

Supplemental Material

CBE—Life Sciences Education

Donovan *et al.*

Supplemental Table 1. Summary of fixed effects from **multilevel model** analyses for variables predicting the SAGE factors of students in the Experimental class. **These analyses support hypothesis 2.**

<i>Quality of Product</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value
<i>Fixed variables</i>															
Intercept	3.58	0.04	<0.001	1.66	0.17	<0.001	1.58	0.18	<0.001	1.48	0.19	<0.001	1.32	0.20	<0.001
Pre-score	-	-	-	0.58	0.05	<0.001	0.58	0.05	<0.001	0.58	0.05	<0.001	0.59	0.05	<0.001
<i>Group type (reference: homogenous)</i>															
Heterogenous	-	-	-	-	-	-	0.18	0.07	0.015	0.18	0.07	0.013	0.43	0.14	0.002
<i>Performance on pre-assessment (reference: LPS)</i>															
MPS	-	-	-	-	-	-	-	-	-	0.12	0.08	0.148	0.28	0.12	0.022
HPS	-	-	-	-	-	-	-	-	-	0.07	0.10	0.510	0.30	0.15	0.050
<i>Performance*</i>															
<i>Group type</i>															
MPS * Heterogenous	-	-	-	-	-	-	-	-	-	-	-	-	-0.30	0.17	0.069
HPS * Heterogenous	-	-	-	-	-	-	-	-	-	-	-	-	-0.42	0.20	0.039
AICc	603.351			501.919			498.066			500.116			499.503		

Supplemental Table 1 cont.

<i>Frustration (Satisfaction)</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value
<i>Fixed variables</i>															
Intercept	3.337	0.04	<0.001	2.03	0.18	<0.001	2.01	0.18	<0.001	2.04	0.19	<0.001	1.93	0.21	<0.001
Pre-score	-	-	-	0.45	0.06	<0.001	0.43	0.06	<0.001	0.43	0.06	<0.001	0.44	0.06	<0.001
<i>Group type (reference: homogenous)</i>															
Heterogenous	-	-	-	-	-	-	0.14	0.06	0.024	0.15	0.06	0.020	0.29	0.12	0.020
<i>Performance on pre-assessment (reference: LPS)</i>															
MPS	-	-	-	-	-	-	-	-	-	-0.01	0.07	0.895	0.10	0.11	0.337
HPS	-	-	-	-	-	-	-	-	-	-0.08	0.09	0.400	-0.03	0.13	0.851
<i>Performance*group type</i>															
MPS * Heterogenous	-	-	-	-	-	-	-	-	-	-	-	-	-0.22	0.15	0.140
HPS * Heterogenous	-	-	-	-	-	-	-	-	-	-	-	-	-0.10	0.18	0.565
AICc	488.654			441.514			438.495			441.789			443.750		

Supplemental Table 1 cont.

<i>Peer Support</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value
<i>Fixed variables</i>															
Intercept	3.81	0.04	<0.001	2.56	0.25	<0.001	2.53	0.25	<0.001	2.50	0.25	<0.001	2.50	0.27	<0.001
Pre-score	-	-	-	0.34	0.07	<0.001	0.33	0.07	<0.001	0.33	0.07	<0.001	0.33	0.07	<0.001
<i>Group type (reference: homogenous)</i>															
Heterogenous	-	-	-	-	-	-	0.1	0.08	0.280	0.09	0.08	0.255	0.11	0.15	0.486
<i>Performance on pre-assessment (reference LPS)</i>															
MPS	-	-	-	-	-	-	-	-	-	0.07	0.08	0.420	0.07	0.14	0.610
HPS	-	-	-	-	-	-	-	-	-	-0.03	0.10	0.782	0.01	0.18	0.961
<i>Performance*group type</i>															
MPS*Heterogenous	-	-	-	-	-	-	-	-	-	-	-	-	-0.004	0.17	0.979
HPS*Heterogenous	-	-	-	-	-	-	-	-	-	-	-	-	-0.053	0.21	0.803
AICc	485.659			462.411			463.306			465.995			470.161		

Supplemental Table 1 cont.

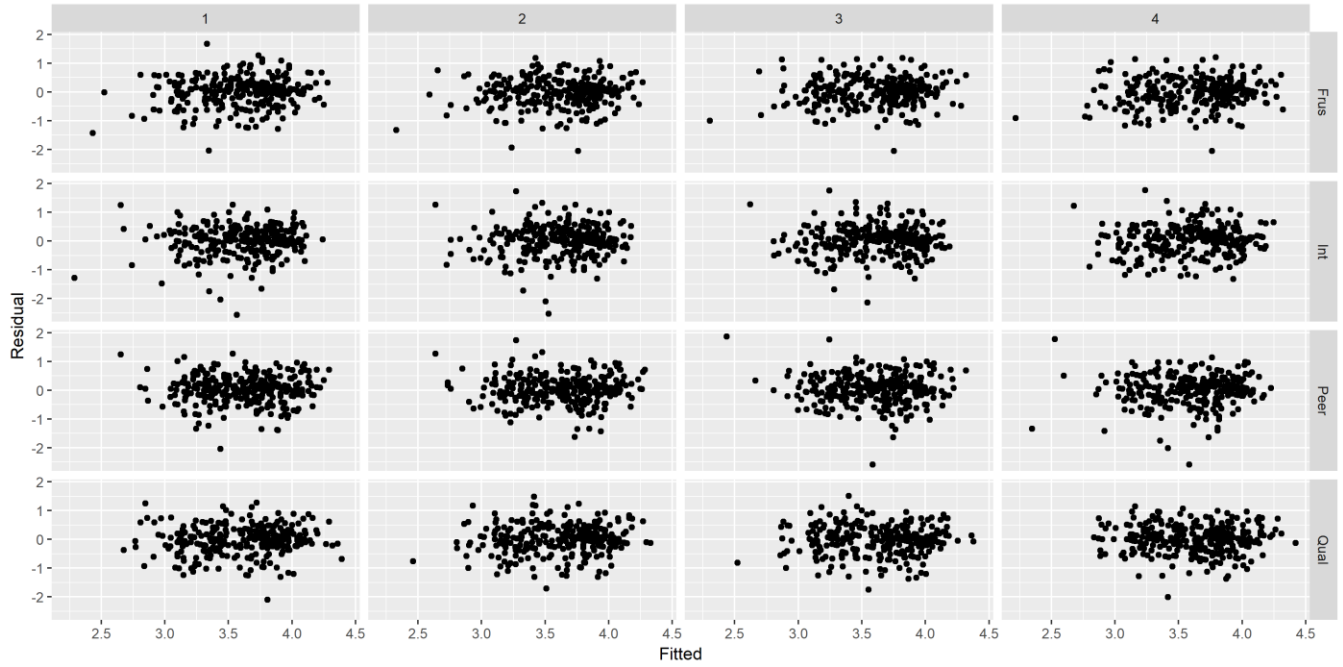
<i>Interdependence</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value
<i>Fixed variables</i>															
Intercept	3.82	0.03	<0.001	2.21	0.28	<0.001	2.18	0.28	<0.001	2.15	0.29	<0.001	2.07	0.31	<0.001
Pre-score	-	-	-	0.42	0.07	<0.001	0.42	0.07	<0.001	0.42	0.07	<0.001	0.43	0.07	<0.001
<i>Group type (reference: homogenous)</i>															
Heterogenous	-	-	-	-	-	-	0.08	0.06	0.157	0.08	0.06	0.171	0.17	0.12	0.154
<i>Performance on pre-assessment (reference LPS)</i>															
MPS	-	-	-	-	-	-	-	-	-	0.01	0.07	0.877	0.07	0.10	0.508
HPS	-	-	-	-	-	-	-	-	-	0.06	0.09	0.484	0.14	0.13	0.286
<i>Performance*group type</i>															
MPS*Heterogenous	-	-	-	-	-	-	-	-	-	-	-	-	-0.11	0.15	0.439
HPS*Heterogenous	-	-	-	-	-	-	-	-	-	-	-	-	-0.13	0.18	0.412
AICc	454.257			425.224			425.291			428.899			432.336		

