here: _____

This exam contains 20 questions for 150 points total. Each question is worth 7.5 points. Please ask questions if you don't understand something. **When you turn in your scantron, also turn in the entire exam.**

Wait until instructed to begin the exam. Good luck!

The functions of some proteins change depending on whether they are in the light or in the dark – they are photoreceptive (PR) proteins. A team of scientists recently determined that PR proteins bind to DNA to regulate gene expression in microbes. Answer the following three questions about this scenario.

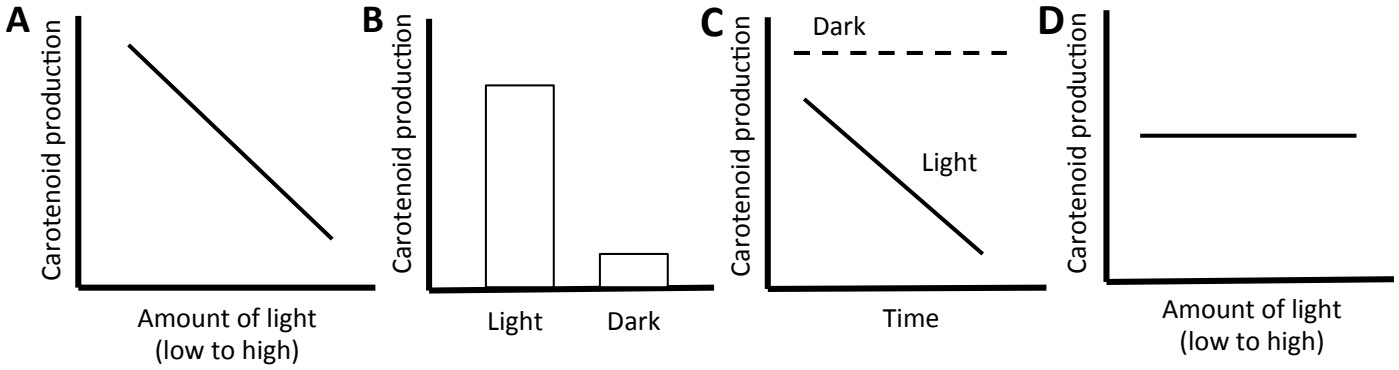
1. Suppose that the team of scientists conducted the following experiment: they mixed the PR proteins with DNA in a test tube and measured the amount of protein that bound to the DNA after 10 minutes under variable amounts of light. What was the <u>independent</u> variable in their experiment?

A. The amount of light that they exposed the test tube to
B. The amount of PR proteins bound to DNA
C. The type of PR proteins used in the experiment
D. The amount of time the light was exposed to the test tube

2. A single PR protein is composed of four identical polypeptide chains that act together to bind DNA. What is the highest level of protein structure that the PR proteins have?

A. Primary
B. Secondary
C. Tertiary
D. Quaternary

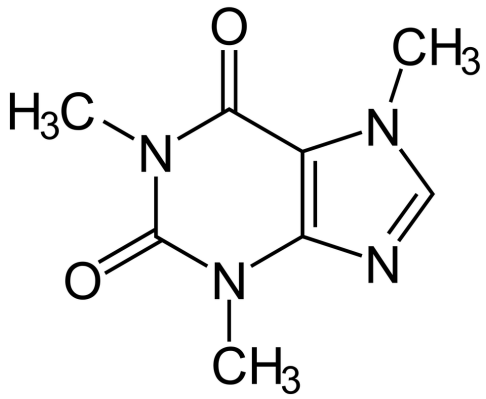
3. When microbes are in the dark, they do not produce molecules called carotenoids because the PR proteins are bound to DNA. In the light however, carotenoids are produced because the PR proteins unbind the DNA. Which of the following graphs best summarizes these statements about carotenoid production in microbes?



4. Which statement about biomolecules is <u>TRUE</u>?

A. Glycogen, cellulose, and starch are made solely from fructose
B. Some, but not all, proteins have quaternary structure
C. DNA contains only C, H, O, and N atoms
D. Phospholipids contain three fatty acids and a phosphate group

Use the figure at the right to answer the following three questions.



5. What type(s) of functional groups is(are) in this molecule?

A. Methyl only
B. Carboxyl only
C. Carboxyl and methyl only
D. Carbonyl and methyl only
E. Carbonyl and methyl and amino

6. What type(s) of bond(s) is(are) in this molecule?

A. Covalent only
B. Hydrogen only
C. Covalent and ionic
D. Hydrogen and covalent

7. What type of molecule is this?

A. It is a lipid
B. It is a carbohydrate
C. It is a protein
D. It is something else other than a lipid, a carbohydrate, or a protein

8. What statement is <u>TRUE</u> about the pH scale?

A. Adding an acid to a solution will decrease the hydrogen ion concentration
B. A solution with a pH of 11 is 1000 times more basic that a solution with a pH of 9
C. As the pH increases, so does the hydrogen ion concentration
D. A solution with pH greater than 7 is considered acidic
E. A base is defined as a substance that reduces the hydrogen ion concentration

9. What happens to make glycogen from glucose monomers?

A. Covalent bonds are formed via dehydration reactions
B. Covalent bonds are formed via hydrolysis reactions
C. Ionic bonds are formed via dehydration reactions
D. Ionic bonds are formed via hydrolysis reactions

10. Which of the following statements about the cytoskeleton is TRUE?

A. Microfilaments are made up of tubulin
B. Intermediate filaments function to help muscles contract
C. Kinesin works with microtubules to help cilia and flagella move
D. Microtubules change length, but intermediate filaments tend not to

Flavonoids are molecules found in food that can affect lipid structure and function. Scientists investigated the effects of flavonoids on cell membrane fluidity by measuring anisotropy. An <u>increase</u> in anisotropy indicates a <u>decrease</u> in membrane fluidity. Use this information to answer the following three questions.

11. If flavonoids are able to easily enter a cell membrane by passive diffusion, what must be true of their properties?

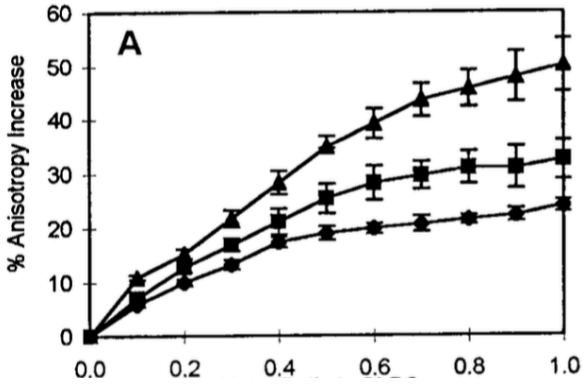
A. Flavonoids have lots of hydroxyl and carboxylic acid groups
B. Flavonoids contain many positively and negatively charged groups
C. Flavonoids have structures similar to steroids
D. Flavonoids are hydrophilic and polar

12. Doing which of the following alterations to a cell membrane would result in a <u>decrease</u> in anisotropy values?

A. Increasing cholesterol concentration in the cell membrane at 37^{o}C
B. Increasing the percentage of saturated fatty acids in the cell membrane
C. Increasing the temperature that the cell is exposed to

13. The graph on the right shows data regarding flavonoids and anisotropy measurements. The experiments were conducted in three different cell types (indicated by the triangles, squares, and circles). What can you conclude about the effects of flavonoids on cell membrane fluidity?

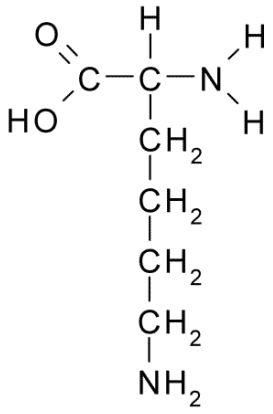
A. Membrane fluidity decreases as the amount of flavonoids increases
B. At 0.6 units of flavonoids, the triangle cell type is more fluid than the square cell type
C. The researchers are testing three different independent variables in this experiment



14. Fimbriae are tiny structures (from 3 to 10 nm in diameter, the size of some proteins!) on the surfaces of bacteria that are used to attach bacteria to a surface. Suppose that a scientist wanted to capture high-resolution images of the fimbriae surfaces. What type of microscope should the scientist use?

A. Confocal microscopy
B. Fluorescence microscopy
C. Scanning electron microscopy
D. Transmission electron microscopy

Lysine (structure shown at the right) is required for proper cell function, but it is not produced in our cells. Instead, we eat lysine (it is in our food) and it must enter our cells somehow. Use this information to answer the following three questions.

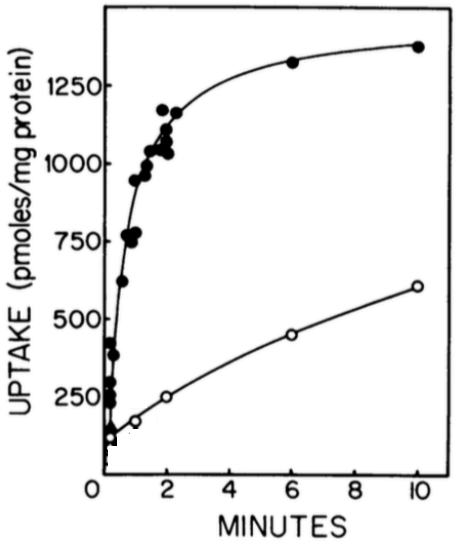


15. Suppose that the concentration of lysine inside a cell is 0.5 mM (millimolar, a unit of concentration), and that the concentration outside the cell is 10 mM. What mode of transport does lysine most likely use to enter a cell?

A. Diffusion without the use of ATP
B. Facilitated diffusion without the use of ATP
C. Facilitated diffusion with the use of ATP
D. Active transport without the use of ATP
E. Active transport with the use of ATP

16. Scientists were interested in how temperature affects lysine uptake into cells. The graph at the right shows data for lysine uptake at 34°C (black circles) and at 0°C (white circles). Which of the following statements based on the graph is TRUE?

A. Lysine uptake is positively correlated with the independent variable (temperature)
B. At lower temperatures there is more cholesterol in the cell membrane
C. Lysine uptake uses a different form of transport at lower temperatures
D. The membrane is more fluid at 0°C than at 34°C



17. Suppose that after lysine enters the cell, it is used to form a very large protein, and then this protein is exported to the extracellular matrix. What mechanism will the protein use to exit the cell?

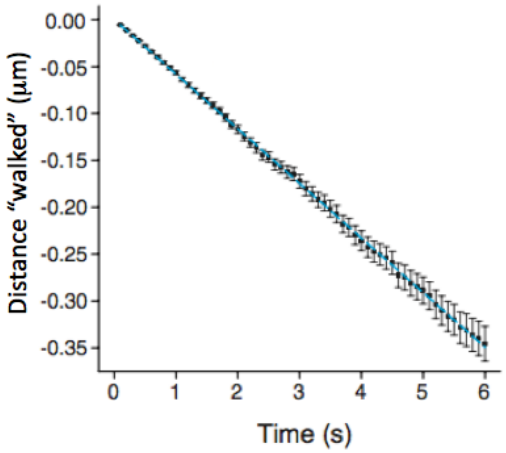
A. Active transport through a transport protein
B. Facilitated diffusion through a transport protein
C. Exocytosis
D. Phagocytosis
E. Pinocytosis

18. An intestinal cell from a mouse is placed in a solution with a very high salt concentration (higher than what is inside the cell). What result will you observe and why?

A. The cell will shrivel because the cell is hypotonic to the salt solution
B. The cell will shrivel because the cell is hypertonic to the salt solution
C. The cell will swell because the cell is hypotonic to the salt solution
D. The cell will swell because the cell is hypertonic to the salt solution
E. The cell will not change size at all because the salt solution is isotonic to the cell

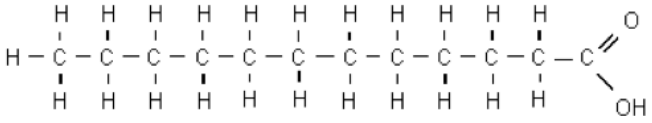
19. Researchers collected data on how far a motor protein "walked" on microtubules in a healthy skin cell, which is shown in the graph on the right. Positive values mean that the motor is walking towards the plus-end, whereas negative values mean that the motor is walking towards the minus-end. Assume that the motor protein is walking in its normal direction. What motor protein were the researchers observing?

A. Dynein
B. Kinesin
C. Myosin

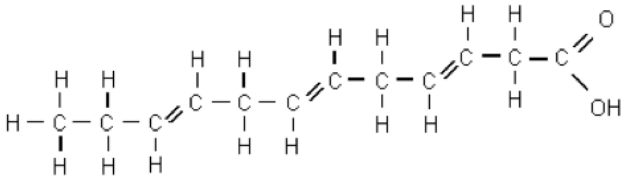


20. Two different fatty acids (X and Y) are shown at the right. Suppose that phospholipids will be made with only these fatty acids and used to make a cell membrane. Which of the following graph(s) is(are) accurate regarding this cell membrane?

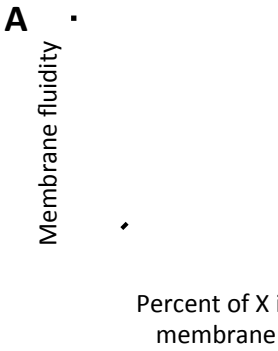
X



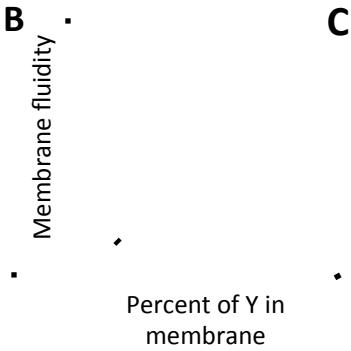
Y



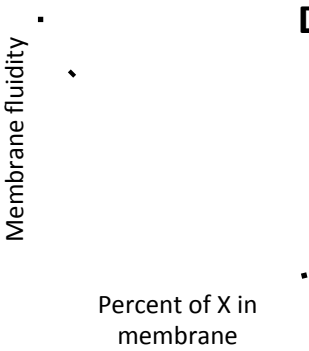
A



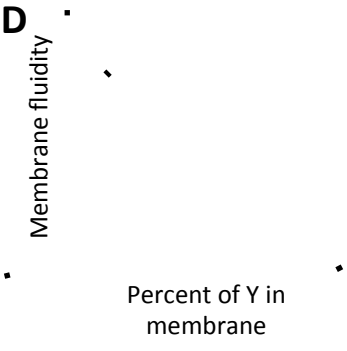
B



C



D



A. Only graph A is accurate
B. Only graph B is accurate
C. Only graph D is accurate
D. Graphs A and D are accurate
E. Graphs B and C are accurate

Fall 2015 Bio 93 (section A)

Exam 2 (10.28.15)

Version A

Instructions: Write your name, and bubble in your version and student ID on your scantron (see front of the room for more details).

Write your name here: _____

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Bacteria can infect human cells by "injecting" toxins into the cells. One such toxin, PE, is produced by the bacterium Pseudomonas and can damage human cells in several ways. Use this information to answer the following three questions.

1. The PE toxin can inhibit the synthesis of proteins such as GPCRs, the sodium-potassium pump, and ion channels. What organelle do the PE toxins bind to in order to inhibit the production of these types of proteins?

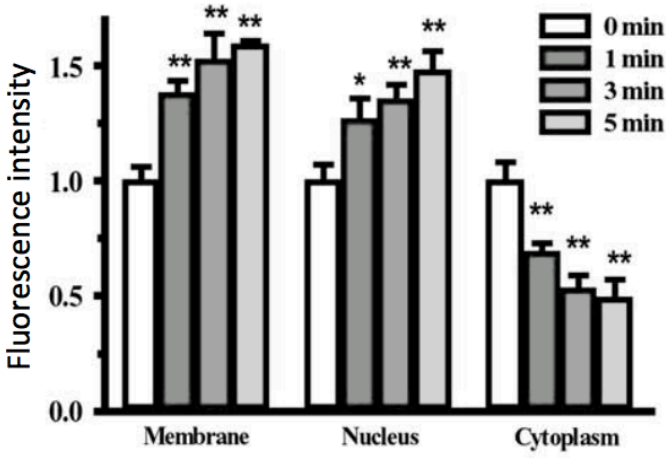
A. Golgi apparatus
B. Rough ER
C. Free ribosomes
D. Smooth ER

2. PE toxins have also been found to enter the nucleus to have adverse effects. Assuming that the PE toxins travel similar to secreted proteins, which of the following is the correct pathway that a PE toxin would take starting from the Golgi and ending up in the nucleus?

A. Golgi → transport vesicle → rough ER → transport vesicle → nuclear envelope → nucleus
B. Golgi → transport vesicle → rough ER → nuclear envelope → nucleus
C. Golgi → rough ER → transport vesicle → nuclear envelope → nucleus
D. Golgi → transport vesicle → nuclear envelope → nucleus
E. Golgi → rough ER → nuclear envelope → nucleus

3. Researchers labeled some PE toxins with fluorescent tags and monitored the movement of PE toxins through the cell over time (data shown at the right). Read the following four statements concerning these data:

I. PE toxins were present in the plasma membrane, nucleus, and the cytoplasm when the experiment started
II. PE toxins are moving into the nucleus and the plasma membrane over time
III. There are more PE toxins in the cytoplasm at 5 minutes than in the nucleus at 5 minutes
IV. PE toxins accumulate at the highest levels in the plasma membrane



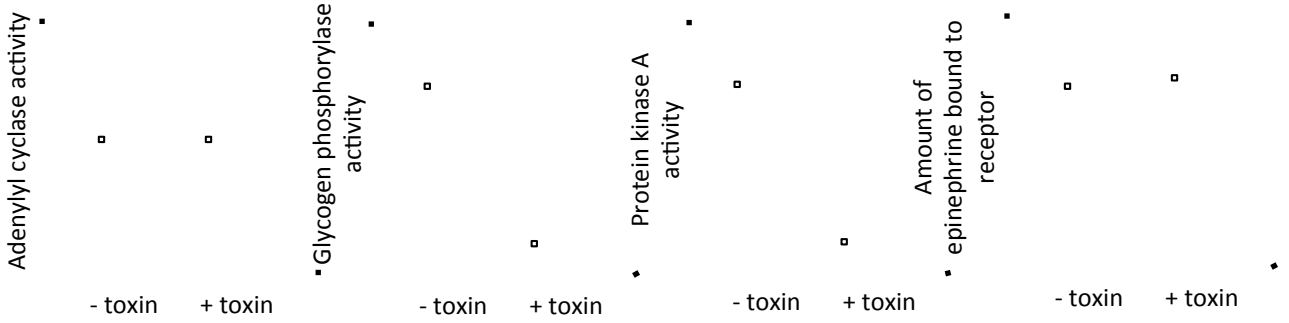
How many of these statements are FALSE?

