

# BIOLOGY 1002B

## TERM TEST

February 8, 2014 Time: 2 Hours

Student number

Room  Row

Print Name \_\_\_\_\_

### INSTRUCTIONS - FOLLOW THE CHECK LIST!

(√)	On your Scantron sheet		Fill the bubbles completely <ul style="list-style-type: none"> <li>• Use <b>HB pencil only</b></li> <li>• No stray marks or doodles</li> <li>• Make all erasures complete</li> </ul> Yes - Calculators are permitted (non-programmable only)  No – Borrowing is not allowed
	Print name	Print clearly	
	Signature	Do your best	
	Instructor	Maxwell	
	Course	Bio 1002B	
	Student number	Print clearly/ Bubble neatly	
	Exam Code	<b>111 – Very important</b>	
	Section	Leave it blank	
	Answer Sheet	Leave it blank	

(√)	On your Test Book		Scantron answers will be emailed to you. Marks will be posted to OWL after all tests are finished.
	Student number	Legibly please	
	Name	Print your name	
	Test Room	The room you're in right now	
	Row number	We will tell you this	
	Indicate your answers in the test book. Leave no questions blank.		

- 1) Please place your **ID** prominently on your desk and sign the attendance sheet when it comes to you.
- 2) There are **12 pages** in this test. Check your paper carefully.
- 3) There is only one fully correct answer for each question. Part marks may be awarded. **Answer all questions.** We do not subtract wrong from right.
- 4) **Indicate your answers in both** the test paper **and** on the Scantron.
- 5) It is your responsibility to transfer all answers from the test book to the Scantron sheet **within the 2 hour test period.**
- 6) When finished, **please stay seated** and raise your hand. We will collect both your test book and Scantron sheet.

<b>Warning</b>	The Scantron marking program has a cheating analysis feature that compares answer patterns for all papers. It alerts us to similarities. We then check seating arrangements. Do not sit near your study partners or write the same test codes. Keep your work directly in front of you. Please help us avoid any and all misunderstandings during these tests
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**Clarifications:** Please defend your arguments **on this page only**. Comments will not be accepted after the test.

Q #	Ans	Clarification	Alt Ans
40	D	<i>If you mean Denis has a <u>dog</u> named Watson, then my answer changes to</i>	B



Circle the best single letter choice for each of the following questions before transferring your answers to your computer sheet.

Note: Questions may have 3, 4 or 5 choices.

1. Its particular evolutionary relationship with other organisms is one reason that *Chlamydomonas* is such a useful experimental organism.

Which of the following descriptions of *Chlamydomonas* evolutionary relationships is correct?

- A. *Chlamydomonas* is only distantly related to any multicellular organism.  
 B. *Chlamydomonas* is more closely related to plants than to animals.  
 C. *Chlamydomonas* is single-celled; therefore it is closely related to Bacteria.  
 D. *Chlamydomonas* diverged from the lineage leading to fungi about 6 billion years ago.

2. The table below shows comparative genomic data for three organisms (Mb = million base pairs).

	<i>E. coli</i>	<i>Chlamydomonas</i>	Human
Genome size	4 Mb	120 Mb	3,000 Mb
Protein coding genes	4,000	15,000	20,000

Assuming that the coding region of a typical gene is roughly the same length in all organisms, which of the following genomes has the lowest proportion of non-coding DNA?

- A. *E. coli*  
 B. *Chlamydomonas*  
 C. Human

3. To make things easier, scientists tend to use only one of the two different mating types of *Chlamydomonas* when doing most experiments in the laboratory.

Which of the following topics could **NOT** be studied using this approach?

- A. DNA replication  
 B. Heterozygote advantage  
 C. Chromosome segregation during mitosis  
 D. Phenotypic consequences of mutated genes

4. Pigments used to harvest light are not freely floating in the cytoplasm; they are bound to proteins.

With respect to light being used as an energy source, which of the following is a consequence of having pigments bound in such pigment-protein complexes?