Supplemental Table 2. The top 10 models of demographic factors that predicted preassessment score, using the dredge function of the MuMIn package for R. We tested all possible models that included our nine demographic factors: GPA, self-rating of proficiency in biology, number of other science classes taken at the college level, years of high school biology, year in university, age, first generation college student, comfort with the English language, and gender. In total, 40 models had $\Delta\text{AICc} \leq 2$, indicating they had the same predictive value. The factors GPA and self rating in biology were included in all models.

Model	AICc
GPA + self rating + HS biology + first generation	2285.5
GPA + self rating + HS biology	2285.6
GPA + self rating + English proficiency	2285.6
GPA + self rating + HS biology + English proficiency	2285.7
GPA + self rating + gender + English proficiency	2285.7
GPA + self rating + HS biology + gender + English proficiency	2285.8
GPA + self rating + English proficiency + first generation	2285.8
GPA + self rating + HS biology + gender	2285.9
GPA + self rating + HS biology + English proficiency + first generation	2286.0
GPA + self rating	2286.1

Supplemental Table 3: $\Delta AICc$ values between the two alternative models for SAGE scores between the Self-formed and Demographic classes. In no instance was the model including class the best fitting model, indicating no different in SAGE scores between students in the Self-formed and the Demographic classes. **This analysis supports hypothesis 5.**

Model number	Variables included	SAGE construct			
		Peer Support	Frustrations with group members	Quality of product and process	Student interdependence
1	Student GPA, SAGE pre-score, Assessment pre-score, group type (heterogenous or homogenous)	-	-	-	-
2	Student GPA, SAGE pre-score, Assessment pre-score, group type (heterogenous or homogenous), Class	0.34	3.07	5.33	6.14



Supplemental Figure 1. Residual plots from four of the five models for each SAGE construct show no evidence of a ceiling effect.

Pre-assessment

Undergraduate Participant Consent Form Group Formation in a Large Enrollment Flipped Classroom

Researchers: Georgianne Connell and Deborah Donovan. Western Washington University

Contact Information: 360-650-6796 or Georgianne.Connell@wwu.edu

360-650-7251 or Deborah.Donovan@wwu.edu

Researchers' statement

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study or not. Please read the form carefully. You may ask questions about the purpose of the research, what we would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions, you can decide if you want to be in the study or not. This process is called 'informed consent.' We will give you a copy of this form for your records.

PURPOSE AND BENEFITS

We would like to obtain information from undergraduates at Western about the effectiveness of different ways of teaching large enrollment courses. If you choose to participate, you will be asked to share with the researchers your responses to a content assessment, a survey on attitudes towards working in groups, and a survey of some demographic information about you. These will be administered prior to the first day of class (attitude and demographic survey) and on the first day of class (content assessment). Course exams will be completed in class. Students who do not give consent will still complete these assignments but their answers will not be used in research. While you may not benefit directly, we hope that the results of this research project will help science faculty to develop and improve teaching and curricula to help students better understand science.

PROCEDURES

If you choose to participate in the research, **the researchers will use your responses to a pre-course assessment of your understandings of biology, your scores on individual and group exams, a pre- and post-instruction survey about group performance, as well as a brief survey to gather student demographic data, to investigate the effectiveness of active-learning strategies in Biol 101.** These assignments will be completed as part of the course, but if you do not want to participate in the research your scores will not be used in the project. Together, the pre-assessment and attitude/demographic surveys will take about an hour to complete. Course exams will be done in class. The act of signing this form means you are willing to participate in the research, not that you are obliged to participate. You will always be given reasonable notice and have the option of refusing participation at any time.

RISKS, STRESSES, OR DISCOMFORT

You may feel uneasy being asked about your understanding of biology and/or science in general.

OTHER INFORMATION

Taking part in these activities is voluntary. Whether or not you choose to participate in this study will not affect your grade or standing in any course or program. If you do not want to participate, your pre-assessment score and student survey will not be included in analyses. You can decide at any time to stop participating in this study. **Information about you is confidential.** We will code research records. The link between the code and your name will be kept in a secured location, separate from the research information. Only the research team will have access to that information. We will keep the link between the records and your name until September 2025 and then we will destroy the link. If we publish any results from this research, we will not use your name.