A. One
B. Two
C. Three
D. Four

4. Which of the following statements about the normal epinephrine-GPCR pathway is TRUE?

A. Epinephrine diffuses across the plasma membrane to bind to its receptor
B. Adenylyl cyclase catalyzes the conversion of ATP to cAMP
C. The G protein becomes activated when GDP is bound to it
D. Phosphorylase kinase phosphorylates protein kinase A

Researchers were examining the mechanism of action of a new bacterial toxin that has been found to interfere with the epinephrine-GPCR pathway. They collected the following data from muscle cells without the toxin (- toxin) and with the toxin (+ toxin). Use these data to answer the next two questions.



5. Based on the data in the figures, which of the following is TRUE?

A. Phosphorylase kinase activity is reduced in the presence of the toxin
B. The G protein can never become activated in the presence of the toxin
C. Glycogenolysis can proceed as normal in the presence of the toxin
D. cAMP concentrations are lower in the presence of the toxin

6. Which of the following is a possible mechanism explaining how the toxin interferes with the epinephrine-GPCR pathway?

A. The toxin significantly decreases the fluidity of the plasma membrane
B. The toxin binds to the epinephrine binding site on the GPCR
C. The toxin dephosphorylates phosphorylase kinase
D. The toxin prevents GTP from binding to G proteins
E. The toxin catalyzes the process that inactivates cAMP

7. Consider the following four cellular events: transport vesicles moving in the cell, active transport of an ion against its gradient, oxidative phosphorylation, and the light reactions. How many of these cellular events require the use of ATP?

A. One
B. Two
C. Three
D. Four

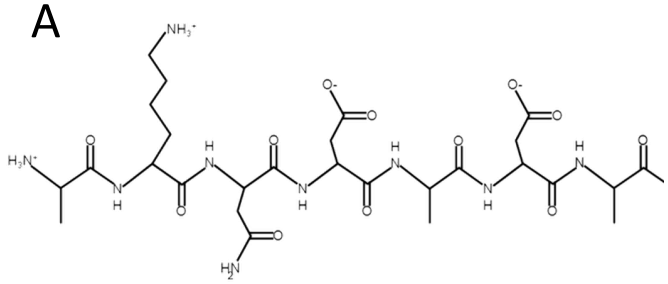
Lipase is an enzyme released by the pancreas that digests fats in the small intestine; however, they are also found in bacteria. Researchers examined lipase function in two species of bacteria, species X and species Y. Use this information to answer the following three questions.

8. The lipase-catalyzed hydrolysis of fats is exergonic. Which of the following statements is TRUE about this reaction?

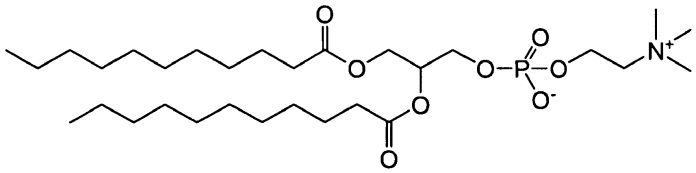
A. ΔG is positive, the reaction is non-spontaneous, and activation energy is raised by lipase
B. ΔG is negative, the reaction is non-spontaneous, and activation energy is lowered by lipase
C. ΔG is negative, the reaction is spontaneous, and activation energy is raised by lipase
D. ΔG is positive, the reaction is spontaneous, and activation energy is lowered by lipase
E. ΔG is negative, the reaction is spontaneous, and activation energy is lowered by lipase

9. Lipase has a high specificity for fats and catalyzes their hydrolysis at high rates. Which of the following molecules will lipase preferentially hydrolyze?

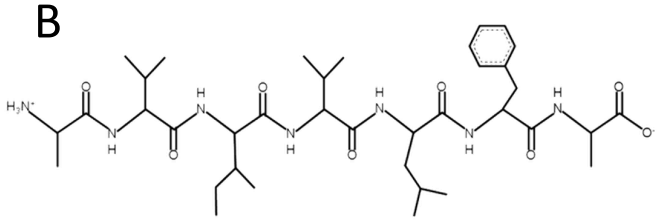
A



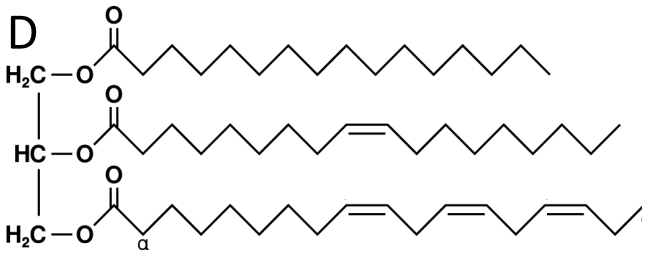
C



B

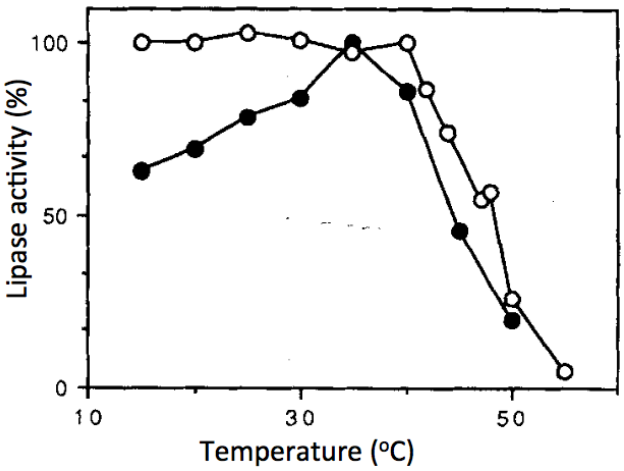


D



10. Researchers collected data on lipase activity from two species of bacteria, X (white circles) and Y (black circles) and the data is shown in the figure on the right. What can you conclude from this figure?

A. The lipase from bacteria X is insensitive to changes in pH
B. Only the lipase from bacteria Y denatures at high temperatures
C. Both lipases reduce the ΔG of the fat hydrolysis reactions that they catalyze
D. Bacteria X likely lives in an environment that undergoes large changes in temperature
E. The lipase from bacteria Y is more active than the lipase from bacteria X at 20 °C



11. When the electron transport chain in a mitochondrion is active, which of the following occurs?

A. Electrons are pumped into the intermembrane space
B. The pH of the mitochondrial matrix decreases
C. ATP synthase actively pumps protons
D. NADH is oxidized to NAD+

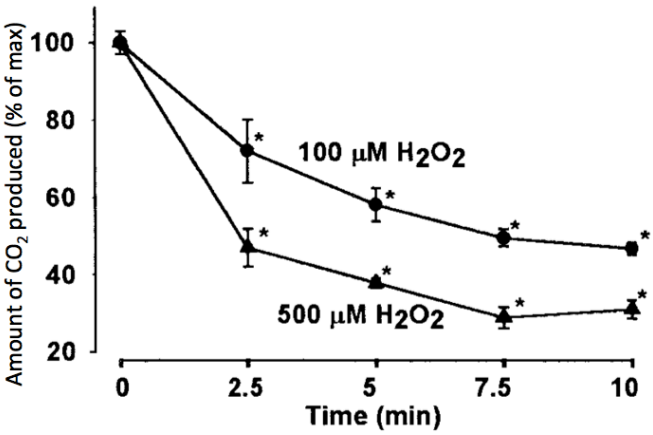
In the aging brain, hydrogen peroxide (H_2O_2) concentrations may increase and have adverse effects on neurons. Researchers recently investigated the effects of H_2O_2 on cellular respiration in neurons. Use this information to answer the following three questions.

12. Hydrogen peroxide may be damaging because it is a powerful oxidizing agent; that is, it can oxidize other molecules while it becomes reduced. What does it mean that hydrogen peroxide becomes reduced?

A. Hydrogen peroxide gains electrons
B. Hydrogen peroxide loses electrons

13. The researchers added two concentrations of H_2O_2 to cells and measured CO_2 production in the mitochondria (data shown at right). What can you conclude from these data?

A. H_2O_2 inhibits glycolysis only
B. H_2O_2 inhibits pyruvate oxidation only
C. H_2O_2 inhibits the citric acid cycle only
D. H_2O_2 inhibits pyruvate oxidation or the citric acid cycle
E. H_2O_2 inhibits glycolysis, pyruvate oxidation, or the citric acid cycle



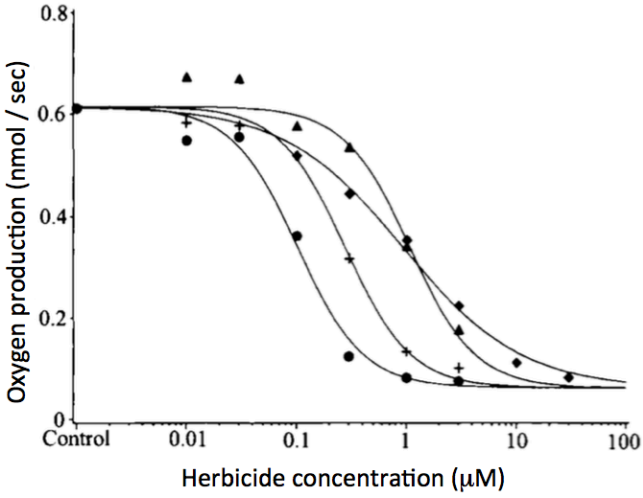
14. Based on the results from the figure, what other effect might H_2O_2 have on cellular respiration in neurons?

A. More ATP and water will be generated than normal
B. Glycolysis will proceed at a slower rate than normal
C. The intermembrane space will have a higher pH than normal
D. There will be fewer hydrogen ions in the mitochondrial matrix than normal

Herbicides are often used to kill weeds and unwanted plants from farmland. Researchers were investigating new types of herbicides and assessed how well they killed weeds. Use this information to answer the following three questions.

15. Researchers were interested in how much herbicide is needed to kill a weed. They collected the data on the right for four different herbicides to help answer their question. Which herbicide is the most potent (i.e. has the biggest effect at the lowest concentration)?

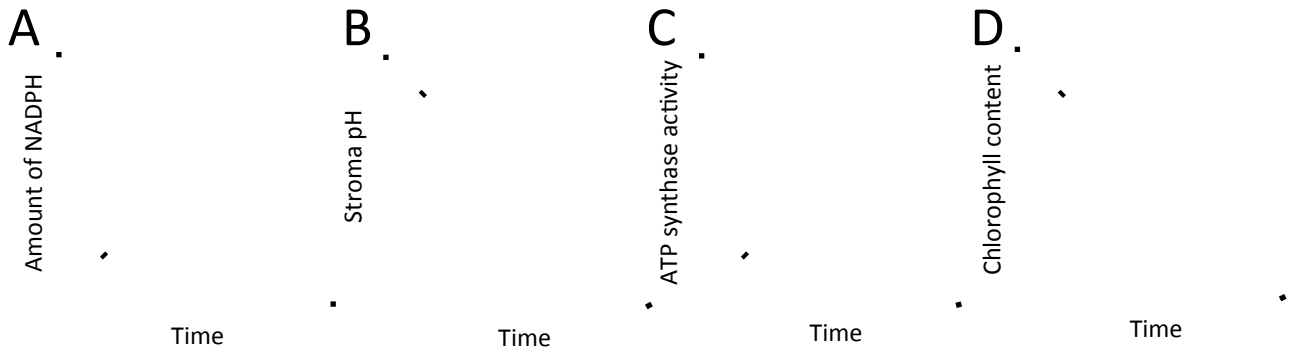
A. Herbicide 1 (plus signs)
B. Herbicide 2 (triangles)
C. Herbicide 3 (diamonds)
D. Herbicide 4 (circles)



16. The researchers found that the herbicides were directly acting on the part of photosynthesis involved with water oxidation. What part of photosynthesis were the herbicides acting on?

A. Photosystem I
B. The electron transport chain between photosystems I and II
C. Photosystem II
D. The electron transport chain after photosystem II
E. The Calvin cycle

17. Because water oxidation is being interfered with, other potentially negative effects will happen to the weeds as well. Which of the following data sets would you expect to observe once oxygen production stops?



EpoB is an anti-cancer drug that is undergoing clinical trials for treatment of breast and ovarian cancer. EpoB may have different effects depending on the dose that is given to cancer cells. Use this information to answer the following three questions.

18. Cancer cells often bypass cell cycle checkpoints and thus keep growing and dividing. Which of the following is an example of a cancer cell bypassing an S phase checkpoint?

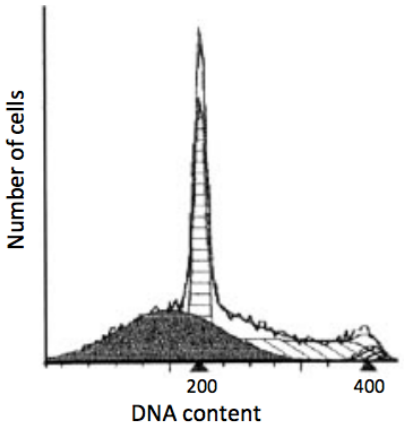
A. A brain cancer cell continues to grow on top of other skin cells, forming multiple layers
B. A prostate cancer cell continues to grow even in the absence of a required growth factor
C. An ovarian cancer cell continues to grow even though its chromosomes do not condense
D. A skin cancer cell continues to grow without all of its chromosomes having sister chromatids

19. At high doses of EpoB, researchers observed that microtubules are stabilized and do not grow, thus never attaching to kinetochores. What stage of mitosis is EpoB likely interfering with?

A. Prophase
B. Prometaphase
C. Metaphase
D. Anaphase
E. Telophase

20. Researchers added low doses of EpoB to lung cancer cells and collected the data shown at the right. What stage of the cell cycle are most of the cells in? (you can ignore the different colors, stripes, and shading in the figure)

A. G1
B. S
C. G2
D. Mitosis



Fall 2015 Bio 93 (section A)

Exam 3 (11.16.15)

Version A

Instructions: Write your name, and bubble in your version and student ID on your scantron (see front of the room for more details).

Write your name here: _____

This exam contains 20 questions for 150 points total. Each question is worth 7.5 points. Please ask questions if you don't understand something. **When you turn in your scantron, also turn in the entire exam.**

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1. Suppose that in giraffes, dark spots is dominant (S) and blue tongues are recessive (t). Suppose that a baby giraffe is born with dark spots and a blue tongue. What are the possible genotypes of the parents?

A. Sstt and SsTt
B. sstt and sstt
C. SsTt and SsTT
D. SStt and ssTT
E. SSTT and SSTt

2. Two autosomal genes control the colors of squash, W and G. The dominant allele of the W gene results in a white squash, and the recessive allele results in a colored squash (green or yellow). The dominant allele of the G gene results in a yellow squash, and the recessive allele results in a green squash. Which of the following statements is FALSE concerning the W and G genes in squash?

A. The W gene is epistatic to the G gene
B. A green squash could have the genotype wwgg
C. If two white squashes are crossed some of their offspring could be colored
D. White squash could have any of the following genotypes: WWGG, WwGg, or WWgg
E. If a yellow squash is crossed with a green squash some of their offspring could be white

3. Hemophilia B is an X-linked recessive blood clotting disorder. Marfan syndrome is an autosomal dominant disorder that affects connective tissue development. Suppose that a male with hemophilia B and heterozygous for Marfan syndrome has a daughter with a woman who is heterozygous for hemophilia B and does not have Marfan syndrome. What is the probability that the daughter will have both hemophilia B and Marfan syndrome?

A. 7/8
B. 3/4
C. 1/2
D. 1/4
E. 1/8

4. Which of the following statements about genetics and inheritance is TRUE?

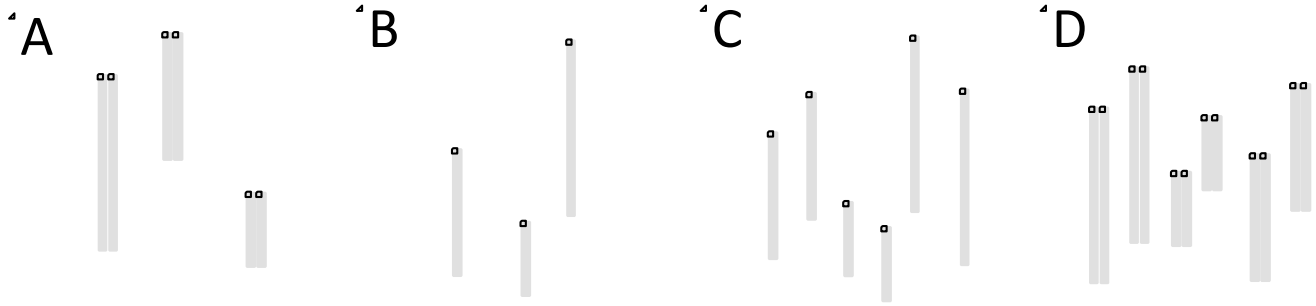
A. An inactive Y chromosome is referred to as a Barr body
B. A child that has an automosomal dominant disorder has to have parents who both also have the disorder
C. The law of independent assortment says that homologous pairs of chromosomes seperate independently during meiosis II
D. A male with an X-linked dominant disorder always has an affected mother
E. If a carrier mates with a homozygous dominant individual, about 50% of the offspring will show the dominant phenotype

5. Which of the following statements about meiosis is TRUE?

A. Crossing over occurs in prophase I and prophase II of meiosis
B. Meiosis I is more similar to mitosis than meiosis II is to mitosis
C. Chiasmatas form during anaphase I but not during anaphase II
D. In humans, four daughter cells with 2n = 23 are formed after meiosis II
E. The law of segregation applies to two alleles of a single gene seperating

Cohesin is a protein that holds together chromosomes after they are replicated. In order for chromosomes to separate during mitosis or meiosis, an enzyme, seperase, must hydrolyze cohesin. Use this information to answer the following three questions.