- A. Efficient energy transfer from one pigment molecule to another.  
 B. Increased ability of light absorption to be used for heat generation.  
 C. Increased number of possible conjugated arrangements of the pigment.  
 D. A change in shape of the protein upon light absorption by the pigment.

Option D only applies to phototransduction, not to energy being used as an energy source...but could have been emphasized better in lecture...so give 0.5 for D.

5. The *car1* mutation of *Chlamydomonas* results in cells unable to synthesize the particular component of the eyespot that contains carotenoid.

Which of the following characteristics is likely shown by *car1* mutant cells?

- A. They are unable to move.
  - B. They are unable to perceive blue light.
  - C. They are unable to determine the direction of a light source.
  - D. They are unable to cause depolarization of the plasma membrane.
- 

6. Bioluminescence is widespread in nature among insects, fungi and bacteria. A recent report has shown that biofluorescence is also common, especially in fish.

With respect to their ability to emit light, how are biofluorescent fish different than bioluminescent fish?

- A. Biofluorescent fish don't need a pigment; bioluminescent fish do.
  - B. Biofluorescent fish need to consume ATP; bioluminescent fish do not.
  - C. Biofluorescent fish have to be exposed to light; bioluminescent fish do not.
  - D. Biofluorescent fish require electrons in an excited state; bioluminescent fish do not.
- 

7. Phototransduction in the human eye and in *Chlamydomonas* may be homologous processes.

Which of the following characteristics of phototransduction are found in both humans and *Chlamydomonas*?

- 1. A component is a seven-membrane-spanning-domain protein that binds a pigment.
- 2. It is triggered by photoisomerization of retinal.
- 3. It results in a change in electrical potential across the plasma membrane.
- 4. It involves the protein opsin, which serves as an ion channel.

A. 1,2 and 3



B. 1 and 3

C. 2 and 4

D. 4 only

E. All of 1,2,3 and 4 are correct

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8. Methionine synthase is an enzyme that requires vitamin B<sub>12</sub> as a cofactor. Even though this enzyme is essential, humans have to obtain vitamin B<sub>12</sub> from their diet.

Why do you suppose that can't we synthesize vitamin B<sub>12</sub> ourselves?

A. Humans lack a key enzyme required for vitamin B<sub>12</sub> synthesis.

B. Humans lack the gene that codes for vitamin B<sub>12</sub>.

C. Vitamin B<sub>12</sub> contains an amino acid that humans cannot synthesize.

D. Vitamin B<sub>12</sub> requires post-translational processing that humans cannot do.

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9. Which of the following statements about protein folding is correct?
1. Urea can prevent a protein from folding into the correct tertiary structure.
  2. Hydrogen bonding is involved in the formation of the tertiary structure but not the secondary structure.
  3. The native conformation of a protein is the conformation with the lowest energy.
  4. ATP is needed for most proteins to fold correctly.

- A. 1,2 and 3  
 B. 1 and 3  
 C. 2 and 4  
 D. 4 only  
 E. All of 1,2,3 and 4 are correct

10. mRNA decay (breakdown) can play an important role in controlling protein abundance.

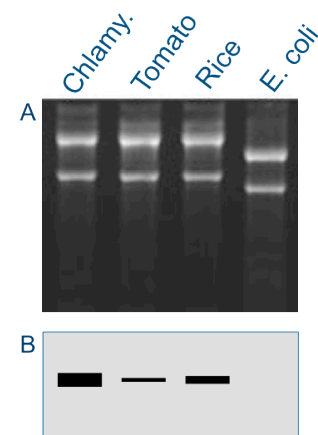
Which of the following scenarios correctly describes a relationship between mRNA decay and protein abundance?