<u>Georgianne Connell</u> Printed name of researcher	_____ Signature of researcher	<u>1-6-15</u> Date
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<u>Deborah Donovan</u> Printed name of researcher	_____ Signature of researcher	<u>1-6-15</u> Date
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Subject's statement

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have any questions, I can contact the researchers using the contact information at the top of this form. If I have questions regarding my rights as a research participant, I can call Janai Symons, Human Protections Administrator (HPA), (360) 650-3082, Janai.Symons@wwu.edu. I will receive a copy of this consent form. I am at least 18 years of age.

_____ Printed name of subject.	_____ Signature of subject	_____ Date
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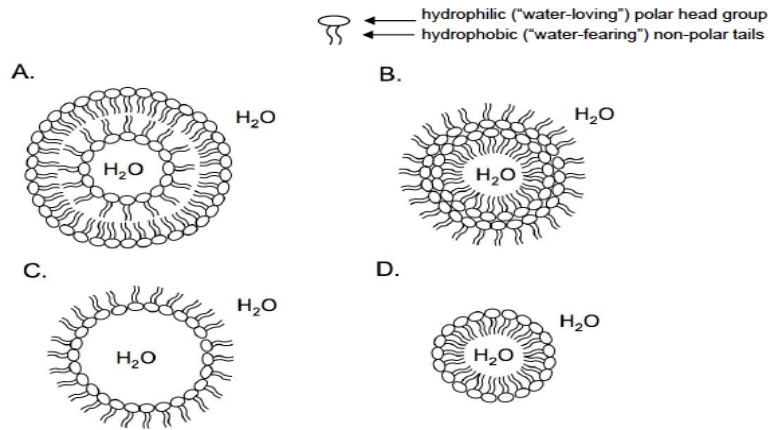
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Pre-Assessment. This assessment is worth 5 participation points (scored based on completion not correct/incorrect answers) and will be used to gauge where the class is on various biological topics. Please answer each question to the best of your ability. Make a best guess when you do not know the answer. You may write on this assessment.

1. All cell membranes:
 - a. allow free movement of materials into or out of the cell.
 - b. allow some substances to enter the cell, but prevent all substances from leaving.
 - c. allow only beneficial materials to enter the cell.

d. allow some substances to pass through, but not others.

2. A phospholipid molecule is diagrammed at the right, and the four diagrams A-D below represent cross sections of spherical structures composed of phospholipids. Which of these structures is most likely to form when phospholipids are vigorously dispersed in water?



3. Hydrogen occur

- an a the same water molecule
- an oxygen atom and a hydrogen atom in two different water molecules
- two hydrogen atoms in the same water molecule
- two hydrogen atoms in two different water molecules


bonds in water between oxygen atom and hydrogen atom in

4. Choose the option that best describes the movement of water across a cell membrane when a cell is at equilibrium.

- for every water molecule that enters a cell, another water molecule leaves.
- water molecules move around outside and inside the cell but do not move across the membrane.
- water molecules move into the cell but not out.
- water molecules move out of the cell but not in.

5. A woman collapses as she finishes the Boston marathon. She ingested lots of water during the race but very little salt. Which statement best explains why she collapsed at the end of the race? *Blood serum is the fluid in the blood vessels.*

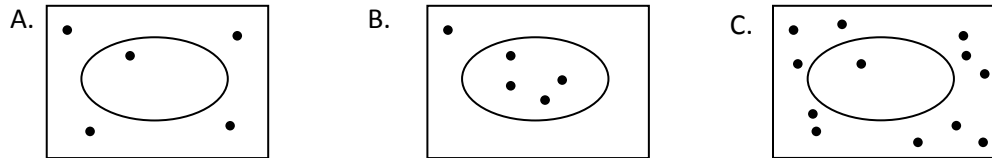
- Her cells are hypotonic and the blood serum is hypertonic. Solutes are moving into her cells, causing them to burst.
- Her cells are hypertonic and the blood serum hypotonic. Water is moving into her cells, causing them to burst.
- Her cells are isotonic and the blood serum is hypotonic. Water is moving into her cells, causing them to burst.
- Her cells are hypotonic and the blood serum is hypertonic. Water is moving out of her cells, causing them to shrivel.
- Her cells are hypertonic and the blood serum hypotonic. The solute is moving into her cells, causing them to shrivel.

6. Water on the  is _____ due to a partial _____ charge on the oxygen atom and partial _____ charges on the H atoms.

- Polar...positive...negative
- Nonpolar...positive...negative
- Polar...negative...positive

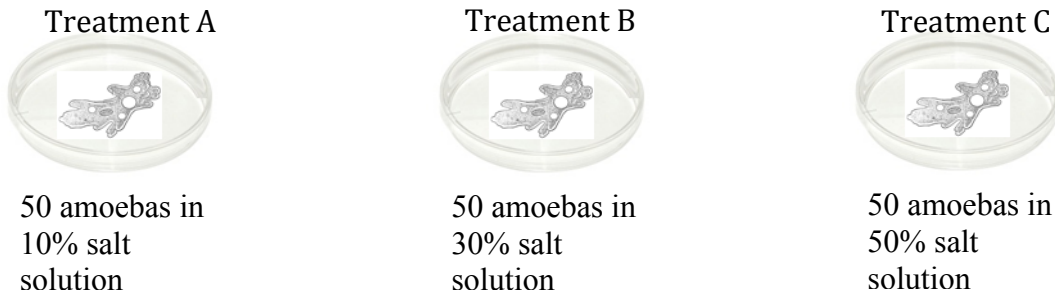
d. Nonpolar...negative...positive

7. A man collapses during an adventure race. He hasn't had water to drink in 24 hours and has been doing intense exercise. Which drawing accurately reflects the concentration gradient between the blood serum and his cells?