6. Which of the following shows a diploid cell in G2 with 2n = 6 and an active form of cohesin?

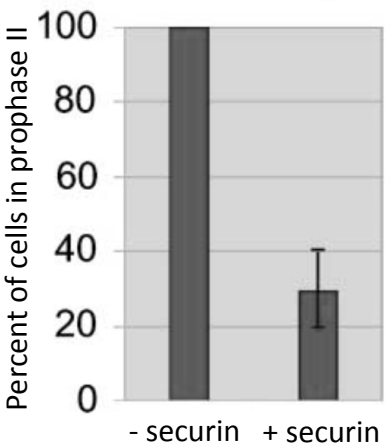


7. Researchers added a seperase inhibitor to a single sperm precursor cell that was about to begin meiosis I. After meiosis was complete, the researchers examined the four sperm cells and found that two of them had a normal karyotype, one of them had an extra copy of chromosome 17, and one of them had no copies of chromosome 17. What effect did the seperase inhibitor have on this cell?

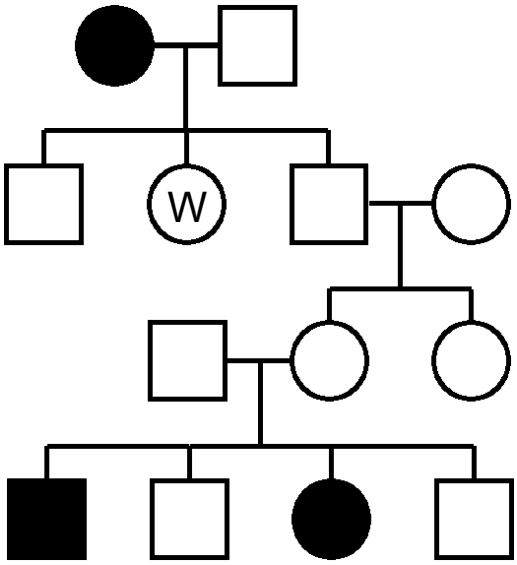
A. The seperase inhibitor caused a nondisjunction of homologous chromosomes in meiosis I
B. The seperase inhibitor caused a nondisjunction of homologous chromosomes in meiosis II
C. The seperase inhibitor caused a nondisjunction of sister chromatids in meiosis I
D. The seperase inhibitor caused a nondisjunction of sister chromatids in meiosis II

18. Researchers added a protein called securin to oocyte precursor cells that were about to begin meiosis I and observed the results on the right. Which of the following is a possible mechanism that explains these results?

A. Securin prevents sister chromatids from seperating
B. Securin prevents homologous pairs of chomosomes from seperating
C. Securin prevents crossing over from occuring
D. Securin prevents anaphase II and telophase II from occuring



The pedigree at the right shows the inheritance of a genetic disorder within a Southern Californian family. Use the pedigree the answer the following two questions.



9. What is the mode of inheritance for this genetic disorder?

A. Autosomal dominant
B. Autosomal recessive
C. X-linked dominant
D. X-linked recessive

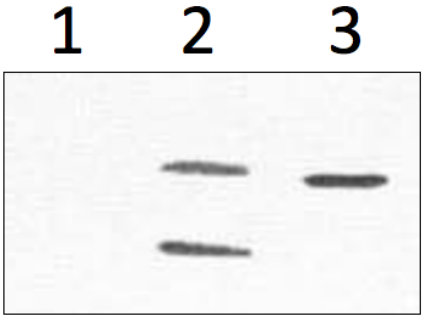
10. Suppose that the female marked W had a child with a male who was homozygous dominant for this genetic disorder. What are the chances that their child is a carrier?

A. 100%
B. 75%
C. 50%
D. 25%
E. 0%

11. Which of the following statements about DNA replication, transcription, and translation is FALSE?

A. AUG is the start codon and UAG is one of the stop codons
B. DNA polymerase adds nucleotides to the hydroxyl ends of DNA molecules
C. Transcription factors must bind to the promotor before RNA polymerase can bind to DNA
D. tRNAs contain anticodons on one end and amino acids on the other end
E. Codons are "read" by ribosomes in the 3' to 5' direction during translation

Dilated cardiomyopathy (DCM) is a common cause of sudden death and heart failure. Many mutations can cause DCM, but several of them are linked to the troponin protein, which is an essential protein that helps regulate muscle contraction in the heart. Use this information to answer the following five questions.



12. The figure at the right shows a northern blot for three different tissue samples from a single rat. The same probe for troponin was used in all three samples. Which of the following statements about these data is most likely TRUE?

A. The cells in sample 1 do not have the troponin gene
B. Alternative RNA splicing resulted in the results in sample 2
C. Sample 3 is homozygous dominant for one troponin allele
D. The troponin gene is transcribed and translated in all three samples

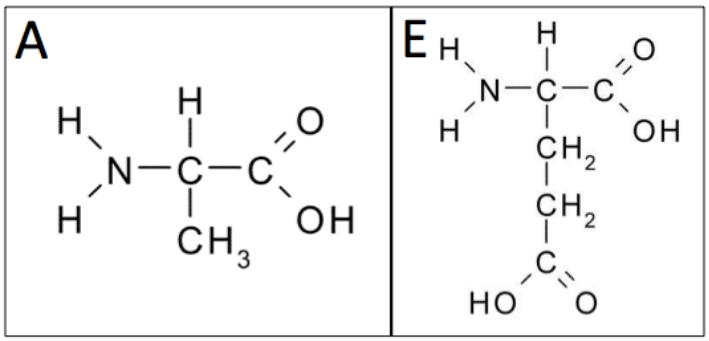
13. A mutation in troponin that has been linked to DCM is A159E, in which the amino acid A is replaced by the amino acid E. The middle portion of the exons (template strand of DNA) that contain the code for the wild-type A and the mutant E are shown in the table at the right. Assuming that the reading frame starts with the first triplet, what is the codon for A?

A. 5' GCA 3'
B. 5' GAA 3'
C. 5' ACG 3'
D. 5' AAG 3'

Wild-type	3′	ATGCGTTAGCTC 5′
Mutant	3′	ATGCTTTAGCTC 5′

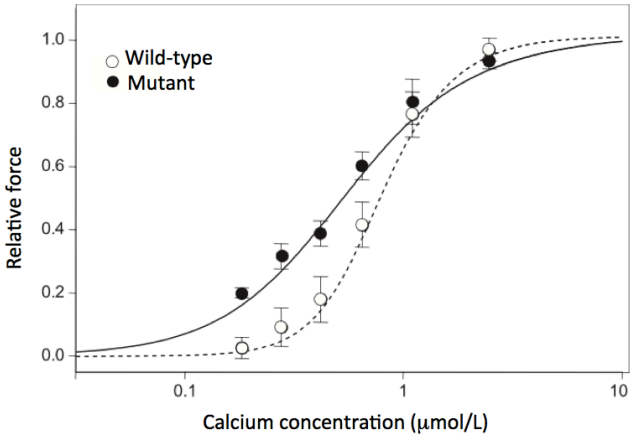
14. The A159E mutation causes a A amino acid to be replaced with a E amino acid (their structures are shown below). What effects do you think the A159E mutation will have on the troponin protein?

A. The mutation will not affect troponin function since both the A and E amino acids are hydrophobic and thus the troponin structure will not be affected
B. The mutation will probably make troponin more stable at low pH and at higher temperatures since the E amino acid is acidic
C. Since the E amino acid is hydrophilic, it will try to be exposed on the surface of the protein and thus will disrupt the tertiary stucture and potentially the function of troponin
D. If the A amino acid is replaced by the basic E amino acid, then the secondary and tertiatry stuctures will be affected and troponin will likely not fold correctly

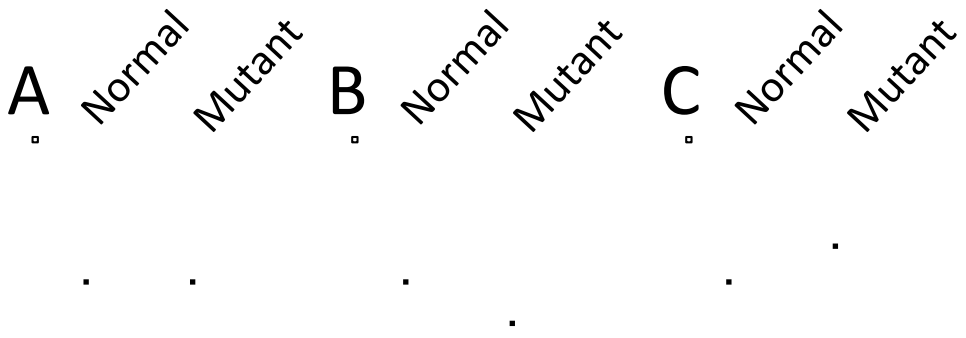


15. Heart muscle cells were isolated from a wild-type human that has a normal troponin gene and from a human that has the A159E mutation. What effects does the A159E mutation have on the amount of force that heart muscle cells can generate?

A. The A159E mutation causes heart muscle cells to contract less forcefully than wild-type cells
B. The A159E mutation causes causes heart muscle cells to contract more forcefully than wild-type cells



16. Researchers identified a new mutation in the troponin gene. Which of the following western blots would support the hypothesis that the new mutation was a nonsense mutation?



17. Which of the following statements is TRUE regarding DNA structure?

A. Chromatin is made up of only nucleic acids
B. Nucleosomes consist of histones and DNA
C. Cytosine pairs with thymine in DNA molecules
D. A nucleotide contains only a nitrogenous base and a deoxyribose sugar

The polymerase chain reaction (PCR) is used to replicate DNA in vitro, that is in a small tube and not in a living cell. To perform PCR, a researcher must add a DNA molecule to be replicated, DNA polymerase, nucleotides, and primers (short nucleic acid molecules) complementary to the specific sequence of DNA that is to be replicated. Use this information to answer the following two questions.

18. A researcher wants to use PCR to replicate a portion of a gene with the sequence 3'-GATCGAGATAGTA-5'. If the primer needs to be complementary to this sequence for PCR to work properly, what should the primer sequence be?

A. 3'-ATGATAGAGCTAG-5'
B. 3'-TACTATCTCGATC-5'
C. 3'-CTAGCTCTATCAT-5'

19. DNA polymerases used for PCR sometimes make errors. The table on the right shows the error rates per million nucleotides for five different polymerases. What can you conclude about these polymerases?

DNA polymerase	Error rate
Pfu	1.3
Deep Vent	2.7
Vent	2.8
Taq	8.0
UlTma	55.0

A. *Vent* polymerase adds RNA bases and not DNA bases to the daughter DNA strand
B. If used to replicate DNA in a cell, *Taq* polymerase would likely result in decreased rates of mismatch repair than *Vent* polymerase
C. The *Taq* polymerase is likely worse at proofreading than the *Deep Vent* polymerase
D. The *Vent* polymerase produces approximately half as many errors per million nucleotides as the *Pfu* polymerase
E. If used to replicate DNA in a cell, the *UlTma* polymerase would likely result in lower cancer rates than the *Pfu* polymerase

20. Which of the following molecules would NOT be able to be detected with a western blot?

A. Adenine
B. A histone
C. DNA polymerase
D. Helicase
E. RNA polymerase

Fall 2015 Bio 93 (section A)

Final Exam (12.7.15)

Version A

Instructions: Write your name, and bubble in your version and student ID on your scantron (see front of the room for more details).

Write your name here: _____

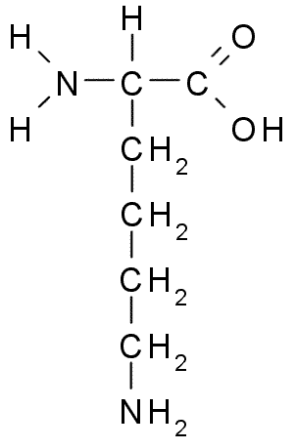
This exam contains 35 questions for 350 points total. Each question is worth 10 points. Choose the best answer for each question. Please ask questions if you don't understand something. **When you turn in your scantron, also turn in the entire exam.**

Wait until instructed to begin the exam. Good luck!

1. Imagine that you are working for a pharmaceutical company and are trying to develop a drug that blocks transcription. Which of the following drugs would directly inhibit transcription from taking place?

A. A drug that prevents 5' caps and poly-A tails from being added
B. A drug that blocks activators from binding to distal control elements
C. A drug that decreases the activity of proteases (enzymes that degrade proteins)
D. A drug that improves the ability of transcription factors to interact with promoters
E. A drug that increases the activity of enzymes that remove methyl groups from DNA

Research has shown that chromatin may be modified depending on external stimuli. In one study, researchers investigated how the emotion of fear affects chromatin. To do this, researchers electrically shocked rats and then examined chromatin from their brain tissue. Use this information to answer the following three questions.

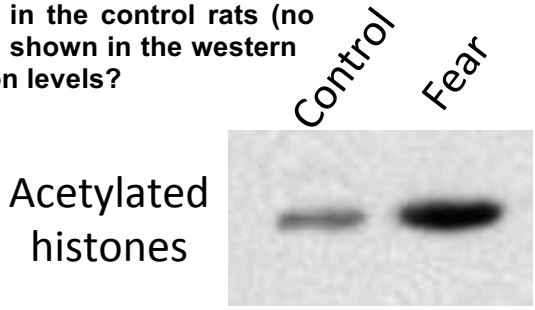


2. Histones normally bind tightly to DNA molecules. The amino acid lysine (shown to the right) largely contributes to the DNA-histone interactions. What type of bonds form between lysines and DNA to hold them together?

A. Covalent
B. Hydrogen
C. Ionic

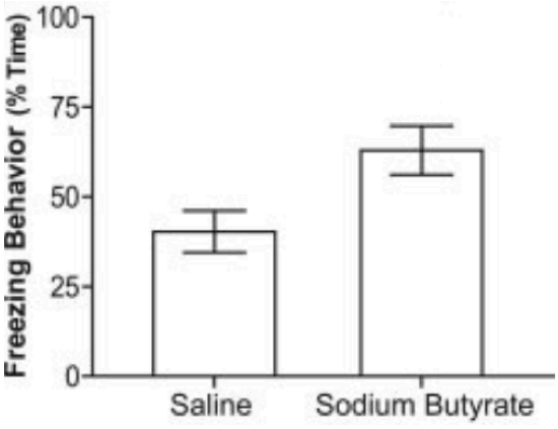
3. Researchers examined the extent of histone acetylation in the control rats (no shocks) and the fear rats (shocked). They collected the data shown in the western blot at the right. Which group would have higher transcription levels?

A. The control group
B. The fear group



4. A behavioral response that is observed from electrically shocking rats is "freezing behavior" in which the rats freeze up and do not move after being shocked (like what might happen when you get really scared). The researchers collected the data at the right for two groups of rats: one was injected with saline (a control), and the other was injected with sodium butyrate, a known inhibitor of histone deacetylases, enzymes that remove acetyl groups from histones. What can you conclude from these data?

A. Histone acetylation levels are lower in the sodium butyrate group compared to the saline group
B. Gene expression is higher in the saline group compared to the sodium butyrate group
C. Higher levels of gene expression are associated with more time spent in the freezing behavior
D. Lower levels of transcription are associated with more time spent in the freezing behavior



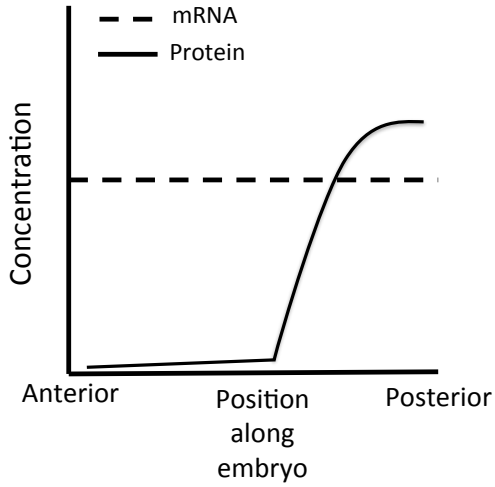
5. Which of the following statements about the genetic basis of development is TRUE?

A. Muscle cells are different from stomach cells because they have different genes
B. Bicoid triggers the development of anterior structures in developing *Drosophila* embryos
C. A morphogen is a nucleotide sequence that controls cellular determination and differentiation
D. Cytoplasmic determinants are proteins that come from the sperm and affect development

There are many maternal effect genes that control development in Drosophila. Caudal is a gene that helps develop the Drosophila body segments. The caudal mRNA levels and* Caudal *protein levels (as measured in the cytoplasm) are shown in the figure at the right. Use these data to answer the following two questions.