- A. A decrease in transcription with an increase in the rate of mRNA decay can result in increased protein abundance.  
 B. An increase in transcription with an increase in the rate of mRNA decay can result in no change in protein abundance.  
 C. An increase rate of protein synthesis but failure to form an apoprotein can be explained by a decrease in mRNA decay.

11. The images at the right show agarose gel and Northern blot analysis for the presence of transcripts of *hexK*, a gene that codes for hexokinase, a glycolysis enzyme, in four different species.

(A) shows the agarose gel stained for DNA, and (B) shows the final Northern blot image.

Based on your knowledge of glycolysis and the Northern blotting technique, what is the most likely reason that there is no band in the *E. coli* lane shown in Figure B?



Although D is the best choice here, B is not outside the realm of possibility. 0.5 for B

- A. Being a prokaryotic organism, *E. coli* does not have a hexokinase gene.  
 B. Under the experimental conditions used, the *hexK* was not transcribed.  
 C. Northern blot analysis is not possible in *E. coli* because it lacks ribosomal RNA.  
 D. The probe used is not similar enough to the *E. coli* transcript to bind to it.

12. Melanie and Abdullah are studying free energy and exergonic/endergonic reactions. Melanie says..."Endergonic reactions bring in free energy and exergonic reactions are those that release free energy."

Abdullah says..."yes, sounds good....but don't exergonic reactions need to bring in free energy to get to the transition state?" Melanie says...."yes....damn, now I'm really confused, thermodynamics sucks!"

Which of the following statements could you offer that would clarify this situation?

- A. Melanie and Abdullah are not taking into account the increase in entropy that occurs during exergonic reactions.
  - B. Thermodynamics considers only the change in the free energy of the products relative to the reactants.
  - C. The transition state only applies to endergonic reactions, it does not apply to exergonic reactions.
  - D. Melanie is incorrect, exergonic reactions do not release free energy.
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13. Melting ice represents a very interesting thermodynamic system.

Which of the following is an accurate conclusion arising from the fact that ice melts spontaneously at room temperature?

- A. Exothermic reactions can be spontaneous.
  - B. Endothermic reactions can be endergonic.
  - C. A decrease in entropy can occur without a phase change.
  - D. Spontaneous reactions can be driven solely by an increase in entropy.
- 

14. Maya is in a debate with Ryan who thinks life goes against the Second Law of Thermodynamics (SLT). He tells her "the idea that life maintains low entropy goes against the SLT, which states that the entropy of a closed system must always increase....energy spontaneously spreads out".

Which of the following mistakes has Ryan made that Maya can nicely point out?

- 1. The SLT states that the entropy of a system *plus its surroundings* must always increase.
- 2. Life is an open system; it maintains low entropy by bringing in energy from its surroundings.
- 3. A living system increases the entropy of the surroundings by releasing gases and heat.
- 4. The fact that energy spreads out is not the same thing as entropy.

A. 1,2 and 3

B. 1 and 3

C. 2 and 4

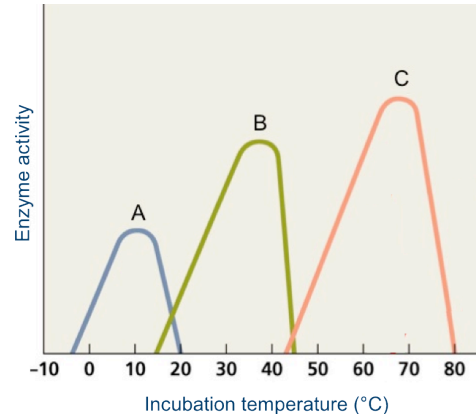
D. 4 only

E. All of 1,2,3 and 4 are correct



15. The figure at right shows the activity of the enzyme rubisco. The enzyme was isolated from three different species of cyanobacteria, each adapted to a different temperature environment.

Which of the following interpretations of the figure is correct?