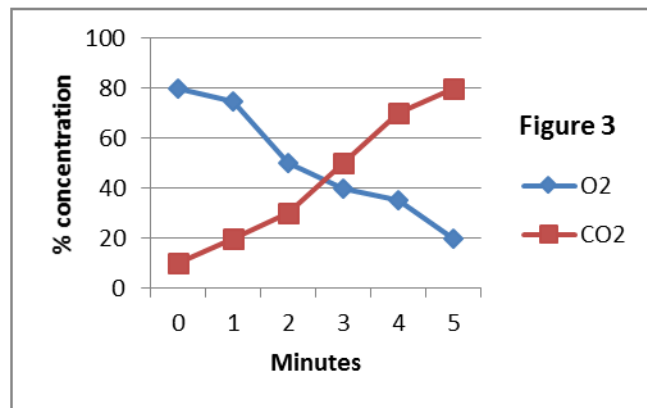
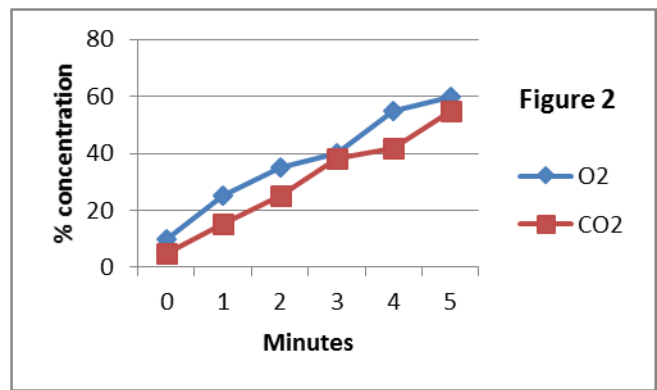
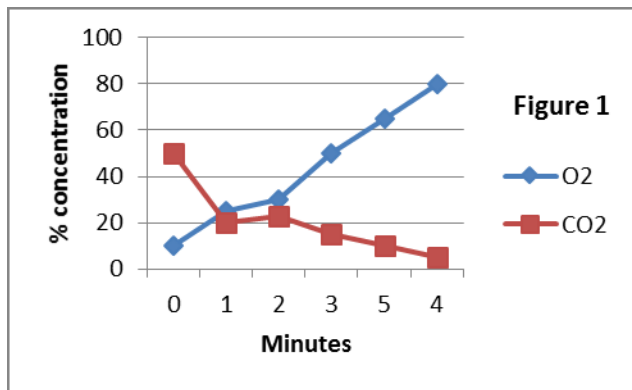
8. A simple carbohydrates (e.g. glucose) needs to be brought into a muscle cell. Assuming the gradient is favorable, how will the molecule move in?
- Simple diffusion, because carbohydrates are small and nonpolar.
 - Active transport, because the cell spends energy to move large molecules.
 - Facilitated diffusion, because carbohydrates are polar.
 - Simple diffusion, because carbohydrates are small and polar.
 - Facilitated diffusion, because carbohydrates are nonpolar.

An experiment is conducted to look at the effects of salt solution on amoebas (a single-celled organism). All of the amoebas contain roughly 25% salt.



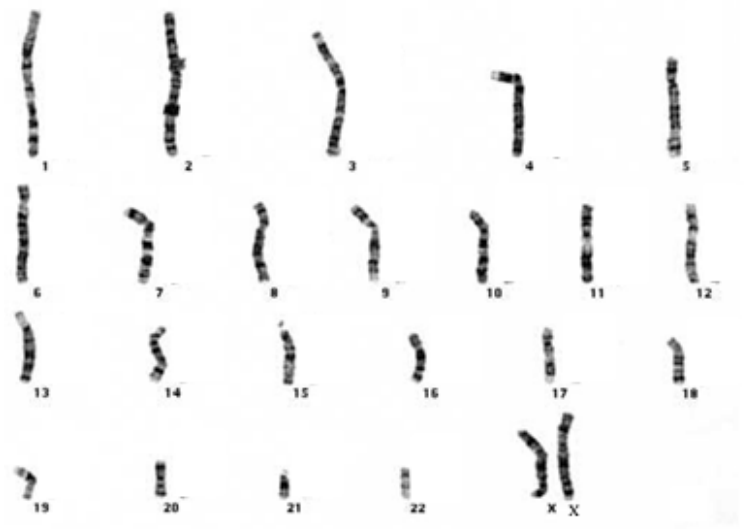
9. Water will move _____.
- Into the amoebas in treatments A, B, and C.
 - Out of the amoebas in treatments A, B, and C.
 - Into amoebas in treatment A and out of amoebas in treatments B or C.
 - Into amoebas in treatment C and out of amoebas in treatments A or B.
 - Into amoebas in treatment B and out of amoebas in treatments A or C.
10. In the amoeba experiment above, lowering the salt concentration from 10% to 3% in **treatment A** would
- Decrease the rate of diffusion of water molecules.
 - Switch the concentration gradient between the solution and the amoeba cells.
 - Raise the salt concentration in the amoebas.
 - Increase the rate of diffusion of water molecules.
11. A mature maple tree can have a mass of 1 ton or more (dry biomass, after removing the water), yet it starts from a seed that weighs less than 1 gram. Which of the following processes contributes the most to this huge increase in biomass?
- absorption of mineral substances from the soil via the roots