6. Which statement regarding the data at the right is TRUE?

A. The distribution of the *caudal* mRNA in the *Drosophila* embryo is similar to the distribution of the *bicoid* mRNA
B. The distribution of Caudal in the *Drosophila* embryo is similar to the distribution of Bicoid
C. Both the distribution of the *caudal* mRNA in the *Drosophila* embryo is similar to the distribution of the *bicoid* mRNA and the distribution of Caudal in the *Drosophila* embryo is similar to the distribution of Bicoid
D. Neither the distribution of the *caudal* mRNA in the *Drosophila* embryo is similar to the distribution of the *bicoid* mRNA nor is the distribution of Caudal in the *Drosophila* embryo similar to the distribution of Bicoid

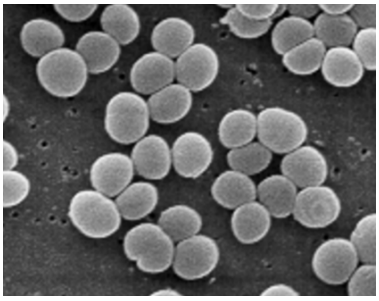


7. Which of the following is the most likely mechanism to explain the distribution of Caudal in the *Drosophila* embryo?

A. *caudal* is not transcribed at the anterior end of the embryo, but it is transcribed at the posterior end of the embryo
B. The *caudal* mRNA does not acquire a 5' cap or a poly-A tail at the anterior end of the embryo, but it does acquire them at the posterior end of the embryo
C. Ribosomes are inactive at the posterior end of the embryo, but are active at the anterior end of the embryo
D. There are two *caudal* alleles, one that expresses a normal Caudal protein at the posterior end of the embryo and one that has a nonsense mutation in the anterior end of the embryo
E. The *caudal* mRNA is modified such that is cannot be read by ribosomes at the anterior end of the embryo, but it can be read at the posterior end of the embryo

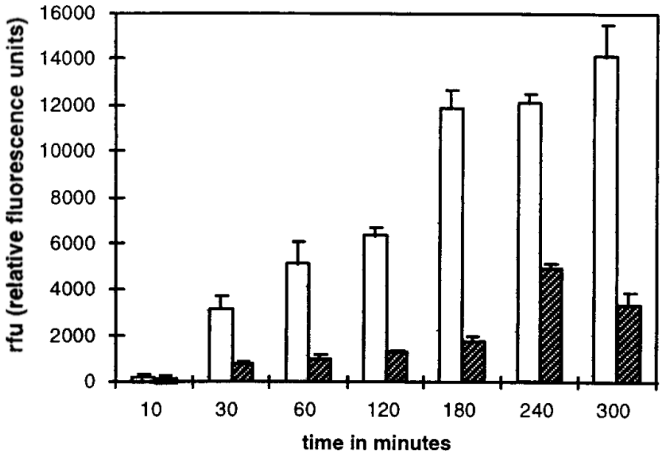
S. agalactiae is a pathogenic bacteria that can cause infections in newborns, including meningitis which may lead to death. In order for S. agalactiae to infect a human host, it must adhere to damaged human tissues and then enter the bloodstream. Researchers have determined that S. agalactiae express a protein (*Lmb*) on their cell surfaces that binds to the human protein* laminin*. Use this information to answer the following three questions.

8. *S. agalactiae* is a gram-positive chemoautotrophic bacterium (shown at the right). Which of the following is the best description of *S. agalactiae*?



A. *S. agalactiae* is a coccus bacteria with a thick peptidoglycan cell wall that obtains its carbon from inorganic molecules (like CO_2)
B. *S. agalactiae* is a coccus bacteria with a thin peptidoglycan cell wall that obtains its carbon from inorganic molecules (like CO_2)
C. *S. agalactiae* is a coccus bacteria with a thick peptidoglycan cell wall that obtains its carbon from organic molecules (like glucose)
D. *S. agalactiae* is a bacillus bacteria with a thick peptidoglycan cell wall that obtains its carbon from inorganic molecules (like CO_2)
E. *S. agalactiae* is a bacillus bacteria with a thin peptidoglycan cell wall that obtains its carbon from organic molecules (like glucose

9. Researchers collected the data on the right from two strains of *S. agalactiae* – one set of bars represents the normal, wild-type *S. agalactiae* and the other set represents a mutant *S. agalactiae* strain that has only one *lmb* allele. A fluorescent signal is obtained when Lmb binds to laminin. Which set of bars is which?



A. The white bars are the wild-type bacteria and the black-striped bars are the mutant bacteria
B. The black-striped bars are the wild-type bacteria and the white bars are the mutant bacteria

10. Suppose that you are trying to design a drug that <u>specifically</u> stopped *S. agalactiae* from expressing Lmb in order to prevent it from binding to laminin and thus infecting humans. Which of the following would be the best at achieving this goal?

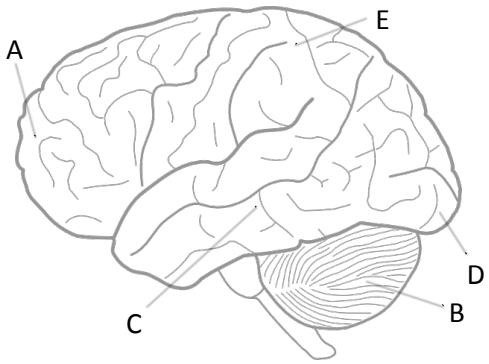
A. A drug that prevents bacterial ribosomes from translating mRNAs for cell surface proteins
B. A drug that blocks activators from binding to the laminin enhancer
C. A drug that prevents the cell wall from incorporating peptidoglycan properly
D. A drug that blocks transcription factors from binding to the Lmb promoter

11. Which of the following statements about tau and CTE is TRUE?

A. CTE is caused by excessive methylation of tau in neurons
B. When tau is not phosphorylated it normally binds to microtubules
C. Tau is a carbohydrate that forms neurofibrillary tangles in CTE patients
D. Expression levels of tau are higher in CTE patients than in healthy people

Receptive aphasia is a neurological disorder in which a patient has difficulty understanding written and spoken language. Oftentimes receptive aphasia is caused by a stroke (lack of oxygen to a part of the brain that leads to neuronal death). Use this information to answer the following two questions.

12. Which labeled region in the figure at the right is likely affected in someone who has receptive aphasia?



13. When a person was initially diagnosed with receptive aphasia, they became very upset, and because of this their body temperature increased. What part of the brain controls body temperature?

A. Hypothalamus
B. Medulla oblongata
C. Midbrain
D. Pons
E. Thalamus

14. Which statement about membrane potential and action potentials is FALSE?

A. Action potential propagation speed and myelin content are positively correlated
B. Under normal conditions, the cytoplasm has a higher potassium ion concentration than the extracellular matrix
C. The sodium-potassium pump normally pumps sodium ions out of the cell
D. The flow of potassium ions through an ungated potassium channel is an example of passive transport
E. The falling phase of an action potential occurs because voltage-gated sodium channels have opened

Leptin is a molecule that is secreted by adipose (fat) cells and may help regulate hunger by interacting with neurons in the hypothalamus. Researchers investigated the effects of leptin on rat hypothalamic neurons. Use this information to answer the following three questions.

15. Leptin is produced by adipose tissues and travels via the blood to interact with neurons in the hypothalamus. This is an example of what type of signaling?

A. Endocrine signaling
B. Paracrine signaling
C. Synaptic signaling

16. Researchers measured the resting membrane potential in three different rat neurons before and after the addition of leptin (see table at the right). Which of the following is a possible explanation for these data?

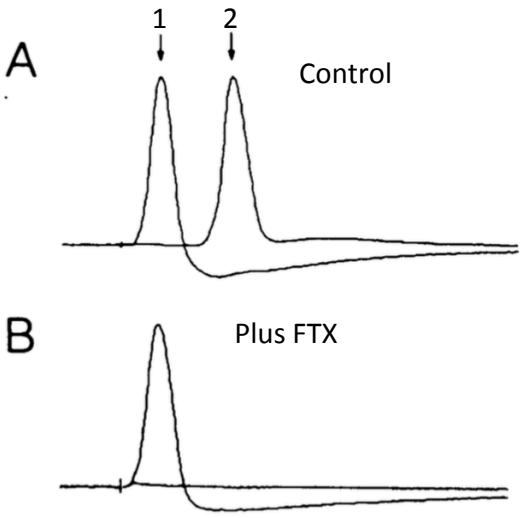
A. Leptin hyperpolarized the rat neurons by opening potassium channels
B. Leptin depolarized the rat neurons by opening potassium channels
C. Leptin hyperpolarized the rat neurons by opening sodium channels
D. Leptin depolarized the rat neurons by opening sodium channels

Neuron	Membrane potential before leptin (mV)	Membrane potential after leptin (mV)
1	-59	-69
2	-62	-75
3	-61	-72

17. Which of the following processes would have the same effect that leptin had on the cell?

A. Opening chloride channels
B. Opening sodium channels
C. Closing potassium channels
D. Closing calcium channels

FTX is a toxin derived from the venom of the funnel web spider. FTX is known to affect neurons throughout the body, and may be toxic to primates. Use this information to answer the following three questions.



18. Researchers measured presynaptic and postsynaptic action potentials in neurons with and without FTX. (see figure at the right, peak 1 corresponds to the presynaptic action potential and peak 2 is the postsynaptic action potential). Where did FTX interact with these neurons?

A. FTX interacts with the region where the axon connects to the cell body of the presynaptic neuron
B. FTX interacts at the synaptic cleft between the presynaptic and postsynaptic neurons
C. FTX interacts in the middle of the axon of the postsynaptic neuron

19. Based on these data from the figure, what type of channel does FTX bind to?

A. A voltage-gated sodium channel
B. A voltage-gated potassium channel
C. A voltage-gated calcium channel

20. Researchers also found that FTX triggers a decrease in acetylcholine release from neurons that stimulate muscle contraction. What effect will this have?

A. Muscles will be over stimulated because more EPSPs are being generated
B. Muscles will be under stimulated because fewer EPSPs are being generated
C. Muscles will be over stimulated because more IPSPs are being generated
D. Muscles will be under stimulated because fewer IPSPs are being generated

The wnt signaling pathway is critical towards proper embryonic development in organisms, including axis formation and cell determination in organs such as bone, heart, and muscle, and it also has other effects throughout an organism. Indeed, the wnt signaling pathway highlights many important concepts you learned about this quarter in Bio Sci 93. Please answer the following 15 questions regarding this pathway.

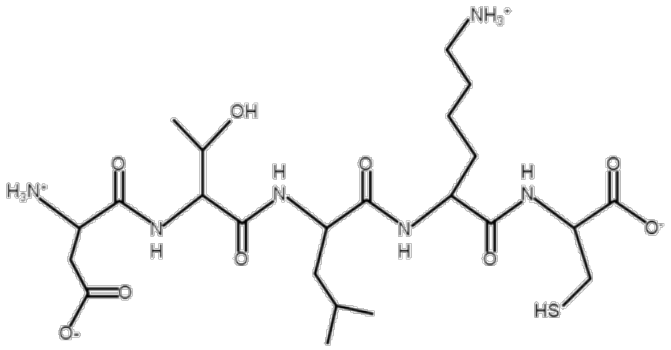
21. The wnt proteins that initiate the wnt signaling pathway are glycoproteins. The name of the receptor that the wnt proteins bind to is frizzled. What type of receptor is frizzled?

A. An intracellular receptor
B. A transmembrane receptor

22. In the absence of a ligand, the wnt signaling pathway is not activated and the cytoplasmic protein β-catenin is phosphorylated extensively and gene expression does not occur. What type of molecule phosphorylates β-catenin?

A. A kinase
B. A MAP
C. A neurotransmitter
D. A phosphatase
E. A phospholipid

23. A portion of the primary sequence of the frizzled receptor is shown to the right. Below are five statements.



1. **There are four peptide bonds in this sequence.**
2. **All of the amino acid R groups in this sequence are polar.**
3. **There is one basic amino acid and one acidic amino acid in this sequence.**
4. **One of the amino acids has an R group with a carboxyl group.**
5. **Some of the R groups can form ionic bonds.**

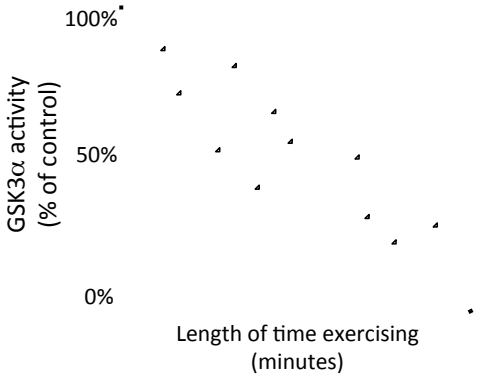
How many of these statements are TRUE?

A. One
B. Two
C. Three
D. Four
E. Five

24. The wnt glycoproteins are produced in cells and secreted so that they can initiate the wnt signaling pathway in other cells. What cellular structure produces the wnt proteins? What cellular structure modifies the wnt proteins to make them glycoproteins?

A. The rough ER makes the wnt proteins and the rough ER modifies them to make them glycoproteins.
B. Free ribosomes make the wnt proteins and the rough ER modifies them to make them glycoproteins.
C. Free ribosomes make the wnt proteins and the Golgi modifies them to make them glycoproteins.
D. The rough ER makes the wnt proteins and the smooth ER modifies them to make them glycoproteins.

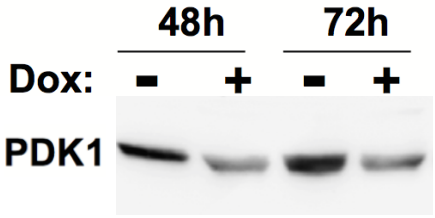
25. In the absence of a ligand, the wnt signaling pathway is not activated because the enzyme GSK3α phosphorylates other proteins which are ultimately degraded by the cell. Researchers collected data on the activity of GSK3α [redacted] exercise (shown at the right). During exercise, the intracellular hydrogen ion concentration increases. What possible effect is exercise having on the activity of GSK3α?



A. Exercise is increasing the activation energy for the reaction that GSK3α catalyzes
B. The change in pH is affecting the tertiary structure of GSK3α
C. The more alkaline conditions are causing GSK3α to be less active and thus hydrolyzed in the cell
D. Exercise is increasing the rates of transcription of the GSK3α gene

26. The wnt signaling pathway regulates cellular respiration by activating a protein PDK1 that prevents pyruvate from being oxidized to acetyl CoA. Researchers investigated the effects that a drug (Dox) has on this process by introducing Dox to cells and performing a western blot at two time periods after Dox was introduced (data shown to the right). What can you conclude about the effects of Dox?

A. Less ATP will be generated by chemiosmosis in the presence of Dox
B. The intermembrane space will be more acidic when Dox is added to cells
C. NADH concentrations will be lower in the mitochondria in the presence of Dox
D. If Dox is added to cells, pyruvate will pass more easily through the mitochondrial membrane



27. While plants do not use the wnt signaling pathway, they use other pathways to help regulate photosynthesis. For example, $NADP^+$ reductase is the enzyme that controls the rate that $NADP^+$ is reduced, and its activity may be regulated by certain pathways. What effect would a decrease in $NADP^+$ reductase activity have on a plant cell?

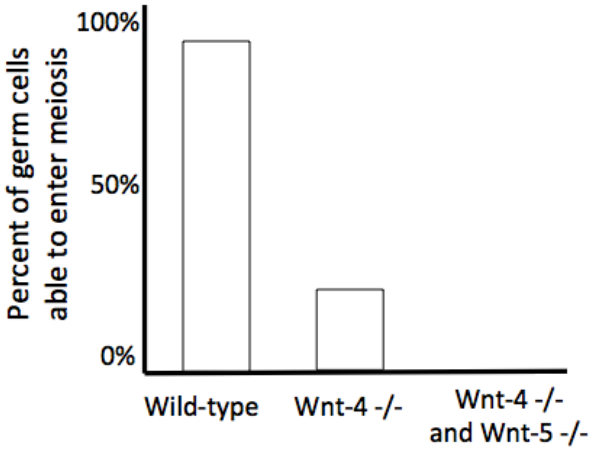
A. NADPH concentrations would increase
B. The thylakoid space would become more basic
C. Less water would be oxidized
D. Photosystem II would stop working
E. The cell would make less G3P

28. One of the proteins involved in the wnt singaling pathway is named dishevelled. At some point in the cell cycle, dishevelled has been shown to interact with kinetochores. What process might disheveled contribute to?

A. Attachment of microtubules to chromosomes
B. Duplication of chromosomes to form sister chromatids
C. Holding chromosomes together during crossing over
D. Formation of asters and the early mitotic spindle
E. Increasing gene expression by unpacking chromosomes

29. Wnt proteins are known to affect meiosis. Researchers investigated the effects of two specific wnt proteins, wnt-4 and wnt-5, on the ability of female ovarian cells to enter meiosis. They collected data (shown at the right) from wild-type ovarian cells, from ovarian cells that were missing both wnt-4 alleles (wnt-4 -/-) and from ovarian cells that were missing both wnt-4 alleles and both wnt-5 alleles (wnt-4 -/- and wnt-5 -/-). What conclusion can you make from these data?

A. All wild-type female germ cells are able to enter meiosis
B. Female germ cells are unable to enter meiosis in the absence of wnt-4
C. Wnt-5 is required for female germ cells to enter meiosis
D. Both wnt-4 and wnt-5 are necessary for female germ cells to enter meiosis



30. Familial exudative viteoretinopathy (FEVR) is an autosomal dominant genetic disorder that results in abnormal blood vessel growth in the eye. Mutations in the *frizzled* gene lead to this disorder. Suppose that a man with FEVR has a baby with a woman who does not have FEVR. What are the chances that their baby has FEVR?