1. That the optimal activity progressively increases from species A to C reflects the influence of temperature on the rate of a reaction.
2. Rubisco activity in species C falls to zero at 42°C. This is probably because the enzyme becomes too rigid.
3. The difference in rubisco activity between species A and C may be due to differences in the primary sequence of the protein.
4. In general, the tertiary structure of rubisco in species B is due to more and stronger bonding arrangements compared to species C.

- A. 1,2 and 3  
 B. 1 and 3  
 C. 2 and 4  
 D. 4 only  
 E. All of 1,2,3 and 4 are correct



16. In many lectures Maxwell kept going on and on about C-H bonds.

What is so special about C-H bonds?

- A. They represent a high entropy form of energy.
- B. They are strongly electronegative and are easily reduced.
- C. They are the source of readily accessible electrons that are found in food.
- D. They are an important bonding arrangement ensuring the proper quaternary structure of proteins.

17. Enzymes are the major group of biological catalysts.

Which of the following statements about enzymes is correct?

- A. To offset the fact that some enzymes have a slow catalytic cycle, their abundance within the cell is usually high.
- B. To proceed quickly, all exergonic processes within cells are dependent upon enzymes.
- C. Enzymes increase the activation energy of a spontaneous reaction.
- D. Enzymes convert endergonic reactions into exergonic reactions.

18. An ABC transporter uses the hydrolysis of ATP to transport molecules across a membrane.

Why does transport require free energy?

- A. Because transport of protons generates ATP.  
 B. Because transport decreases the entropy of the system.  
 C. Because the molecules it transports are either large or charged.  
 D. Because you are moving molecules down a concentration gradient.

C. is incorrect because a protein pore could facilitate transport of large molec. or ions.

19. The *Peyton1* mutant of *E. coli* results in a desaturase always being present in the cell.

How do *Peyton1* cells compare to wild-type cells?

- A. *Peyton1* cells will grow more slowly at low temperature.  
 B. *Peyton1* cells will have membranes that are less fluid at higher temperatures.  
 C. *Peyton1* cells will have greater desaturase abundance at low temperature.  
 D. *Peyton1* cells will have a lower maximum growth temperature.

20. The most severe form of cystic fibrosis is caused by the  $\Delta F508$  mutation of CFTR. A less severe form of the disease is caused by a mutation where arginine is replaced by histidine at amino acid 117 (R117H).

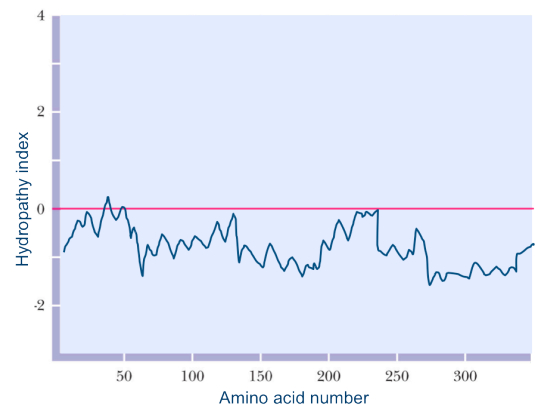
Which of the following most likely explains why the R117H phenotype is less severe than that of the  $\Delta F508$  mutation?

- A. The R117H form of CFTR is synthesized on free cytosolic ribosomes.  
 B. The R117H form of CFTR attains a native conformation that is identical to wild-type.  
 C. The R117H form of CFTR successfully passes through the endoplasmic reticulum.  
 D. While the  $\Delta F508$  mutation affects the transmembrane domain, the R117H mutation only prevents ATP binding.

21. The figure at right is a hydropathy plot used to study protein structure.

Which of the proteins below is most likely represented by the hydropathy plot shown?

- A. Channelrhodopsin  
 B. Citrate synthase  
 C. Chlorophyll-binding protein I  
 D. Acetate transporter



B is the only non-membrane protein. This characteristic is reflected in the hydropathy plot

22. A couple of weeks ago when you were walking to Bio class the sun was shining but the temperature outside was  $-20^{\circ}\text{C}$ . You probably passed at least one pine or spruce tree. Such "evergreen" trees keep their leaves all winter long.