- b. absorption of organic substances from the soil via the roots
 - c. incorporation of CO₂ gas from the atmosphere into molecules by green leaves
 - d. incorporation of H₂O from the soil into molecules by green leaves
 - e. absorption of solar radiation into the leaf
12. You have a friend who lost 15 pounds of fat on a diet. Where did the mass go?
- a. The mass was released as CO₂ and H₂O.
 - b. The mass was converted to energy and used up.
 - c. The mass was converted to ATP molecules.
 - d. The mass was broken down to amino acids and eliminated from the body.
 - e. The mass was converted to urine and feces and eliminated from the body.
13. You eat a grape high in glucose content. How could a glucose molecule from the grape provide energy to move your little finger?
- a. The glucose is digested into simpler molecules having more energy.
 - b. The glucose molecule itself reacts and gets transformed into ATP.
 - c. The glucose is turned into energy.
 - d. The energy of the glucose is transferred to ATP.
 - e. The energy of the glucose is transferred to CO₂ and H₂O.
14. You eat a grape high in glucose content. Some of the energy in those glucose molecules will be unusable by your cells. What form does this unusable energy take?
- a. Chemical energy (ATP)
 - b. Light energy
 - c. Kinetic energy
 - d. Thermal energy (heat)
15. Which of the following best describes how a plant cell gets the energy it needs for cellular processes?
- a. The chloroplasts provide all the ATP needed by the plants.
 - b. ATP is transported to cells that lack chloroplasts (roots, stems, etc.).
 - c. In the light, the ATP comes from the chloroplasts, in the dark, from mitochondria.
 - d. Most ATP comes from digestion of organic matter absorbed by roots, some comes from chloroplasts.
 - e. The sugars made by photosynthesis can be used by respiration to make ATP.
16. If green algae cells in a water-based buffer solution containing only inorganic salts are placed in a sealed container at room temperature with excess carbon dioxide gas and exposed to light, the cells will:
- a. live for many hours and multiply.
 - b. live for several hours, but fail to multiply because there is no source of carbon in the buffer solution.
 - c. live for several hours, but fail to multiply because no oxygen is present.
 - d. die rapidly, because no oxygen is present.
17. Review the figures depicting gas concentrations within a cell to determine which statement is true.
- a. Figure 1 accurately represents gas concentrations during photosynthesis.
 - b. Figure 2 accurately represents gas concentrations during cellular respiration.
 - c. Figure 3 accurately represents gas concentrations during photosynthesis.

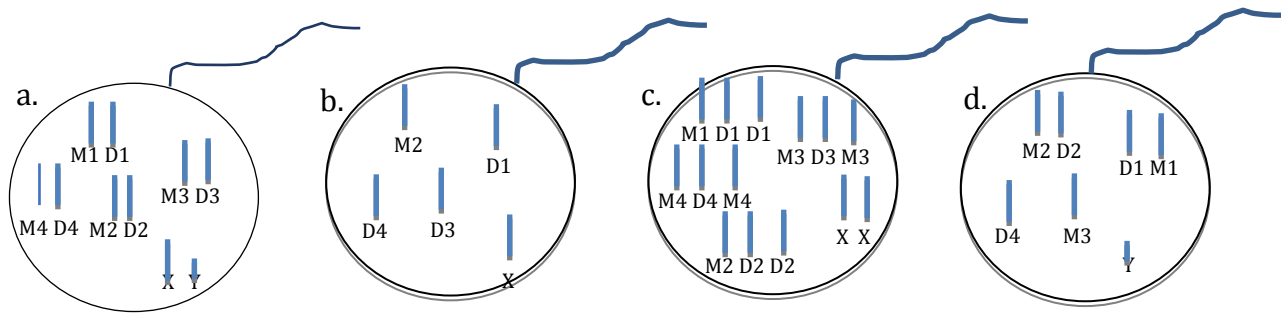


18. How would a total loss of functioning in the mitochondria affect a plant cell?
- There would be an excess of water molecules being produced.
 - There would be a lack of ATP being produced.
 - There would be a lack of Oxygen production.
 - There would be an excess of CO₂ being produced.
 - There would be an excess of ATP molecules being produced.
19. A loss of functioning of the stomata in a plant cell would lead to a lack of these photosynthetic **reactants** _____.
- CO₂ and water
 - CO₂ and ATP
 - ATP and NADPH
 - CO₂ and O₂
 - light and ATP
20. In which way are plants and animals **different** in how they **use** energy?
- Plants use energy to build molecules; animals cannot.
 - Animals use energy to break down molecules; plants cannot.
 - Animals use energy to move; plants cannot.
 - Plants use energy directly, animals must transform it.

21. Here is a karyotype of a human skin cell in G_0 phase. The karyotype _____.
- Should have fewer autosomes.
 - Shouldn't have sex chromosomes.
 - Should have a Y chromosome.
 - Should have a second set of autosomes.



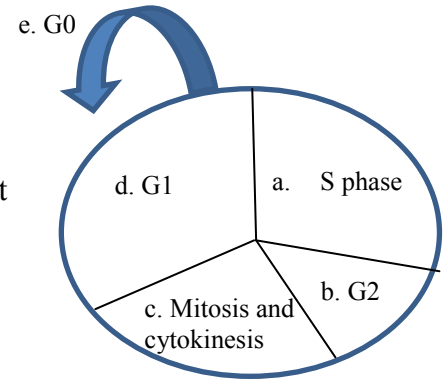
22. Answers **a** through **d** represent sperm cells (just focusing on chromosomes 1-4 and the sex chromosomes). Which is an accurate representation of a **sperm cell**?



23. If dandelions have 16 total chromosomes, how many chromosomes are packaged into egg or pollen (the plant's gametic cells)?
- 32
 - 25
 - 16
 - 8
24. If dandelions have 16 total chromosomes, how many chromosomes are packaged into an individual leaf cell?
- 32
 - 25
 - 16
 - 8

Use the cell cycle figure to answer the next two questions.

25. In which stage of the cell cycle will a skin stem cell enter into (or stay in) if proto-oncogenes are on and tumor suppressors are off?
26. In which phase of the cell cycle do cancer cells spend the least amount of time?
27. All of the following can lead to cancer except:
- Viruses
 - Mutated proto-oncogenes
 - Nondisjunction
 - Mutated tumor suppressors
28. Which statement is true?
- Chromosomes are made up of nucleotides and proteins.
 - Chromatin is the condensed form of a chromosome.
 - DNA is composed of chromosomes.
 - DNA is composed of phospholipids.
29. Meiosis ____ while mitosis ____.
- Reduces chromosome number by $\frac{1}{2}$... maintains chromosome number.
 - Produces identical daughter cells ... produces genetically varied daughter cells.
 - Occurs in G1 phase of the cell cycle ... occurs in G2 phase of the cell cycle.
 - Produces body cells ... produces sex cells.
30. Monosomy and trisomy are most viable (pregnancy proceeds to term) on ____.
- Sex chromosomes
 - Autosomes
 - The largest chromosomes
 - The smallest chromosomes
 - Both A and D are correct.



31. **Epistasis.** Human skin color follows polygenic inheritance (A, B, and C genes) but albinism (lack of pigment) follows epistasis genetics and is autosomal recessive (D gene).