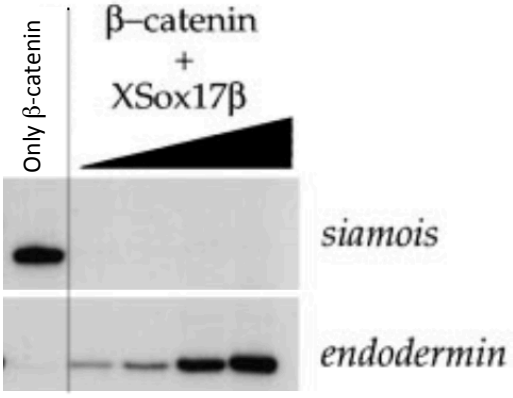
A. There is a 0% chance because the father has two identical *frizzled* alleles
B. There is a 50% chance because the father has two different *frizzled* alleles
C. There is a 100% chance because the father has two identical *frizzled* alleles
D. There is a 0% chance or a 50% chance because you don't know what *frizzed* alleles the father has
E. There is a 50% chance or a 100% chance because you don't know what *frizzed* alleles the father has

31. In the absence of a ligand, the wnt signaling pathway is not active and a repressor named Groucho blocks expression of target genes by blocking general transcription factor binding sites. What region of DNA does Groucho bind to?

A. 5-cap
B. Distal control element
C. Enhancer
D. Poly-A tail
E. TATA box

32. When the wnt signaling pathway is active, the protein β-catenin is able to regulate the expression of many genes. Researchers investigated the effects of β-catenin on the expression of two genes, *siamois and endodermin*, in frog embryos in the presence of β-catenin only and in the presence of β-catenin and increasing amounts of another protein, XSox17β. A northern blot of their results is shown to the right. Below are four statements about these data:

1. **The *siamois* gene is repressed by XSox17β**
2. **XSox17β might be a specific transcription factor for the *endodermin* gene**
3. **XSox17β likely degrades the siamois protein**
4. **In the absence of XSox17β, β-catenin might initiate expression of proteins that remove methyl groups from the *endodermin* gene**



How many of these statements are TRUE based on these data?

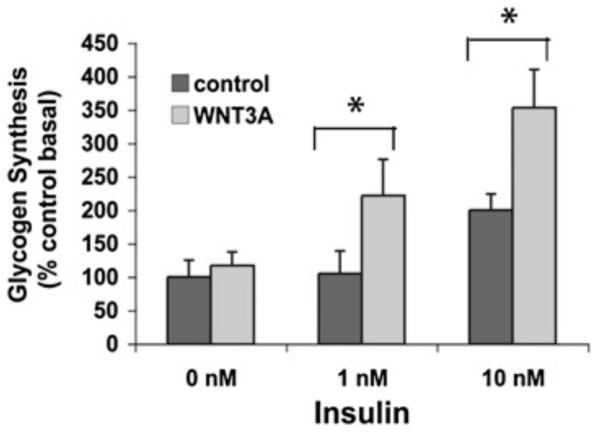
A. Zero
B. One
C. Two
D. Three
E. Four

33. Researchers investigated the effects of one of the wnt proteins, WNT3A, on glycogen synthesis in cells. What molecules are required to synthesize glycogen in a cell?

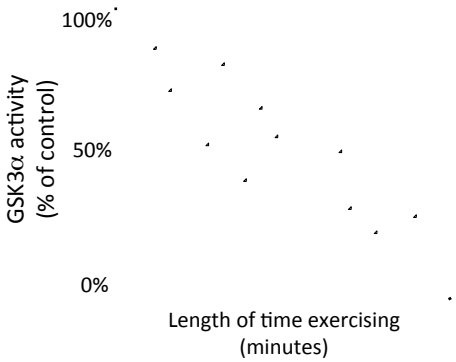
A. Glucose and water only
B. Amino acids and a specific enzyme only
C. Glucose and a specific enzyme only
D. Amino acids, a specific enzyme, and water only
E. Glucose, a specific enzyme, and water only

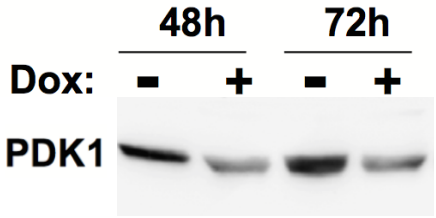
34. Researchers added WNT3A to cells in the presence of insulin and measured glycogen synthesis rates. Which of the following would produce the OPPOSITE effect of what WNT3A has on glycogen synthesis?

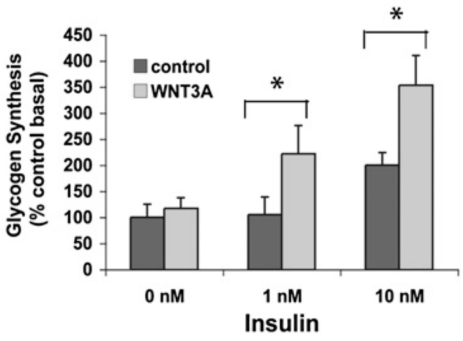
A. Increasing release of GABA from neurons
B. Exposing muscle cells to epinephrine
C. Preventing pyruvate from entering mitochondria in skin cells
D. Increasing the expression levels of glucose transporters in liver cells
E. Altering the light reactions so that they could take place in the dark



35. How many of the following figures about the wnt signaling pathway show correlation and not causation?







A. Zero
B. One
C. Two
D. Three

Reading guide for lesson 1
Chapter 1, pages 16 to 24

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Describe the steps of the scientific process (or method) in your own words, using the terms hypothesis, prediction, experiment, and analysis.

What is the difference between inductive reasoning and deductive reasoning? Provide an example of each.

Can an experiment prove that a hypothesis is true? Why or why not?

How is the "real" scientific process (or method) different from the "textbook" scientific process?

Read the section on "investigating coat coloration in mouse populations" and Figure 1.25. Then answer the "interpret the data" question in Figure 1.25 and concept check 1.3 question 4 (what if?) on page 21.

Define the following terms. Apply these terms to the coat coloration experiment you just read about.

Variable:

Controlled experiment:

Independent variable:

Dependent variable:

How is a theory different from a hypothesis?

Read and analyze the “scientific skills exercise” on page 22. You will be answering the questions associated with this exercise as part of your pre-class assignment on Mastering Biology.

How is science different from technology?

How is science influenced by society? How does society benefit from science?

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 2
Chapter 2, pages 28 to 30, 36 to 41,
Chapter 3, pages 45, 48 to 49, 51 to 54

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

What is the difference between an element and a compound?

How do neutrons, protons, and electrons interact to form an atom? Examine Figure 2.4 for a model of a helium atom.

Skip to page 36 (concept 2.3)

What is a covalent bond? How do covalent bonds function to create molecules?

What is the difference between a single bond and a double bond? Examine Figure 2.10 to see examples of covalent bonds forming various molecules.

What is the valence of an atom? How does valence allow you to determine how many bonds an atom can form? What is the valence of hydrogen, oxygen, nitrogen, and carbon?

What is electronegativity? How does electronegativity result in nonpolar covalent bonds and polar covalent bonds? Examine Figure 2.11 for an example of polar covalent bonds.

Define the following terms and provide an example of each. Examine Figure 2.12 for an example of ionic bonding.

Ionic bond:

Ion:

Cation:

Anion:

Salt:

What is a hydrogen bond? Examine Figure 2.14 for an example of a hydrogen bond. Complete the "Draw it" exercise in the space below.

What are van der Waals interactions?

Complete the following table to summarize your knowledge about types of bonds and molecular interactions.

Bond type	Bond formed by…	Relative bond strength	Example(s)
Covalent			
Ionic			
Hydrogen			
Van der Waals			

Why is molecular shape so important to determining molecular function?

Define the following terms and provide an example of each from the formula $2\ H_2 + O_2 \rightarrow 2\ H_2O$.

Chemical reaction:

Reactant:

Product:

What does it mean when a reaction has reached chemical equilibrium?

Skip to page 45 (concept 3.1)

What is a polar covalent bond and what is a polar molecule? Why is a water molecule considered to be polar?

Answer the three concept check 3.1 questions on page 45 in the space below.

Skip to page 48 (water: the solvent of life)

Define the following terms and explain how they are related to dissolving table salt into a boiling pot of water. Examine Figure 3.7 for a diagram of what happens when salt is dissolved in water.

Solution:

Solvent:

Solute:

Aqueous solution:

What are the similarities and differences between hydrophobic substances and hydrophilic substances? Give an example of each.

Skip to page 51 (concept 3.3)

Define the following terms and give an example of each, if applicable.

Hydrogen ion:

Hydroxide ion:

Hydronium ion:

Acid:

Base:

Is NaOH an acid or a base? Why? Is H_2CO_3 an acid or a base? Why?

What does the pH scale measure? What is the equation for calculating pH?

Draw a graph of the relationship between pH and the number of hydrogen ions. Place the number of hydrogen ions on the x-axis and pH on the y-axis.

When moving up on the pH scale from 5 to 6, what is the equivalent change in the number of hydrogen ions?

What is a buffer? Give two examples of a buffer.

Answer concept check 3.3 question 3 on page 53.

Read and analyze the "scientific skills exercise" on page 54. You will be answering the questions associated with this exercise as part of your pre-class assignment on Mastering Biology.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 3
Chapter 4, pages 62 to 63
Chapter 5, 67 to 86

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Start at concept 4.3 on page 62.

What is a functional group? How do functional groups contribute to molecular properties?

Complete the following table for the seven most important biological functional groups. Examine Figure 4.9 for help.

Chemical group	Structure (draw it!)	Polar or non-polar?	Other properties	Examples
Hydroxyl				
Carbonyl				
Carboxyl				
Amino				
Sulfhydryl				
Phosphate				
Methyl				

Skip to page 67 (concept 5.1)

What is a polymer? What is a monomer? Give a biological example of each.

How are dehydration and hydrolysis reactions similar and different? Draw generic dehydration and hydrolysis reactions, including all reactants and products for each type of reaction.

Why is there such a diversity of biological polymers even though there are a limited number of biological monomers?

Complete the following table about the types of carbohydrates. Examine Figure 5.3, 5.4, and 5.6 for examples of carbohydrate structures.

	Description	Function	Contains what functional groups?	Polar or non-polar?	Examples
Monosaccharides					
Disaccharides					
Polysaccharides					

How is a disaccharide formed from monosaccharides? How is a polysaccharide formed from monosaccharides?

Complete the following table about the types of polysaccharides. Examine Figure 5.6 for structural comparisons between polysaccharides.

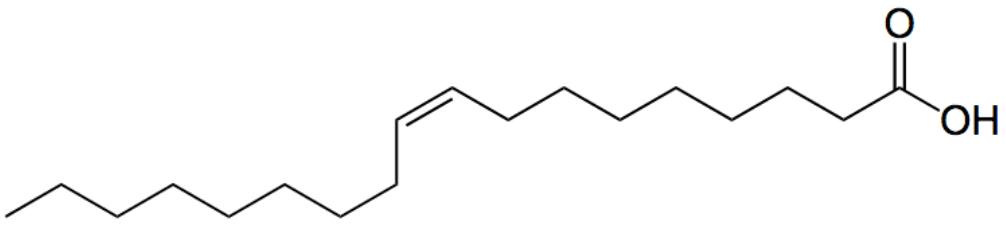
	Structural characteristics	Functional characteristics	Found in what organisms?
Starch			
Glycogen			
Cellulose			
Chitin			

What property do all lipids share with each other?

How do fatty acids and glycerol molecules make up fats? How many fatty acids and glycerol molecules are in a single fat molecule? Can you draw a basic depiction of a fat? Examine Figure 5.9 for an example.

What is the difference between a saturated fatty acid (or fat) and an unsaturated fatty acid (or fat)? What do these terms tell you about whether a fat is liquid or solid at room temperature?

Oleic acid is shown below. Is oleic acid a saturated or unsaturated fatty acid? If it were part of a fat, would the fat be liquid or solid at room temperature? Why?



What is a trans fat? Why are trans fats thought to be harmful to health?

How does a phospholipid differ structurally and functionally from a fat? In what part of a cell are phospholipids abundant? Examine Figure 5.11 for more details on phospholipids.

What are steroids? Steroids have very different structures from fats and phospholipids, so why are they classified as lipids?

What is the difference between a polypeptide and a protein?

What are some of the different functions that proteins have? See Figure 5.13 for an overview.

Draw a generic amino acid that has an amino group, a carboxyl group, and a side chain (R group). Which group varies to give twenty different amino acids?

What are the ways that structural characteristics of amino acids can influence their properties? Examine Figure 5.14 to see how the twenty amino acids differ in their structure and properties.

What is a peptide bond? What does it link together and what reaction is used to form it?

Protein function is exquisitely linked to protein structure. Complete the following table to compare the four levels of protein structure. See Figure 5.18 for help.

Level	Description	Structural features	What kinds of bonds hold it together?
Primary			
Secondary		Alpha helix: Beta sheet:	
Tertiary		Disulfide bridge:	
Quaternary			

What happens to a protein's structure and function when it denatures?

Answer concept check 5.4 question 3 in the space below.

What is a nucleic acid? What three components make up a nucleotide?

What are the differences between the nitrogenous bases pyrimidines and purines? List the names and one-letter abbreviations for each type.

How does the sequence of nucleotides in DNA influence the amino acid sequence of a protein?

Describe the structure of a DNA molecule, using the terms double helix and antiparallel. See Figure 5.25 for a visualization of DNA and RNA structure.

Complete the following table to compare and contrast DNA and RNA.

	DNA	RNA
Types of pyrimidines		
Types of purines		
Type of sugar		
Function		

Complete the following table summarizing all types of biomolecules.

	Contains what structural groups?	Polar or non-polar?	Examples
Carbohydrates			
Lipids			
Proteins			
Nucleic acids			

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 4
Chapter 7, pages 124 to 130
Chapter 6, pages 118 to 119

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Start on page 124.

What are the major functions of the plasma membrane? What does it mean that the plasma membrane is selectively permeable?

What kinds of biomolecules are found in plasma membranes?

Phospholipids are the most abundant lipid in plasma membranes. What does it mean that phospholipids are amphipathic? How does property affect their orientation in the membrane?

Answer the “make connections” question in Figure 7.2

Figure 7.3 shows a model of an animal cell’s plasma membrane. What does it mean that this is a fluid mosaic model? How many different types of molecules can you find in this drawing?

What evidence do we have that plasma membranes are fluid and not static structures? See Figure 7.4 for details. Answer the “what if?” question in Figure 7.4.

Explain how each of the following factors affect membrane fluidity. Examine Figure 7.5 for a visual depiction of how some of these factors act on membrane fluidity.

a) temperature:

b) saturation level of fatty acids:

c) cholesterol:

Answer concept check 7.1 question 2 on page 129 in the space below.

If phospholipids are the main determinant of a membrane's fluidity, what kinds of biomolecules affect a membrane's function?

Compare and contrast the structures and functions of integral proteins and peripheral proteins.

What is a transmembrane protein? Examine Figure 7.6 for a drawing of a transmembrane protein.

What are the six major functions of membrane proteins? Figure 7.7 provides a summary.

What are the major functions of membrane carbohydrates such as glycolipids and glycoproteins?

What types of molecules can cross the lipid bilayer without extra help? Why can they do this?

What types of molecules *cannot* cross the lipid bilayer on their own? Why can't they? How do transport proteins help these molecules through?

Answer concept check 7.2 question 2 in the space below.

Skip to page 118 (the extracellular matrix of animal cells)

Describe the structure and the function of the following molecules found in the extracellular matrix.

Collagen:

Proteoglycans:

Fibronectin:

Integrins:

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 5
Chapter 7, pages 130 to 138

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

What is diffusion? How does a solute's concentration gradient affect the direction that a solute diffuses? Examine Figure 7.10 to visualize diffusion of solutes.

Why is diffusion considered to be passive transport?

What is osmosis? How is it similar to yet different from diffusion?

Examine Figure 7.11 and answer the "what if?" question in the space below.

Define the following terms with related to tonicity and give an example of each.

Hypotonic:

Isotonic:

Hypertonic:

Complete the table below to summarize the effects of tonicity on animal and plant cells. For each empty box, explain what will happen to a cell placed in that environment and *why* it happens.

	Hypotonic solution	Isotonic solution	Hypertonic solution
Animal cell			
Plant cell			

What is facilitated diffusion? How is it similar to yet different than passive transport?

What are channel proteins, ion channels, gated channels, and carrier proteins? How are their structures and functions similar yet different? See Figure 7.14 for drawings of these types of proteins.

Read and analyze the “scientific skills exercise” on page 134. You will be answering the questions associated with this exercise as part of your pre-class assignment on Mastering Biology.

What is active transport? How is it similar yet different to passive transport and facilitated diffusion? What is required for active transport to work?

Examine Figure 7.15 to see details of the sodium-potassium pump, a specific type of active transport. Summarize the function of the sodium-potassium pump in your own words.

Examine Figure 7.16 for a review of passive and active transport. Answer the question associated with the figure in the space below.

What is the membrane potential and how does it form? How does the membrane potential result in an electrochemical gradient?

Why is it not totally correct to say that an ion diffuses down its “concentration gradient?” Why is it more appropriate to say that an ion diffuses down its “electrochemical gradient?”

What is an electrogenic pump? What is a proton pump?

How does cotransport move molecules across a membrane? How do proton pumps contribute to cotransport?

How do large molecules such as proteins and polysaccharides move across cell membranes?

Compare and contrast exocytosis and endocytosis in terms of the way they move molecules across cell membranes. Give an example of each.

Define the three sub-types of endocytosis and give an example of each.

Phagocytosis:

Pinocytosis:

Receptor-mediated endocytosis:

Complete the following table to summarize transport mechanisms across plasma membranes.

	Membrane molecules involved?	Direction that solute moves? (up / down concentration gradient)	Energy required? (yes / no)	Examples
Diffusion				
Facilitated diffusion				
Active transport				
Cotransport				
Exocytosis				
Endocytosis				

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 6
Chapter 6, pages 93 – 96, 112 – 117

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Describe how the following parameters are important to microscopy.