What happens to the light that evergreen leaves absorb during the winter?

- A. Evergreen leaves absorb light and store the photons in reaction centers until summer.
- B. Evergreen leaves absorb green light as well as red and blue light in the winter.
- C. Evergreen leaves absorb light but lose it to heat and fluorescence in the winter.
- D. Evergreen leaves are psychrophilic; they absorb the light and use it for photosynthesis, which they can only do in the winter.

Evergreens cannot be psychrophilic since they don't die at temps  $+20^{\circ}\text{C}$ ....but acknowledge difficulty. 0.5 marks for D.

23. Electron flow along an electron transport chain is a spontaneous process from molecules that are strong reducing agents to molecules that are stronger oxidizing agents. Yet, based on redox potential, respiratory and photosynthetic electron transport chains look very different.

Given your knowledge of photosynthetic electron transport, which one of the following molecules is the strongest reducing agent (most easily oxidized)?

- A. P680
- B.  $\text{H}_2\text{O}$
- C. P700\*
- D. NADPH

24. Bacteria that carry out anoxygenic photosynthesis have an advantage over those that carry out oxygenic photosynthesis. Anoxygenic photosynthetic bacteria have a single photosystem that allows them to grow in very low light environments.

Which of the following characteristics of anoxygenic photosynthetic bacteria allows them to grow under very low light?

- A. They do not need to generate ATP.
- B. They use electron donors that are easy to oxidize.
- C. They do not need to generate oxygen ( $\text{O}_2$ ).
- D. They don't need to respire.

25. Natural Selection favours random mutations that by chance result in organisms better suited to their environment. However, natural selection has yet to result in the evolution of a form of Rubisco that does not have oxygenase activity.

Why hasn't it?

- A. Mutations that have resulted in the loss of oxygenation have probably also greatly decreased carboxylation as well.
- B. Natural selection cannot improve on something that is already essential to cell function.
- C. Evolution takes time; and since Rubisco is found only in eukaryotes, it evolved recently.
- D. Since it still generates one molecule of 3-phosphoglycerate (PGA), the oxygenation reaction is not that wasteful.

26. The Calvin Cycle represents the major pathway of carbon fixation in all photo-autotrophic organisms.

Which of the following statements about the biochemistry of the Calvin Cycle is correct?

1. It takes three turns of the cycle (3 CO<sub>2</sub> molecules) to generate one molecule of glyceraldehyde 3-phosphate.
2. The reductive phase of the cycle involves the oxidation of NADPH, and results in an increase in the free energy of the carbon substrates.
3. Without the regeneration of ribulose 1,5-bisphosphate (RuBP), the cycle will stop.
4. The carboxylation reaction results in the synthesis of one three-carbon molecule.

A. 1,2 and 3

B. 1 and 3

C. 2 and 4

D. 4 only

E. All of 1,2,3 and 4 are correct



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27. Evolutionary biochemists think that glycolysis represents a very ancient metabolic pathway.

Which of the following would be evidence in favour of this claim?

A. Glycolysis can operate without enzymes.

B. Glycolysis does not require ADP

C. Glycolysis is not dependent on O<sub>2</sub>.

D. Glycolysis does not generate CO<sub>2</sub>.

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28. A key enzyme of the citric acid cycle (Kreb Cycle) is citrate synthase. This enzyme catalyzes the conversion of oxaloacetate to citrate.

How is the activity of citrate synthase likely regulated?

A. It is inhibited by pyruvate.

B. It is inhibited by high levels of NAD<sup>+</sup>.

C. It is activated by a high ADP/ATP ratio.

D. It is activated by high levels of citrate.

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29. FADH<sub>2</sub> is similar to NADH in that it is also oxidized by the respiratory electron transport chain. However, oxidation of FADH<sub>2</sub> does not yield as much ATP as the oxidation of NADH.