Julie has the following genotypes that affect her skin color: Her genotype for skin pigmentation is: AaBBcc and her genotype for producing pigment is: dd.

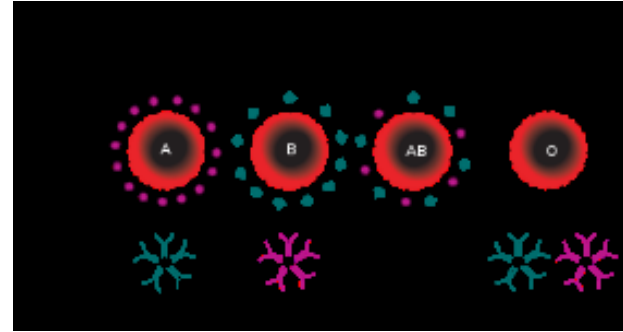
Which statement is true regarding Julie's phenotype?

- Julie has intermediate skin color.
- Julie has dark skin color.
- Julie has light skin color.
- Julie is albino.

32. Refer to the question and answer options above. Which answer option would you have chosen if Julie's genotype for producing pigment was Dd?

33. What type of blood plasma can you receive if you have type AB blood?

- AB or O
- O only
- AB or B
- AB only
- AB, A, or B



34. How might a mutation create a new, beneficial function?

- If the mutation altered the gene product's activity.
- It could not; all naturally occurring mutations are harmful.
- If the mutation activated a gene that was harmful.
- If the mutation had no effect on the activity of the gene product.

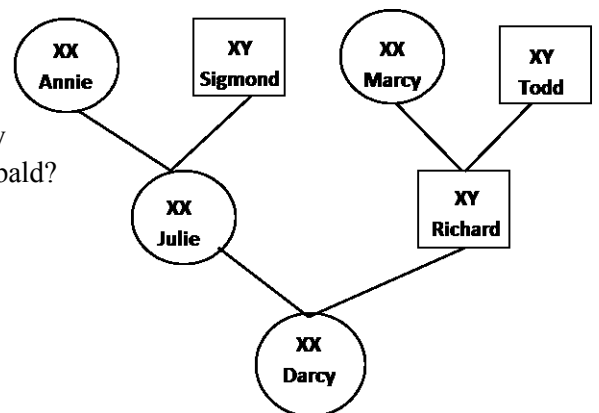
35. There are people in Susan's family who have had Polycystic Kidney Disease (PKD). PKD is a single-gene disease in which clusters of fluid-filled sacs (cysts) form in the kidneys, often leading to kidney failure by the age of 10 and a reduced lifespan. Below is a list of facts that she has gathered from researching 5 generations of her family. Help her to draw the correct conclusion based on these facts.

- There is an equal probability of PKD affecting men and women.
- Symptoms seem to "disappear" in some generations.
- Her mother had genetic testing done and one gene showed PKD but she doesn't have any symptoms.

- PKD is a sex linked disease
- PKD is a recessive disease.
- PKD is due to a single random mutation that is not heritable.
- PKD is a polygenic; the more genes that are mutated, the sicker the individual is.

36. Darcy has noticed that her mom is showing signs of male pattern baldness (heritable, sex-linked on the X chromosome, recessive condition) and she is getting worried that she may have it to. What are the odds that Darcy will have male pattern baldness if her father Richard wasn't bald?

- 0%
- 25%
- 50%
- 100%



37. Which molecule is **not** directly involved in translation?
- DNA
 - mRNA
 - tRNA
 - rRNA
38. Individuals who have sickle cell disease (autosomal recessive disease) make red blood cells that are misshaped. Having two alleles with the sickle cell mutation results in errors to
- Polypeptide chain folding
 - RNA sequence
 - Golgi apparatus functioning
 - The sequence of amino acids in the polypeptide chain
 - All of the above
39. Here is a section of genetic code for a healthy tumor suppressor gene.
First, determine if this code is DNA or mRNA.
Then, use the mRNA table to determine the healthy polypeptide sequence.

- UGU – CGA – CAC –

AGU -

- Thre – Pre – Glu – Thre
- Cys – Arg – Hist – Ser
- Cys – Ser – Gly – Asp
- Thre – Ala – Val – Ser

		Second letter of codon					
		U	C	A	G		
First letter of codon	U	UUU UUC	UCU UCC UCA UCG	UAU UAC	UGU UGC	U C	
		UUA UUG		UAA UAG		UGA UGG	A G
		CUU CUC CUA CUG		CCU CCC CCA CCG		CAU CAC CAA CAG	CGU CGC CGA CGG
	A	AUU AUC AUA	ACU ACC ACA ACG	AAU AAC	AGU AGC	U C	
AUG		AAA AAG		AGA AGG		A G	
G	GUU GUC GUA GUG	GCU GCC GCA GCG	GAU GAC	GGU GGC GGA GGG	U C		
			GAA GAG		Glycine	A G	

Figure 13.5 Discover Biology 4/e
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40. This is what the **mutated** tumor suppressor gene looks like: - ACA – TCT – GTG – TCT-. Use the information in the question above to determine where the mutation(s) occurred. Note that one of the mutations was accommodated by amino acid redundancy. In which location of the code did the redundancy occur?

- ACA – TCT – GTG – TCT -

-
-
-
-

41. Many infectious diseases are becoming difficult to treat because of bacterial resistance to antibiotics. Populations of bacteria can become resistant when they are exposed to an antibiotic. What is the best general explanation for how this occurs?
- Over time, the antibiotic triggers the bacteria's immune system to destroy the antibiotic.
 - The antibiotic activates enzymes in bacteria that can destroy the antibiotic.
 - The antibiotic increases the bacterial mutation rate, so that resistant mutant bacteria are more likely to arise.
 - The antibiotic kills all the bacteria that did not have antibiotic-resistant mutations. Resistant bacteria survive and reproduce.

The allele for lactose tolerance has been tracked in a community (population A) for 5 generations. Review the table that shows the number of each allele in the population.

Table 1. Change in the lactose tolerance allele over 5 generations in population A.