Magnification:

Resolution:

Contrast:

Use Figure 6.2 to answer these questions: Approximately how big is a frog egg? What is the range of sizes for most bacteria? How many times smaller is an atom compared to a mitochondrion?

What is the major difference between a light microscope and an electron microscope?

Complete the following table to help you organize information about types of microscopy. Use Figure 6.3 for help.

Type	Uses light or electrons?	Description	What it is good for
Brightfield			
Phase-contrast			
Fluorescence			
Confocal			
Scanning electron microscopy			
Transmission electron microscopy			

Answer concept check 6.1 question 2 on page 97 in the space below.

Skip to page 112 (concept 6.6)

What is the cytoskeleton? What three major molecular structures make up the cytoskeleton? What are the major roles of the cytoskeleton?

How do motor proteins interact with the cytoskeleton to achieve cell motility?

How do microtubules change size using the protein tubulin?

What are centrosomes and centrioles? See Figure 6.22 for a microscopic image of these structures. What type of microscopy was used to obtain this image?

How do microtubules contribute to the movement of cilia and flagella? How is the motor protein dynein involved? See Figure 6.23 for a comparison of cilia and flagella movement, and Figure 6.24 for a comparison of their structures.

How are microfilaments involved in muscle cell contraction (along with the motor protein myosin), amoeboid movement, and cytoplasmic streaming?

How did intermediate filaments get their name? Are intermediate filaments more or less “sturdy” than microtubules and microfilaments?

Draw what microtubules, microfilaments, and intermediate filaments look like. Use the figures from pages 113 – 117 to help you.

Complete the following table to help you organize information about cytoskeleton components. See Table 6.1 for help.

	Made up of what protein	Description of structure	Diameter (nm)	Functions	Cellular examples
Microtubules					
Microfilaments					
Intermediate filaments					

Answer concept check 6.6 question 2 on page 118 in the space below.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 7
Chapter 6, pages 97 to 112

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Start at concept 6.2 on page 97.

Define the following components that all cells have:

Plasma membrane:

Cytosol:

Chromosomes:

Ribosomes:

How are eukaryotic cells different from prokaryotic cells? (We are skipping the details on prokaryotic cells for now - we will come back to them later in the class)

Skip to figure 6.8 on page 100.

Examine the animal cell in Figure 6.8 on page 100. This is a overview figure that will be useful as a reference point as you read about organelles in next few pages. (We are skipping plant cells for now, we will come back to them when we talk about photosynthesis later in the class)

Describe the structure and function of each of the following cellular components. Examine Figure 6.9 for visual representations of these structures.

Nucleus:

Nuclear envelope:

Nucleolus:

Chromosomes:

Chromatin:

How are molecules regulated from entering / exiting the nucleus?

Answer concept check 6.3 question 3 on page 104 in the space below.

What are ribosomes made of? Where do these components come from? What is the major function of ribosomes? Examine Figure 6.10 for visualizations of ribosomes.

What is the difference between free and bound ribosomes?

What components of the cell are part of the endomembrane system? What functions does the endomembrane system perform in the cell?

Describe the structure and function of the smooth endoplasmic reticulum (ER). See Figure 6.11 for a view of the smooth ER.

Describe the structure and function of the rough endoplasmic reticulum (ER). See Figure 6.11 for a view of the rough ER.

Write one sentence comparing the smooth and rough ER.

Describe the structure and function of the Golgi apparatus. What is the difference between the “cis” and “trans” sides of the Golgi apparatus? See Figure 6.12 for a view of the Golgi.

Describe the path that vesicles may take from the ER through the Golgi apparatus and to other parts of the cell.

How might biomolecules be modified as they pass through the Golgi apparatus?

Describe the structure and function of lysosomes. See Figure 6.13 for a view of lysosomes.

Compare and contrast the processes of phagocytosis and autophagy.

What are vacuoles? How do they function in animal cells?

Review Figure 6.15 for a summary of the endomembrane system. Answer concept check 6.4 question 3 on page 108 in the space below.

Describe the function of mitochondria. Are they present in animal cells? In plant cells? See Figure 6.17 for a view of mitochondria. (We are skipping chloroplasts for now, we will cover them later in the class)

The endosymbiont theory is a great example of biological evolution. Describe the endosymbiont theory in your own words in the space below.

How many membranes does a mitochondrion have? What are the roles of cristae and the mitochondrial matrix?

Answer concept check 6.5 question 3 on page 112 in the space below.

What are peroxisomes? How do they function in animal cells?

Complete the following table to summarize your knowledge of animal cell components.

Component / organelle	Structural description / features	Functions	What would happen if a cell lost this component?
Nucleus			
Ribosome			
Smooth endoplasmic reticulum			
Rough endoplasmic reticulum			
Golgi apparatus			
Lysosome			
Vacuole			
Mitochondrion			
Peroxisome			

Reviewing lessons 4, 5, 6, and 7: Draw a typical eukaryotic cell, including all of the key structures that were discussed in lessons 4, 5, 6, and 7. Can you draw the processes of exocytosis, endocytosis, active transport, and passive transport on your drawing? Additionally, go back to Figure 6.8 on page 100 and cover up all of the text boxes, then try to identify all of the structures and give their functions.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 8
Chapter 11, pages 212 – 226

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Start on page 212 (local and long-distance signaling)

How can cells communicate via direct contact? How are gap junctions involved in one of these processes? See Figure 11.4 for examples of cells communicating via direct contact.

How are paracrine signaling, synaptic signaling, and endocrine signaling similar yet different? In which method are hormones used? Examine Figure 11.5 for details.

Do all cells respond to secreted signaling molecules? If not, why?

Briefly describe what happens in each of the three stages of cell signaling. Refer to Figure 11.6 for a visual representation of these steps.

Reception:

Transduction:

Response:

What is a signal transduction pathway?

What is a ligand and how does it interact with cells?

Where can receptors be found within a cell?

What is the largest family of human cell-surface receptors?

How does a G protein-coupled receptor (GPCR) function as a receptor? Summarize the four steps listed in Figure 11.8 on page 215 in your own words.

What happens if cell-surface receptors such as GPCRs malfunction?

Skip section receptor tyrosine kinases and ion channel receptors – go to "intracellular receptors" on page 217

Where are intracellular receptors found in the cell? How do signaling molecules pass through the cell membrane?

Explain how intracellular receptor signaling pathways can turn on or off gene expression. See Figure 11.9.

Answer concept check 11.2 question 1 on page 218 in the space below.

Transduction often involves many steps. What are some examples of these steps? What is a benefit to having many steps in a pathway? Is the original signaling molecule passed along a pathway through the cell?

What are protein kinases and protein phosphatases? How do they contribute to signal transduction pathways? What happens when a protein is phosphorylated or dephosphorylated? Refer to Figure 11.10 for an example of a phosphorylation cascade.

What are second messengers? What are the two most common second messengers?

What is cyclic AMP (cAMP)? How is it made by adenylyl cyclase?

Summarize the steps in a GPCR initiated cAMP second messenger transduction pathway as shown in Figure 11.12.

Skip section on calcium ions and IP3 – go to concept 11.4 on page 223

Where in the cell may the final response to a signaling pathway occur?

Describe how a signaling pathway may activate gene expression. See Figure 11.15 for a visual depiction of this process.

In your own words, describe the steps of the stimulation of glycogen breakdown by epinephrine, as summarized in Figure 11.16.

How is a response amplified through a signal transduction pathway?

Explain how cell signaling is specific. Why don't all cells respond to the same signaling molecules? Examine Figure 11.17 for a summary the specificity of cell signaling.

Answer concept check 11.4 question 3 on page 227 in the space below.

Read and analyze the "scientific skills exercise" on page 226. You will be answering the questions associated with this exercise as part of your pre-class assignment on Mastering Biology.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 9
Chapter 8, pages 142 – 157

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Define metabolism and metabolic pathways. How are catabolic pathways and anabolic pathways different? Give an example of each.

Define and give examples of the following types of energy:

Kinetic energy:

Thermal energy:

Heat:

Potential energy:

Chemical energy:

Skip to page 145 (concept 8.2)

What is Gibb's free energy (G)?

Explain how free energy can change (ΔG) as a function of temperature.

What does it mean for chemical reactions if ΔG is positive (greater than zero)? If ΔG is negative (less than zero)?

What is the relationship between G and stability? In other words, are systems (or molecules) more or less stable when G is high? When G is low? See Figure 8.5 for examples of how free energy influences stability.

Describe what it means for a chemical reaction to be at equilibrium.

If you want a review of chemical reactions, go back to pages 40 – 41 (concept 2.4)

What is the difference between an exergonic reaction and an endergonic reaction? Do these reactions require or release energy? Are these reactions spontaneous or non-spontaneous? Is ΔG positive or negative for each reaction? Examine Figure 8.6 for a graphical interpretation of these types of reactions.

If the conversion of water and carbon dioxide to glucose is an endergonic reaction, how do plants power photosynthesis?

What happens when $\Delta G = 0$?

Are living cells in equilibrium? What would happen if a cell was in equilibrium?

Answer concept check 8.2 question 3 on page 148 in the space below.

Describe the three main types of cellular work and give an example of each:

Chemical work:

Transport work:

Mechanical work:

How does energy coupling allow cellular work to be accomplished?

Describe the structure of ATP (adenosine triphosphate). How is it different from ADP (adenosine diphosphate) and P_i (inorganic phosphate)?

The following is the equation for ATP hydrolysis, which is an exergonic reaction:

$$ATP + H_2O \rightarrow ADP + P_i$$

How does this reaction release energy?

How do cells use the energy released from ATP hydrolysis to power endergonic reactions? How is phosphorylation involved in this process? See Figures 8.10 and 8.11 for examples of how ATP hydrolysis and phosphorylation power chemical reactions or power cellular work.

Explain how ATP is hydrolyzed and synthesized, using Figure 8.12 as a reference.

If a chemical reaction is exergonic, does it say anything about whether it proceeds quickly or slowly?

What is an enzyme and a catalyst?

Re-draw Figure 8.13 on page 152, and while you do so explain why the free energy of the reaction first increases (the activation energy, E_A) to reach the transition state before decreasing in the end. This is an example of an exergonic reaction.

In the space below, complete the “Draw it” activity associated with Figure 8.13. This is an example of an endergonic reaction.

Why is heating a cell to increase the rate of a specific chemical reaction a bad idea?

How do enzymes speed up chemical reactions? Re-draw Figure 8.14 in the space below to help you visualize how enzymes affect chemical reactions.

Write the equation for a generic reaction that is catalyzed by an enzyme, making sure to include the enzyme, substrate, and product.

Do enzymes catalyze only specific reactions, or do they catalyze lots of different reactions? Why is this?

Describe the relationship of an enzyme's active site to its specificity.

Explain how catalysis occurs in an enzyme's active site using Figure 8.16 as a reference.

Are enzymes used up in the chemical reactions that they catalyze?

What direction will enzymes catalyze reactions?

How do substrate and enzyme concentrations affect chemical reaction rates?

Explain how each of the following factors affect enzyme activity:

Temperature (Figure 8.17a):

pH (Figure 8.17b):

Cofactors:

Inhibitors:

Answer concept check 8.4 question 1 on page 157 in the space below.

Read and analyze the "scientific skills exercise" on page 155. You will be answering the questions associated with this exercise as part of your pre-class assignment.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 10
Chapter 9, pages 162 – 177, 180 – 181

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

How are cellular respiration and photosynthesis related? Examine Figure 9.2 for details.

How are fermentation and cellular respiration different? How are they similar?

What is the overall equation for cellular respiration?

What types of molecules can be used as "fuel" for cellular respiration?

What is a redox reaction? What is oxidation? What is reduction? What happens to electrons in these cases?

Figure 9.3 shows methane combustion as an example of a redox reaction. Explain in your own words how electrons are being transferred, what components are being reduced or oxidized, and why energy is released.

In cellular respiration, glucose is oxidized and oxygen (O_2) is reduced. What atoms in the glucose molecule are oxidized? Why do we say that oxygen is reduced? Describe how hydrogen atoms moved from one compound to another in cellular respiration.

How are electrons transferred in cellular respiration? Where are the "high energy" electrons and how do they end up as "low energy" electrons?

In the end of cellular respiration, hydrogen atoms (and their electrons) end up bound to oxygen to form water. Describe how the intermediate NAD^+ acts as an electron carrier.

Explain why NAD^+ is considered to be oxidized and NADH is considered to be reduced.

How do NADH molecules act as storage centers for energy during cellular respiration?

Describe how NADH transfers energy to oxygen using an electron transport chain. Examine Figure 9.5 to see how electrons "fall" down the electron transport chain, releasing energy along the way.

Why is oxygen (O_2) considered the "terminal electron receptor" in the electron transport chain?

Answer concept check 9.1 question 2 on page 167 in the space below.

Give a brief description of each of the main steps of cellular respiration. See Figure 9.6 for an overview of the process.

Glycolysis:

Pyruvate oxidation:

Citric acid cycle:

Oxidative phosphorylation:

For each molecule of glucose, how many molecules of ATP can be made via cellular respiration?

Describe how glucose is converted to pyruvate during glycolysis.

How is ATP produced during glycolysis by substrate level phosphorylation?

What is the net energy yield (molecules of ATP and NADH) from glycolysis per molecule of glucose?

Where do the NADH molecules generated from glycolysis go?

Does glycolysis occur in the absence of oxygen?

NOTE: You do NOT need to know all of the ten steps of glycolysis (that can wait for Bio 98!). For this class, you should know that glucose is converted to pyruvate and yields some ATP and NADH (see above for how much of each).

How does pyruvate enter mitochondria? (Remember back to lesson 5 to think about why this makes sense!)

Describe the overall reaction of pyruvate oxidation, making sure to describe what happens to pyruvate, acetyl CoA, carbon dioxide (CO_2), NAD^+ and NADH. See Figure 9.10 for help.

What product from pyruvate oxidation enters the citric acid cycle?

Figure 9.12 shows the citric acid cycle. For each molecule of acetyl CoA and each "turn" of the cycle, how many molecules of CO_2 are released? How many molecules of ATP are formed by substrate level phosphorylation? How many NADH and $FADH_2$ (which is the reduced form of FAD) molecules are produced?

Where do the NADH and $FADH_2$ molecules generated from the citric acid cycle go?

NOTE: You do NOT need to know all of the eight steps of the citric acid cycle (that can wait for Bio 98 as well!). For this class, you should know that acetyl CoA is ultimately oxidized to form CO_2, NADH, $FADH_2$, and ATP. Figure 9.11 is a nice overview of the process.

Answer concept check 9.3 question 2 on page 172 in the space below.

Give a brief description of the electron transport chain: what is it made of and what happens to electrons as they move down the chain? ***NOTE: You do NOT need to know all of the details shown in Figure 9.13 (that can wait for Bio 98 as well!).***

Describe how ATP synthase makes ATP from ADP and inorganic phosphate. See Figure 9.14 for a visual depiction of how it works. What type of molecule is ATP synthase?

Why is it accurate to describe ATP synthase as an ion channel operating in reverse?

Explain what chemiosmosis is and how it relates to ATP synthase function.

Why is maintaining a H^+ gradient so important to generating ATP? See Figure 9.15 for details.

In your own words, describe what the overall functions of the electron transport chain and chemiosmosis are. See Figure 9.15 for help.

Summarize Figure 9.16 in your own words. Also add on to this figure where carbon dioxide is released and where oxygen is used. ***This is an important figure to know that summarizes the major concepts about cellular respiration.***

How much ATP can be produced by cellular respiration? Why is the final amount variable?

How efficient is cellular respiration? Where does the rest of the energy stored in glucose go?

Answer concept check 9.4 questions 1 and 2 on page 176 in the space below.

Read and analyze the “scientific skills exercise” on page 177. You will be answering the questions associated with this exercise as part of your pre-class assignment.

Skip to page 180, concept 9.6.

Can other biomolecules besides glucose be used as fuel for cellular respiration?

How can proteins and fats be used in cellular respiration? What steps of cellular respiration do they enter?

Which biomolecule stores the most energy? Why?

Why do we need to eat food and breathe oxygen?

Complete the summary table to help you organize information about cellular respiration.

	Glycolysis	Pyruvate oxidation	Citric acid cycle	Oxidative phosphorylation
Where in the cell does it occur?				
Overall reactants?				
Overall products?				
How much ATP is made?				
Are NAD^+ or NADH involved?				

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 11
Chapter 10, pages 185 – 200, 203, 205

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Describe the basics of photosynthesis in your own words.

Define each of the following types of organisms and give an example of each:

Autotroph:

Photoautotroph:

Heterotroph:

Describe the function of each of the following parts of a plant. Try covering up the labels in Figure 10.4 and try to identify the structures.

Mesophyll:

Stomata:

Stroma:

Thylakoids:

Chloroplasts:

Chlorophyll:

What is the overall equation for photosynthesis? How is this equation related to cellular respiration?

When making sugars ($C_6H_{12}O_6$) in photosynthesis, where do the carbon atoms come from? The hydrogen atoms? The oxygen atoms?

Write the equation for photosynthesis again, this time noting which atoms (molecules) are reduced and which are oxidized.

Is photosynthesis an exergonic or endergonic reaction? If endergonic, where does the energy come from?

Briefly describe the two stages of photosynthesis:

Light reactions:

Calvin cycle:

How are $NADP^+$ and NADPH used in the light reactions? How are they similar to NAD^+ and NADH?

What is photophosphorylation?

How is carbon fixation related to the Calvin cycle?

Why is the Calvin cycle sometimes referred to as the “dark reactions” ?

Answer concept check 10.1 question 3 on page 190 in the space below.