Why doesn't oxidation of FADH<sub>2</sub> generate as much ATP as oxidation of NADH?

A. Energy is more spread out in FADH<sub>2</sub>.

B. FADH<sub>2</sub> has fewer C-H bonds than NADH<sub>2</sub>.

C. FADH<sub>2</sub> oxidation occurs at complex II; it therefore bypasses the proton-pumping of Complex I.

D. FADH<sub>2</sub> oxidation to FAD releases fewer electrons than the oxidation of NADH to NAD<sup>+</sup>.

30. The presence of uncoupling proteins has been shown to play an important role in keeping newborn infants warm.

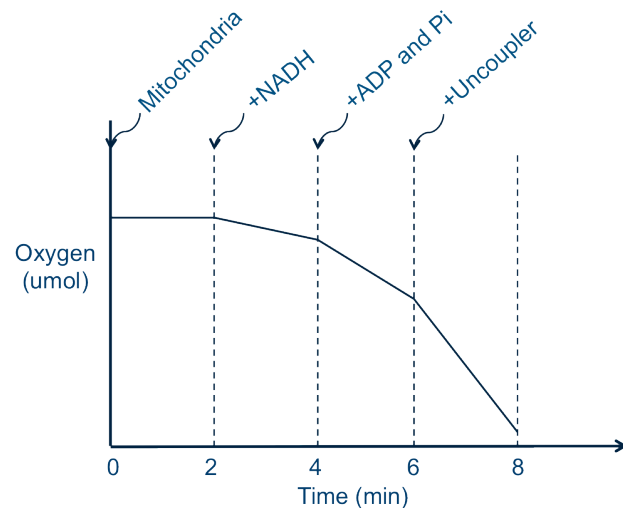
What is the link between uncoupling proteins and heat generation?

- A. Uncoupling proteins are linked to enzyme-dependent ATP generation, which produces heat.  
 B. Uncoupling proteins decreases the entropy of fat cells, which results in an increase in heat.  
 C. Uncoupling proteins prevent the free energy released during electron transport to be transferred to ATP. It is lost as heat instead.

31. The image at right shows the change in oxygen as a function of time in an O<sub>2</sub> electrode chamber. The chamber contains isolated mitochondria, and various molecules are added sequentially at the time points shown.

During which time frame is the proton gradient at its greatest?

- A. 0 - 2  
 B. 2 - 4  
 C. 4 - 6  
 D. 6 - 8



32. When a culture of *Chlamydomonas* cells is placed in a Petri dish and exposed to **HIGH** intensity light, the cells will migrate away from the light. They move away from the light because the light is potentially harmful.

How could high intensity visible light be harmful?

- A. High light can randomly ionize membrane lipids causing their breakdown.  
 B. High light can heat up the cells causing protein denaturation.  
 C. High light can donate electrons from photons to O<sub>2</sub> producing reactive oxygen molecules.  
 D. High light can increase the amounts of P680<sup>+</sup>, which is potentially harmful.

33. When a culture of *Chlamydomonas* cells is placed in a Petri dish and exposed to **LOW** intensity light, the cells will migrate towards the light. They move towards the light to increase their rate of photosynthesis.

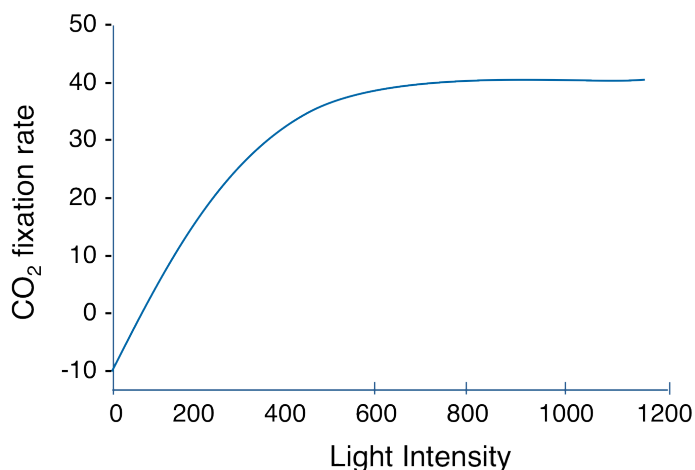
Which of the following scenarios would signal to a cell that it should increase its rate of photosynthesis?