# of Generations Tracked	T allele (tolerance)	t allele (intolerance)	Population Total
1	2	98	50
2	7	103	55
3	25	100	65
4	60	100	80
5	101	79	90

42. Which is likely to be true about the culture that this population lives in?
- Dairy is not an important source of food.
 - The community relies on dairy as a source of nutrition.
 - Dairy is important in some generations but not in others.
 - The community will discourage the consumption of dairy due to a lack of tolerant individuals.
43. Which force of evolution is behind the **change in allele frequencies** that you see from the data for generations 1 to 5?

- a. Genetic drift
- b. Gene flow
- c. Mutation
- d. Natural selection – disruptive selection
- e. Natural selection – directional selection

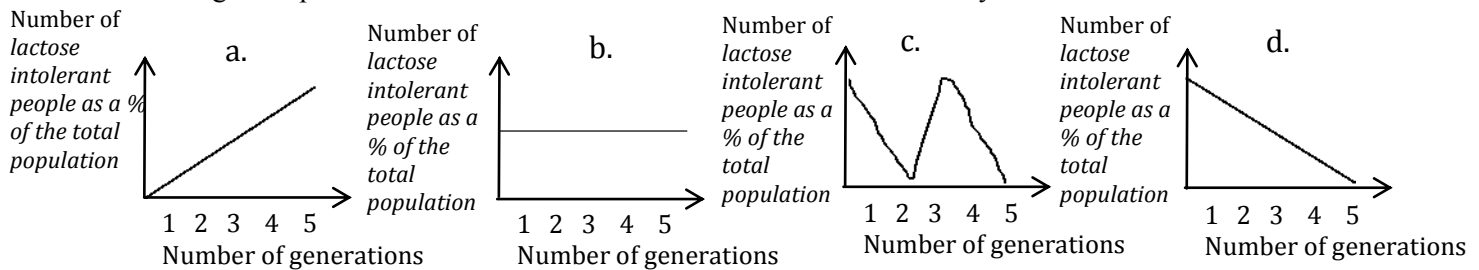
44. The allele for lactose tolerance was initially introduced to the community (population A) through gene flow with a neighboring village (population B). Gene flow _____ genetic diversity *within* population A and made community A's genetics _____ to the genetics of community B.

- a. Increased ... less similar
- b. Decreased ... less similar
- c. Increased ... more similar
- d. Decreased ... more similar

45. A subset of community A migrates to a new, isolated area. The force of evolution that describes this is _____ and it leads to an immediate _____ of alleles within community A.

- a. Gene flow ... increase
- b. Genetic drift ... loss
- c. Natural selection ... increase
- d. Genetic drift ... increase
- e. Gene flow ... loss

46. Which figure depicts the overall trend in lactose intolerance for community A?



47. Which generation was closest to allele fixation for the lactose intolerance allele?

- a. Generation 1
- b. Generation 2
- c. Generation 3
- d. Generation 4
- e. Generation 5

48. Which is the selection pressure for the dominant (T) allele?

- a. Additional nutrition if you have the dominant (T) allele.
- b. Lack of nutrition if you have the dominant (T) allele.

- c. Side effects such as cramping if you have the dominant (T) allele.
- d. Sexual selection of the dominant (T) allele.

49. Which statement is **false** about the lactose tolerance allele?

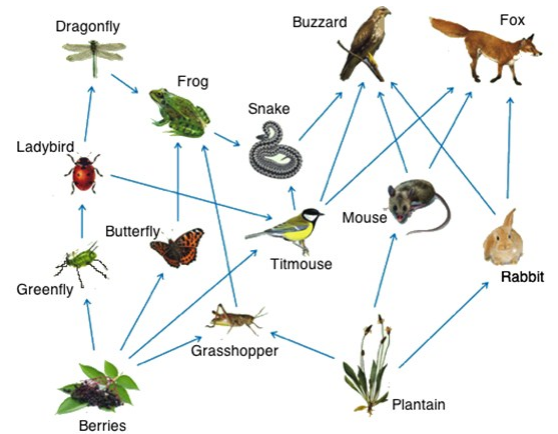
- a. The allele was amplified within the community because it was adaptive.
- b. The lactose tolerance allele was introduced to the human population by a mutation.
- c. The allele for lactose tolerance was created by an individual so that he/she could drink milk.
- d. Having the dominant allele means that you will be able to eat dairy without negative side effects.

50. Genetic drift can occur from all of the following except:

- a. Meiotic processes such as independent assortment
- b. Natural disaster
- c. Migration
- d. Mutation

51. Which species from this list would have the highest amount of biomass represented in this food web?

- a. Plantain
- b. Grasshoppers
- c. Rabbits
- d. Buzzards



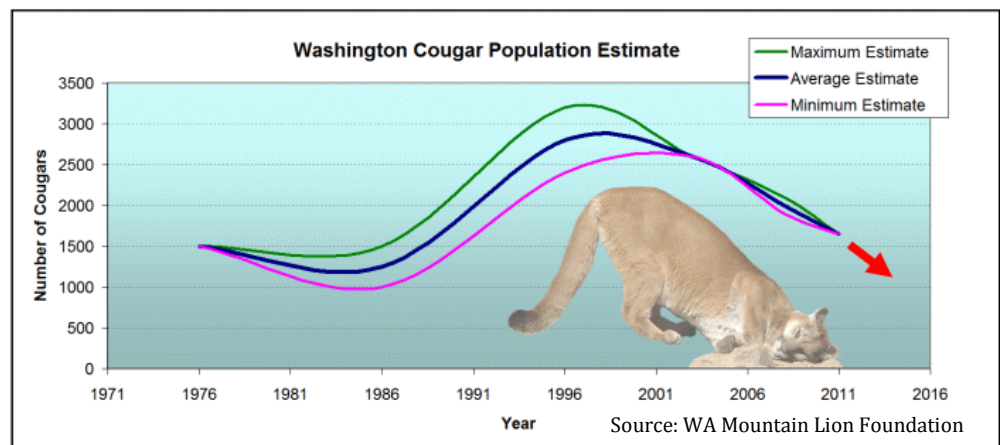
52. What immediate effect would a decrease in foxes have on this food web?