Photosynthesis occurs at the highest rates when violet-blue and red light shines on leaves. Explain how the pigments chlorophyll a, chlorophyll b, and carotenoids contribute to this observation (*this question summarizes concept 10.2 from page 190 to page 192 up to the section called “excitation of chlorophyll by light”*)

Answer the question associated with Figure 10.10 in the space below.

Explain how electrons are elevated to higher energy states when chlorophyll absorbs light. Use Figure 10.12 for help with your answer.

Describe the structure and function of each of the following components of a photosystem:

Reaction-center complex:

Light-harvesting complex:

What is the role of the primary electron receptor in a photosystem? What molecule is this similar to in cellular respiration?

Explain how a photosystem captures light energy via the electron transfer from chlorophyll a molecules to the primary electron receptor.

What are the differences between photosystem II and photosystem I?

Summarize how photosystems II and I generate ATP and NADPH via linear electron flow, using Figure 10.14 as a reference. Figure 10.15 also shows a helpful analogy of the process.
NOTE: You do not need to know the details of each of the eight steps of the light reactions; however you should be able to explain how water is converted to oxygen, ATP, and NADPH using light energy.

Skip section on cyclic electron flow.

Answer concept check 10.2 question 2 on page 199 in the space below.

Explain how chemiosmosis powers the production of ATP in chloroplasts and mitochondria.

Where do the electrons that enter the electron transport chain come from in photosynthesis? In cellular respiration?

In the presence of light, what is the pH in the stroma of chloroplasts? In the thylakoid space?

Summarize the light reactions in your own words (see last paragraph of concept 10.2 on page 199 for help).

What products formed from the light reactions enter the Calvin cycle?

What are the major inputs and outputs of the Calvin cycle?

How many molecules of CO_2 does it take to produce one molecule of glyceraldehyde-3-phosphate (G3P)?

Briefly explain what happens in each of the three steps of the Calvin cycle.

Carbon fixation:

Reduction:

Regeneration of the CO_2 acceptor:

For the net synthesis of one G3P molecule, how many molecules of ATP and NADPH does the Calvin cycle consume?

What happens to the G3P that the Calvin cycle produces?

NOTE: You do NOT need to know all of the details of the Calvin cycle. For this class, you should know that CO_2 is converted to G3P and uses up some ATP and NADPH in the process (see above for how much of each).

Skip to page 203.

Read and analyze the "scientific skills exercise" on page 203. You will be answering the questions associated with this exercise as part of your pre-class assignment.

Skip to page 205.

Examine Figure 10.22. Explain what is going on in this figure in your own words in the space below. ***NOTE: This is a GREAT figure to know well!***

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 12
Chapter 12, pages 232 – 239, 242 – 248

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

What are three functions of cell division? See Figure 12.2.

What is the cell cycle?

What is the difference between chromosomes and chromatin?

How many chromosomes are in human somatic cells? How many are from each parent?

How many chromosomes are in human gametes?

After chromosomes duplicate are the two sister chromatids that form identical? What is the significance of centromeres?

How do the steps of mitosis and cytokinesis lead to two new cells?

Examine Figure 12.5 and summarize the steps of the figure in your own words.

Answer concept check 12.1 question 2 in the space below.

Describe what happens in each stage of the cell cycle. See Figure 12.6 for a visualization of the cell cycle.

Mitotic phase (M):

Interphase:

S phase:

G1 phase:

G2 phase:

Define these structures that are part of mitosis. See Figure 12.8 for help.

Mitotic spindle:

Centrosome:

Aster:

Kinetochore:

Metaphase plate:

Using the text on pages 235 – 238 and Figure 12.7 for help, complete the following table to summarize the steps of mitosis.

Step	Brief summary of step	What is happening to chromosomes?	What is happening to the mitotic spindle?	Draw what is happening in the step!
G2 of interphase				
Prophase				
Prometaphase				

Metaphase				
Anaphase				
Telophase				

How does the cleavage furrow lead to cleavage and cytokinesis in animal cells? ***You can skip how cytokinesis occurs in plant cells.***

Skip sections on binary fission and mitosis evolution and go to page 242.

Answer concept check 12.2 question 1 on page 242 in the space below.

Examine Figure 12.14 and summarize in your own words how this experiment led to the conclusion that the cell cycle is driven by molecular signals present in the cytoplasm.

How is the cell cycle control system regulated by checkpoints? See Figure 12.15 for a visualization of the control system and checkpoints.

Skip section on the cell cycle clock and go to page 244 (stop and go signs). You do not need to know cyclin or MPF.

What happens if a cell passes through the G1 checkpoint? What sometimes happens if a cell does not pass the G1 checkpoint?

Describe how chromosome placement in anaphase relates to the M phase checkpoint.

Describe how each of the following external factors that influence cell division:

Growth factor: (see Figure 12.18)

Density-dependent inhibition: (See Figure 12.19)

Anchorage dependence:

What are possible hypotheses to explain why cancer cells do not follow the normal signals that control the cell cycle?

Define the following terms related to cancer. See Figure 12.20 for how cancer can develop.

Benign tumor:

Malignant tumor:

Metastasis:

Describe how cancer can be treated with different methods.

Read and analyze the “scientific skills exercise” on page 248. You will be answering the questions associated with this exercise as part of your pre-class assignment.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 13
Chapter 13, pages 252 – 264
Chapter 15, pages 304 – 306

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Define the following terms:

Heredity:

Variation:

Genetics:

Genes:

Gametes:

Somatic cells:

Locus:

What is the difference between asexual reproduction and sexual reproduction?

What does a karyotype show?

Draw a pair of duplicated homologous chromosomes and label the sister chromatids and the centromere. See Figure 13.3 for help.

What sex chromosomes do females have? Males? How are sex chromosomes different than autosomes?

Humans have 46 chromosomes. Describe what chromosomes a child gets from their father and what they get from their mother.

Diploid cells have two sets of chromosomes, abbreviated 2*n*. Haploid cells have a single set of chromosomes, abbreviated *n*. What does *n* and 2*n* equal for human gametes and somatic cells?

Redraw Figure 13.4 in the space below. This will help you distinguish between sister chromatids and homologous chromosomes and will help you work with the *n* notation.

Describe the human life cycle, using the words mitosis, meiosis, sperm, egg, zygote, and fertilization. See Figure 13.5 for help.

Skip section on the variety of sexual life cycles and go to page 257 (concept 13.3).

Answer concept check 13.2 question 1 on page 257 in the space below.

Briefly explain how meiosis I and meiosis II result in four haploid daughter cells (rather than two diploid cells which are obtained through mitosis). See Figure 13.7 for help.

What separates in meiosis I? What separates in meiosis II? Which is similar to mitosis?

Use Figure 13.8 to complete the following table that summarizes the stages of meiosis I and meiosis II.

Stage	Brief summary of what happens in this stage	What is happening to chromosomes in this stage?	Draw what a cell might look like that is going through this stage
Prophase I			
Metaphase I			

Anaphase I			
Telophase I and cytokinesis			
Prophase II			
Metaphase II			
Anaphase II			
Telophase II and cytokinesis			

What happens during crossing over? During synapsis? How are chiasmata involved in these processes?

Review Figure 13.10 to help fill in the following table comparing mitosis and meiosis.

	Mitosis	Meiosis
Number of divisions?		
Synapsis of homologous chromosomes?		
Number of daughter cells?		
Are daughter cells genetically identical?		
Do homologous chromosomes get separated? Sister chromatids?		
Biological role in organisms?		

What three events occur during meiosis that *do not* occur during mitosis?

Read and analyze the “scientific skills exercise” on page 262. You will be answering the questions associated with this exercise as part of your pre-class assignment.

Explain how the following three processes lead to genetic variation among offspring:

Independent assortment: (See Figure 13.11)

Crossing over: (See Figure 13.12)

Random fertilization:

Skip to page 304 (concept 15.4)

What is a nondisjunction? At what stages of meiosis can it occur? Can it occur in mitosis? See Figure 15.13.

What is aneuploidy? What are monosomy and trisomy? What is polyploidy? What are the consequences of aneuploidy?

Describe the four types of damage that can occur to chromosomes, and explain how they can occur during meiosis. See Figure 15.14 for a visualization of these errors.

Deletion:

Duplication:

Inversion:

Translocation:

What happens to most human zygotes that are aneuploid? What happens if the aneuploidy is less severe and the zygote develops into a fetus and survives birth?

You don't need to know the specific details of the genetic diseases presented on pages 306-307, but read about them for your own knowledge.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 14
Chapter 14, pages 267– 276, 290

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

What was the "blending" hypothesis? What was the "particulate" hypothesis? How are they similar and different?

As you read about Mendel's experiments with pea plants, you will be introduced to many new terms. Define the terms below, and give an example (if applicable):

Character:

Trait:

True-breeding:

Hybridization:

P generation:

F1 generation:

F2 generation:

Mendel crossed purple-flowered pea plants and white-flowered pea plants. If the blending hypothesis was supported, what results would he have obtained?

What results did Mendel obtain in the F1 plants when he performed the cross described above? What results did he obtain when he crossed the F1 plants with each other? (See Figure 14.3 for the results). What was Mendel's explanation for these results?

Answer the "what if?" question from Figure 14.3 in the space below.

Why did Mendel think that purple flowers were a dominant trait and white flowers were a recessive trait?

Mendel came up with a model to explain his results. Summarize each of the following components of his model in your own words:

1. Alternative versions of genes (alleles) account for variations in inherited characters:

2. For each character, an organism inherits two copies (i.e. two alleles) of a gene, one from each parent:

3. If the two alleles at a locus differ, then one, the dominant allele, determines the organism's appearance; the other, the recessive allele, has no noticeable effect on the organism's appearance:

4. The law of segregation states that the two alleles for a heritable character segregate (separate from each other) during gamete formation and end up in different gametes:

If an organism has identical alleles for a given gene, what alleles will their sperm or eggs get? If an organism has two different alleles for a given gene, what percentage of sperm or egg will get each allele?

How do changes in DNA give rise to different alleles and thus different traits? Summarize Figure 14.4 in your own words to answer this question.

What are Punnett squares used for? Draw a simple one in the space below. What goes on the edges of the boxes? What goes inside the boxes?

If the letter *P* represents the gene for flower color, what does a capital *P* indicate? A lowercase *p*?

To see if you really understand the law of segregation and how simple crosses work, re-draw the crosses and Punnett square from Figure 14.5 and explain the results in your own words.

For a given pair of alleles, what is the difference between a homozygous and a heterozygous pair? What is the difference between a homozygous dominant pair and a homozygous recessive pair?

What is an organism's phenotype? What is its genotype? Do crosses always result in the same phenotypic and genotypic ratios? See Figure 14.6 for an example.

Explain how you can use a testcross to determine the genotype of an unknown organism. What two organisms are crossed in a testcross? See Figure 14.7 for an example of how it works.

What is the difference between a monohybrid cross and a dihybrid cross? Give an example of each.

Use the text on page 273 and Figure 14.8 to summarize how to perform dihybrid crosses with Punnett squares. How is this related to doing a monohybrid cross with a Punnett square?

How does the 9:3:3:1 phenotypic ratio of a heterozygous dihybrid cross support the law of independent assortment?

When is the law of independent assortment valid?

Answer concept check 14.1 question 1 on page 274 in the space below.

Answer concept check 14.1 question 2 on page 274 in the space below.

What is the multiplication rule? Give an example using tossing coins in the air.

How is the multiplication rule applied to monohybrid crosses? Give an example.

What is the addition rule? Give an example using tossing coins in the air.

How is the addition rule applied to monohybrid crosses? Give an example.

Summarize Figure 14.9 in your own words to explain how the rules of addition and multiplication apply to genetics.

How can you use probabilities and the rules of multiplication and addition to predict offspring phenotypes and genotypes of dihybrid crosses? Give an example from the text.

How can you use probabilities and the rules of multiplication and addition to predict offspring phenotypes and genotypes of trihybrid crosses (three characters)? Give an example from the text.

Answer concept check 14.2 question 1 on page 276 in the space below.

Answer concept check 14.2 question 2 on page 276 in the space below.

Answer concept check 14.2 question 3 on page 276 in the space below.

Skip to page 290. Carefully read through the tips for genetic problems. These will come in helpful as you work through genetics problems in this class (and in Bio 97!).

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 15
Chapter 14, pages 279, 282 – 285
Chapter 15, pages 296 – 298

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Start on page 279 (epistasis)

What is epistasis? What do we mean when one gene is epistatic to another gene? See Figure 14.12 for an example using coat color in Labrador retrievers.

What is polygenic inheritance? See Figure 14.13 for an example with skin color in humans.

How are epistasis and polygenic inheritance similar, but different?

How does the environment affect phenotypic variation?

Read and analyze the "scientific skills exercise" on page 281. You will be answering the questions associated with this exercise as part of your pre-class assignment.

What do the following symbols mean in a pedigree? Why are pedigrees useful?

Square:

Circle:

White symbol:

Colored symbol:

Horizontal line:

Vertical line:

Examine Figure 14.15 and summarize in your own words why a widow's peak and attached earlobes are dominant or recessive traits.

How can you use pedigrees to predict characteristics of offspring?

How do the genotypes differ between an individual who has a recessive disorders and those who are carriers? How might their phenotypes differ? See Figure 14.16 for an example.

Answer the question associated with Figure 14.16 in the space below.

Most people who have recessive disorders are born to parents with what genotype?

Why are genetic disorders not evenly distributed between different populations of people?

What are three examples of human recessive disorders?

What is an example of a dominantly inherited disorder that is not lethal?

Why are dominant alleles that cause a lethal disease rare?

Why are some disorders referred to as multifactorial?

The remaining sections in Chapter 14 on genetic testing and counseling are infinitely fascinating and I encourage you to read through them. However, there are no specific reading guide questions about these sections.

Skip to page 296 (concept 15.2).

What is the genotype for a human female? For a human male?

What parts of the X and Y chromosomes are homologous to each other?

What sex chromosomes do eggs contain? Do sperm contain?

How does the SRY gene lead to the development of a male?

What are sex-linked genes, Y-linked genes, and X-linked genes?

Can a father pass X-linked alleles to his sons? To his daughters?

Why are the terms homozygous and heterozygous invalid when referring to male X-linked genes?

If a male has a recessive allele on his X chromosome, will he express that trait?

Why do more males have X-linked recessive disorders than females?

How can a woman express a phenotype for an X-linked recessive disorder?

Summarize the three scenarios from Figure 15.7 in your own words to see if you understand inheritance of X-linked genes.

Answer the question associated with Figure 15.7 in the space below.

Name three examples of human X-linked disorders.

What is a Barr body? Do they occur in males or females?

Why do we consider female cells to be a mosaic regarding X chromosome inactivation?

What are the two types of cells females can possess regarding the X chromosome? See Figure 15.8 for an example of how X chromosome inactivation affects cat fur color.

What is bound to an X chromosome in order to inactive it?

Answer concept check 15.2 question 2 on page 298 in the space below.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 16
Chapter 16, pages 312 – 322, 325 – 326, 328 – 330

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

For a review of the basics on nucleic acids, review pages 84 – 86.

Summarize what Griffith found about transformation of nonpathogenic bacteria into pathogenic bacteria. See Figure 16.2 for help.

Summarize what Hershey and Chase found about how bacteriophages infect bacteria, leading them to conclude that DNA, and not protein, was the genetic material of cells. See Figure 16.4 for help.

Answer the "what if" question associated with Figure 16.4 in the space below.

What did Chargaff discover about DNA diversity and the relative amounts of nucleotides in DNA strands?

Using Figure 16.5 for help, draw a DNA nucleotide, labeling the phosphate, deoxyribose sugar, and a nitrogenous base. Which end of the nucleotide is the 5' end and which is the 3' end?

Read and analyze the "scientific skills exercise" on page 316. You will be answering the questions associated with this exercise as part of your pre-class assignment.

Describe the structure of a DNA double helix. What does it mean that the strands are antiparallel? Where are the relatively hydrophobic nitrogenous bases? Where are the hydrophilic phosphate groups?

How do the nitrogenous bases pair up with each other? Why do they pair in this way? How many hydrogen bonds form between these pairs? See Figure 16.8 for help.

Answer concept check 16.1 question 1 on page 318 in the space below.

Summarize the basic steps of how DNA replicates in your own words. Use Figure 16.9 for help.

What does it mean when we refer to “parental” and “complementary” DNA strands?

How did Messelson and Stahl figure out that DNA replicates via the semiconservative model and not the conservative or dispersive models? See the text and Figures 16.10 and 16.11 for help in forming your answer.

Define each of the following terms related to DNA replication. For each term, describe its function and also note what kind of biomolecule it is (if applicable).

Origin of replication:

Replication fork:

Helicase:

Single-strand binding protein:

Topoisomerase:

Primase:

Primer:

DNA polymerase:

Using these terms you just defined, write a paragraph summarizing how DNA replication occurs. Use the text from pages 320 – 322, Figure 16.13 and Figure 16.14 for help.

NOTE: You do not need to know the differences between synthesis of leading and lagging strands (as shown in Figures 16.15, 16.16, and 16.17). That can wait for Bio Sci 99!

After reading to the end of "synthesizing a new DNA strand," skip to page 325 (proofreading and repairing DNA).

Describe how each of the following mechanisms can "fix" a DNA strand that has an incorrect nucleotide.

DNA polymerase "proofreading":

Mismatch repair:

Skip to page 328 (concept 16.3).

How many nucleotide pairs are in a human chromosome? If this DNA molecule were stretched out, how long would it be? (Note: you do not need to memorize these facts, but they are simply amazing to think about!)

What is chromatin? How is it different from a chromosome?

Summarize the structure and relative size of each of the following levels of chromatin packing in a eukaryotic chromosome. Use Figure 16.22 for help.

DNA (double helix):

Histones:

Nucleosomes:

30-nm fiber:

Looped domains:

Metaphase chromosome:

Answer the "make connections" question in Figure 16.23 on page 330 in the space below.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 17
Chapter 17, pages 336 – 344

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Start at "basic principles of transcription and translation" on page 336.