- a. Buzzard populations would decrease.
- b. Plantain populations would decrease.
- c. Rabbit populations would decrease.
- d. Greenfly populations would increase.

53. Why are food webs limited to only 4 (or 5) trophic levels at most?

- a. There isn't enough diversity on Earth to accommodate more levels.
- b. Most species only feed on one prey item.
- c. Energy is lost as heat at each trophic level.
- d. Competition prohibits additional levels.

This figure depicts cougar populations in Washington State.



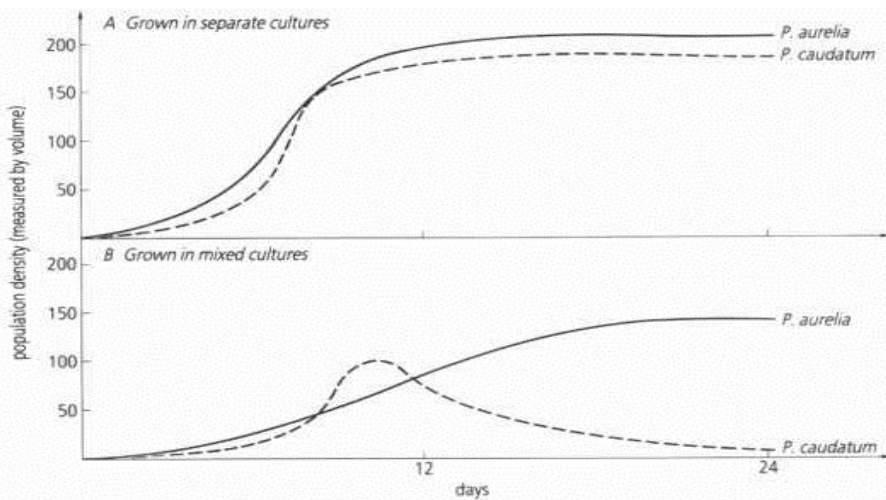
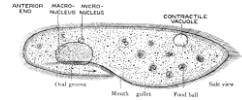
54. Consider the number of cougars estimated in a given year. How many deer would need to be present to support that many cougars?

- a. 10-100 deer
- b. 1000 deer
- c. 10,000 – 100,000 deer
- d. 500,000 deer
- e. Millions of deer

55. Which of the following statements about inbreeding is **false**?

- a. Inbreeding lowers genetic diversity in a population.
- b. Inbreeding works in opposition to natural selection.
- c. Inbreeding usually occurs in small populations.
- d. Inbreeding creates mutations.

56. Consider the figure below depicting two species of paramecium grown in separate flasks (A) and together in the same flask (B). These two species do not consume one



- a. Competition occurred without niche partitioning
- b. Competition occurred with niche partitioning
- c. *P. caudatum* had adaptations that allowed it to survive in culture with *P. Aurelia*.
- d. *P. aurelia* and *P. caudatum* engaged in a successful mutualism

(B) indicate that:

Use the nutrient pools figure below to answer the next 2 questions.

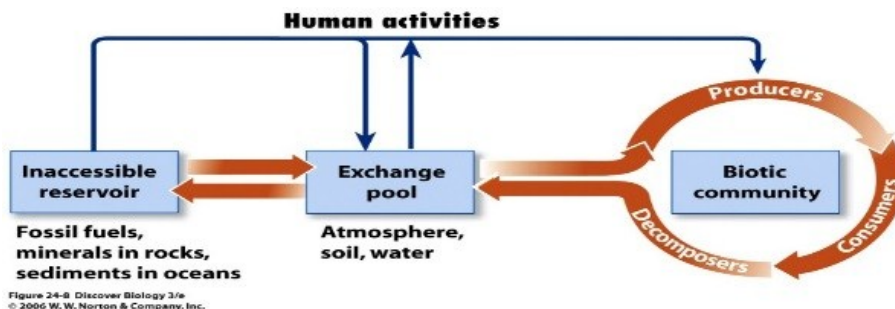
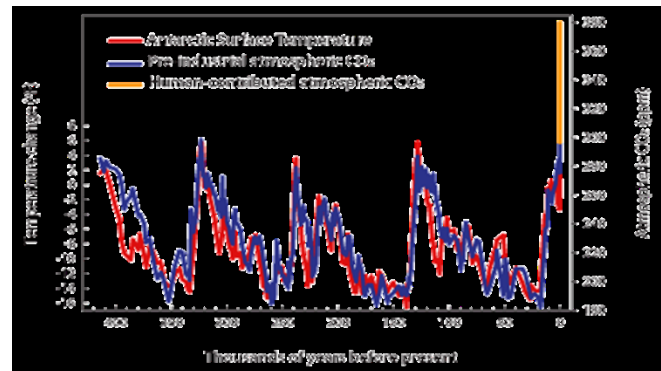


Figure 24-8 Discover Biology 3/e © 2006 W. W. Norton & Company, Inc.

57. Reduction of meat in the human diet decreases the movement of CO₂ _____.
- From the biotic community to the exchange pool.
 - From the inaccessible reservoir to the exchange pool.
 - From the exchange pool to the biotic community.
 - From the biotic community to the inaccessible reservoir.
58. Human induced eutrophication increases the movement of nitrogen and phosphorus into the _____.
- Inaccessible reservoir
 - Exchange pool
 - Biotic community
 - Inaccessible reservoir *and* exchange pool
 - Exchange pool *and* biotic community
59. The figure of the Antarctic ice core sample dating back 400 thousand years ago showed all of these conclusions except _____

See figure in color on the screen

- CO₂ levels and temperature are tightly correlated.
- Today's temperatures are the highest in the past 400,000 years.
- Temperature fluctuates between warm and cool periods approximately every 100,000 years.
- Today's temperatures should be decreasing since we are at the end of an interglacial phase.



60. In eutrophication, what is directly responsible for lowering O₂ levels?
- Nitrogen
 - Phosphorus
 - Phytoplankton
 - Zooplankton
 - Bacteria
61. I answered each question to the best of my ability (best guesses are okay!).
- Yes, all of them.
 - Yes, most of them.
 - No, I do not see the value in answering these questions prior to a class.