What does gene expression mean? (see page 334 for details)

What are the differences between DNA and RNA (refer back to pages 84 to 87 if you want more details)

Briefly describe how transcription results in the production of messenger RNA (mRNA). What is a primary transcript?

Briefly describe how translation results in the production of proteins.

Summarize the flow of information from DNA to RNA to protein with a simple drawing. See Figure 17.3 for an example.

Describe how the triplet code and codons are used to produce proteins starting from the template strand of DNA. See Figure 17.4 for a visual of this process.

Why is the mRNA molecule complementary to the DNA template strand and not identical?

A template strand of DNA has the sequence 3' – AGCGTA – 5'. Using what you read on page 338, what is the noncoding or complementary DNA sequence and what is the mRNA sequence? Make sure to indicate which ends are the 5' and 3' ends. How many codons are in the mRNA sequence?

What direction does translation “read” the mRNA sequence to produce proteins? What does each codon “code” for?

Examine the genetic code in Figure 17.5 and explain why the genetic code is redundant. NOTE: You do NOT need to memorize this figure.

What is the start codon? What amino acid does it code for? What are the three stop codons? What do start and stop codons do?

Why is the correct reading frame so important for translation?

Answer concept check 17.1 questions 3 and 4 in the space below.

Describe the roles of each of the following components of transcription:

RNA polymerase:

Promoter:

Terminator:

Transcription unit:

Transcription factors:

TATA box:

Summarize the three steps of transcription in your own words. Use Figure 17.7 as a guide; this is the level of detail you should know for transcription.

Initiation:

Elongation: (Figure 17.9 is helpful)

Termination:

Explain how RNA processing alters the primary transcript to produce a final mRNA molecule ready for translation.

Describe the roles of the following modifications of mRNA after transcription. See Figure 17.10.

5' cap:

poly-A tail:

Explain how RNA splicing is used to remove introns from mRNA and to keep exons. See Figure 17.11.

What is the spliceosome made of? What does it do?

Explain how a single gene can encode more than one protein via alternative RNA splicing.

Answer concept check 17.3 question 3 in the space below.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 18
Chapter 17, pages 345 – 357

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Summarize the basic concept of translation in your own words, using Figure 17.14 as a guide. This is the level of detail you should know for this class. **NOTE: we are going to go light on the details on translation – that can wait for Bio Sci 99! You do NOT need to know any of the details in Figures 17.15, 17.16, 17.17, 17.18, 17.19, or 17.20. You can skip through pages 345 – 351 relatively quickly as you answer the next set of questions.**

Describe the basic structure and function of the following components of translation.

Transfer RNA (tRNA):

Anticodon:

Ribosomal RNA (rRNA):

Briefly explain how amino acids are attached to tRNAs.

Briefly explain how translation is initiated.

Briefly explain how the polypeptide chain is elongated during translation.

Briefly explain how translation is terminated.

Is energy required for translation? If so, what molecule provides the energy?

What direction does mRNA move through the ribosome?

What are post-translational modifications? Give a few examples.

What determines whether a ribosome is free or bound to the ER?

Explain how signal peptides are used to target proteins to different parts of the cell.

Skip to page 354.

Summarize Figure 17.24 in your own words. This is a great overview figure of transcription and translation.

Define the following types of mutations and describe the effects that they can have on a protein. Also give an example of each. Use the text and Figure 17.26 for help.

Point mutation:

Nucleotide-pair substitution:

Silent mutation:

Missense mutation:

Nonsense mutation:

Deletion:

Insertion:

Frameshift mutation:

Explain how a point mutation in the hemoglobin gene results in sickle cell anemia. See Figure 17.25 for details.

Do all mutations have negative effects on a protein? Can they have neutral or positive effects?

Describe how new mutations in DNA can result from the following:

Errors in DNA replication:

Mutagens:

Answer concept check 17.5 question 1 in the space below.

Answer concept check 17.5 question 3 in the space below.

What is the final overall definition of a gene that the chapter concludes with?

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 19
Chapter 18, pages 365 – 373

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Explain how differential gene expression results in different cell types even though they have the same genome.

Examine Figure 18.6. In the next few pages you will be reading and answering questions about the regulation of gene expression in more detail.

How do histone acetylation and DNA methylation affect gene expression? See Figure 18.7

Explain how epigenetic inheritance can result in traits being passed on to future generations.

Review Figure 18.8 for a summary of a eukaryotic gene and its transcript. Define the following terms (some are from lesson 15, but this will be a good refresher).

Enhancer:

Promoter:

Terminator:

Proximal control elements:

Distal control elements:

Exon:

Intron:

Primary RNA transcript:

5’ cap:

Poly-A tail:

Using Figure 18.8, summarize in your own words how a eukaryotic gene is transcribed and how the primary transcript is processed.

If only RNA polymerase and transcription factors are present, transcription occurs at a low rate. What is needed for high levels of transcription?

Using the text from the section “enhances and specific transcription factors” and Figure 18.10, explain in your own words how activators, DNA-bending protein, and mediator proteins, in addition to transcription factors and RNA polymerase, lead to the initiation of transcription. It may be useful to also make a drawing similar to Figure 18.10 as you explain the process.

Answer concept check 18.2 question 3 on page 373 in the space below.

How can repressors inhibit gene expression?

Use the text and Figure 18.11 to explain how combinations of control elements lead to regulation of gene expression.

Read and analyze the “scientific skills exercise” on page 370. You will be answering the questions associated with this exercise as part of your pre-class assignment.

How is gene expression coordinated in eukaryotes? (i.e. how are many genes turned on / off at once by a single chemical signal?)

How does alternative RNA splicing regulate transcription?

Explain how the initiation of translation can be regulated in a cell.

How long do mRNAs usually survive in eukaryotic cells? What regulates how long they survive?

Explain how protein processing can be regulated in the cell.

How can proteins be tagged for destruction in the cell?

Answer concept check 18.2 question 4 on page 373 in the space below.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 20
Chapter 18, pages 376 – 383

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

What three processes are used to transform a frog zygote into a tadpole? See Figure 18.16.

What is differentiation? What is morphogenesis? How are they similar?

Review Figure 18.11. How do different sets of activators come to be present in the liver cell and the lens cell?

What are cytoplasmic determinants? Explain how they can lead to early paths of differentiation in cells. See Figure 18.17a.

Explain how induction triggers changes in target cells during development. See Figure 18.17b.

What does it mean that a cell has undergone determination? What is the molecular explanation for determination?

What molecular process is usually regulated to control differentiation?

Explain how differentiated cells are “specialists” at making tissue-specific proteins.

Using the text and Figure 18.18 for help, summarize how the *myoD* gene is a master regulatory gene that when expressed determines and differentiates an embryonic cell into a muscle cell. By summarizing this process, you will understand how different types of cells are produced in the body via the regulation of gene expression.

What is pattern formation? What is positional information?

Describe the body plan of *Drosophila*, with regards to its head, thorax, abdomen, anterior-posterior axis, dorsal-ventral axis, and left-right axis. See Figure 18.19a.

Briefly describe how the *Drosophila* egg develops into a larva. See Figure 18.19b.

What are homeotic genes? What are embryonic lethals?

What are maternal effect genes? What types of molecules do they code for? Describe how maternal effect genes can affect the phenotype of a mother's offspring.

What is an egg-polarity gene? Are mutations in egg-polarity genes usually embryonic lethal?

What is the *bicoid* gene? What is the phenotype of a fly with two mutant *bicoid* genes? See Figure 18.21.

What are morphogens and what is the morphogen gradient hypothesis?

Summarize how researchers determined that the Bicoid protein was a morphogen and supported the morphogen gradient hypothesis.

In a mature *Drosophilia* egg, where is the *bicoid* mRNA concentrated? What happens when it is translated to the Bicoid protein? See Figure 18.22.

Answer concept check 18.4 question 1 on page 383 in the space below.

Answer concept check 18.4 question 2 on page 383 in the space below.

Answer concept check 18.4 question 4 on page 383 in the space below.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 21
Chapter 27, pages 567 – 572, 575 – 576, 582 – 584

NOTE: The pages for this reading assignment are NOT in your custom Bio 93 textbook. These pages are only available via the eText accessed through Mastering Biology.

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Are most prokaryotes unicellular or multicellular?

What are the three common shapes of prokaryotes? See Figure 27.2.

What is the function of the cell wall in prokaryotes?

Describe the differences in Gram-positive and Gram-negative bacteria, especially with respect to the peptidoglycan content in their cell walls. See Figure 27.3 for a visual of the differences.

How does Gram staining help inform medical treatment options?

Explain how capsules and endospores can help protect bacteria.

Explain how bacteria use fimbriae to stick to substrates or to one another. See Figure 27.6.

Describe the structure and function of flagella and explain how they can help bacteria perform taxis.

How is the internal organization of prokaryotes different from that of eukaryotes?

How is the genome of a prokaryote different from that of a eukaryote? What is a nucleoid and a plasmid?

How are differences in ribosomes used as antibiotic treatment options?

Explain briefly how bacteria reproduce by binary fission. Go back to pages 240 – 241 and Figure 12.2 for a review.

Skip to page 575 (concept 27.3)

Define the following types of major nutrition modes that bacteria employ. See Table 27.1 for assistance.

Photoautotroph:

Chemoautotroph:

Photoheterotroph:

Chemoheterotroph:

What is the major difference between obligate aerobes, obligate anaerobes, and facultative anaerobes?

Briefly explain what fermentation is and how it is different from cellular respiration. Go back to pages 177 – 179 for a review.

Skip to page 582 (concept 27.6)

How many different species of bacteria are in human intestines?

What is a mutualistic bacteria? Give an example of one living in human intestines.

How do pathogenic bacteria infect their hosts using exotoxins and endotoxins? Give an example of each.

Read and analyze the “scientific skills exercise” on page 584. You will be answering the questions associated with this exercise as part of your pre-class assignment.

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 22
Chapter 49, pages 1086 – 1092, 1097 – 1098

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

Using the text on pages 1086 to 1090 and Figure 49.11, describe the function of each of the following regions of the human brain:

Cerebrum:

Cerebral hemispheres:

Cerebral cortex:

Corpus callosum:

Cerebellum:

Diencephalon:

Thalamus:

Hypothalamus:

Brainstem:

Midbrain:

Pons:

Medulla oblongata:

Reticular formation:

Limbic system:

Amygdala:

Make a simple drawing of the human brain, and label the structures from above on your drawing.

Answer concept check 49.2 questions 1, 2, and 3 on page 1090 in the space below.

What are the functions of each of the following areas of the brain?

Sensory areas:

Association areas:

Motor areas:

Using the text and Figure 49.16, describe the function of each of the following lobes:

Frontal lobe:

Temporal lobe:

Parietal lobe:

Occipital lobe:

How does lateralization affect brain function?

What can happen if the frontal lobe is damaged?

Answer concept check 49.3 question 3 on page 1093 in the space below.

Skip to page 1099 (Alzheimer's disease)

How is Alzheimer's disease characterized?

What are two main features found in the brains of Alzheimer's patients?

How is tau related to neurofibrillary tangles and Alzheimer's disease? (this is the same tau that we talked about in lesson 6 on the cytoskeleton!)

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 23
Chapter 48, pages 1061 – 1071

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

What are neurons?

How do electrical and chemical signals vary in the nervous system?

Describe the structure and function of each of the following parts of a neuron. See Figure 48.2 for a visualization of a neuron.

Cell body:

Dendrite:

Axon:

Synapse:

What are neurotransmitters and where in a neuron do they function?

What are glial cells (glia)? How are they different from neurons?

Describe the role of each of the following types of neurons that are involved in information processing. See Figure 48.5 for a visualization of these types of neurons.

Sensory neuron:

Interneuron:

Motor neuron:

What is the difference between the central nervous system and the peripheral nervous system?

What is the difference between neurons and nerves?

Answer concept check 48.1 question 2 on page 1064 in the space below.

What electrical charge is on the inside of a neuron? On the outside?

What is the membrane potential of a cell? What is the value for the resting potential of a neuron?

What are the concentrations of potassium (K^+), sodium (Na^+), and chlorine (Cl^-) ions inside and outside of mammalian neurons? See Table 48.1 for the values.

How are the sodium and potassium ion concentration gradients maintained in cells by the sodium-potassium pump?

Explain how ion channels contribute to the resting potential.

Which ion contributes the most to generating the resting potential?

Summarize Figure 48.6 and the text on pages 1064 – 1065 (up to "modeling the resting potential") in your own words to see if you understand how the resting potential is formed in neurons.

Summarize Figure 48.7a and the text on page 1065 ("modeling the resting potential") in your own words to explain how the equilibrium potential (E) for potassium is -90 mV (E_K).

Summarize Figure 48.7b and the text on page 1065 to 1066 ("modeling the resting potential") in your own words to explain how the equilibrium potential (E) for sodium is +62 mV (E_{Na}).

Explain how the net flow of potassium and sodium ions lead to a resting potential of -60 to -80 mV.

You do not need to know the Nernst equation or how to use it.

Answer concept check 48.2 question 2 on page 1066 in the space below.

What are voltage-gated ion channels? What triggers them to open and what happens when they open? See Figure 48.9 for a visualization of this process.

What is the difference between hyperpolarization and depolarization? What channels open in each case to elicit each response? See Figure 48.10 for how membrane potential changes.

Complete the “draw it” exercise from Figure 48.10 in the space below.

What are graded potentials?

Explain how depolarization leads to action potentials if a threshold is reached. See Figure 48.10c for a graph of an action potential.

Why do we refer to action potentials as “all-or-none” responses?

Using Figure 48.11 and the text in the section “generation of action potentials,” complete this table to help you summarize the steps of action potential generation.

	Brief summary of events	Range of membrane potential (mV) in this step	Are gated Na channels open or closed?	Are gated K channels open or closed?
1. Resting state				
2. Depolarization				
3. Rising phase				
4. Falling phase				
5. Undershoot				

Explain how the refractory period prevents the generation of action potentials. What causes the refractory period to occur?

How are action potentials propagated along the length of an axon? See Figure 48.12 for help answering this question.

Why do action potentials only move toward the synaptic terminals?

Explain how frequency of action potential generation relates to strength of stimuli or responses.

Explain how myelin sheaths and nodes of Ranvier affect the speed that action potentials travel down an axon.

What is saltatory conduction?

You are now ready to complete the pre-class assignment on Mastering Biology.

Reading guide for lesson 24
Chapter 48, pages 1071 – 1076

Complete this reading guide as you read the textbook pages listed above. You might not have to read every word on every page, rather pay close attention to the questions in this guide and answer them as you work through the textbook. Also pay close attention to the terms that are underlined: these are key terms that you should know the definitions of and be able to apply in new situations.

How do electrical and chemical synapses differ? Which are used more often?

Explain what happens at a chemical synapse in your own words. Be sure to use the terms synaptic cleft, synaptic vesicle, and neurotransmitter. Use the text on pages 1071 to 1072 and Figure 48.16 for help.

Answer the "what if" question for Figure 48.16 in the space below.

What is a ligand-gated ion channel (ionotropic receptors)? Where are they found? How do they contribute to postsynaptic potentials?

What is the difference between an excitatory postsynaptic potential (EPSP) and an inhibitory postsynaptic potential (IPSP)? The movement of what ions contribute to these responses?

Explain how postsynaptic potentials may be "combined" to induce an action potential in the postsynaptic neuron.

What is the difference between temporal summation and spatial summation? Use Figure 48.17 for help.

Explain how IPSPs can counter the effects of EPSPs to prevent depolarization and action potential generation in the postsynaptic neuron. See Figure 48.17d for an example.

How are metabotropic receptors different from ligand-gated ion channels?

Explain two ways for how neurotransmitters are involved in the termination of neuronal signaling. (See Figure 48.18 for help).

Summarize some of the neurotransmitters by completing the following table. Use the text from pages 1074 to 1076 for help.

Neurotransmitter	Type of neurotransmitter	Biological functions / effects
Acetylcholine		
Glutamate		
GABA		
Norepinephrine		
Dopamine		
Serotonin		
Endorphins		
Nitric oxide		

Answer concept check 48.4 questions 1 and 2 on page 1076 in the space below.

Read and analyze the “scientific skills exercise” on page 1076. You will be answering the questions associated with this exercise as part of your pre-class assignment.

You are now ready to complete the pre-class assignment on Mastering Biology.

Supplementary Table S1. Comparison of gender distributions of students included in each multiple linear regression model versus those not included in the model. Statistical comparisons were made using Chi-squared tests.

Exam	Percent males in model	Percent males not in model	*p* value
Exam 1	28.2	36.0	0.24
Exam 2	27.2	37.1	0.13
Exam 3	28.9	33.3	0.50
Final Exam	25.4	35.7	0.11

Supplementary Table S2. Comparison of ethnicity distributions of students included in each multiple linear regression model versus those not included in the model. Statistical comparisons were made using Chi-squared tests. URM – underrepresented minority (African American, Latino@, Native American).

Exam	Percent URM in model	Percent URM not in model	*p* value
Exam 1	42.5	39.8	0.70
Exam 2	40.5	43.9	0.63
Exam 3	40.3	43.7	0.63
Final Exam	39.2	44.1	0.48

Supplementary Table S3. Comparison of total SAT scores of students included in each multiple linear regression model versus those not included in the model. Statistical comparisons were made using paired t-tests.

Exam	Average SAT ± SD in model	Average SAT ± SD not in model	*p* value
Exam 1	1650.3± 201.7	1642.1± 189.0	0.60
Exam 2	1646.0± 196.6	1653.4± 203.1	0.85
Exam 3	1653.7± 199.1	1638.2± 197.2	0.41
Final Exam	1653.7± 195.9	1642.1 ± 201.4	0.30