- A. High NAD<sup>+</sup>/NADH ratio.  
 B. High levels of G3P.  
 C. Low ADP/ATP ratio.  
 D. High levels of Acetyl CoA.

Only A reflects that the energy state of the cell is low.

The figure below shows a light response curve for CO<sub>2</sub> fixation in *Chlamydomonas* cells; both mitochondria and chloroplasts are functional.

**Use this figure to answer the following two questions.**



34. At a light intensity of 200, which of the following is limiting the rate of carbon fixation?

- A. The rate at which the Calvin Cycle can regenerate RuBP.
- B. The catalytic turnover time of Rubisco.
- C. The amounts of NADPH and ATP.
- D. The rate of cyclic electron transport.

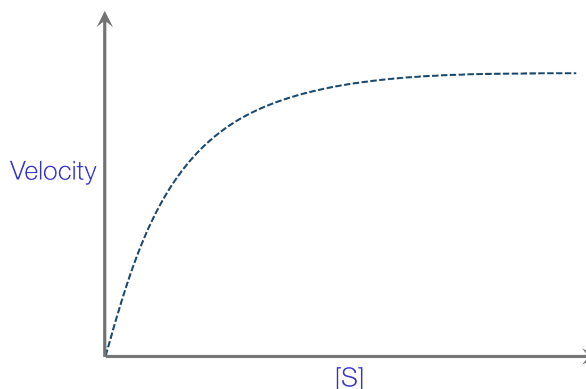
35. At light saturation (i.e. above 800), which of the following is the actual rate at which the Calvin Cycle is fixing CO<sub>2</sub>?

- A. 10
- B. 30
- C. 40
- D. 50

To determine the actual rate of the Calvin Cycle you need to take into account respiration. You do that by adding 10 (the rate in the dark) to 40 = 50

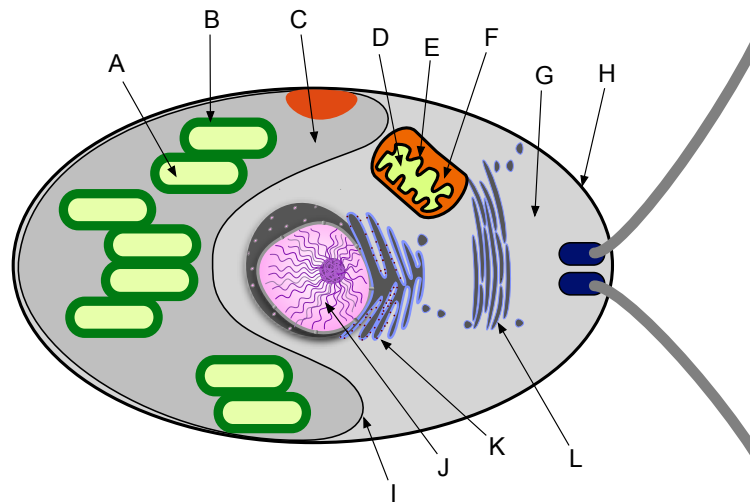
36. This figure shows the rate of an enzyme-catalyzed reaction as a function of substrate concentration.

Which of the following would most likely decrease the  $V_{\max}$  of the reaction?



- A. Decrease in temperature
- B. Increase in enzyme concentration
- C. Increase in substrate concentration
- D. Decrease in the affinity of the enzyme for substrate

Use this labeled picture of a *Chlamydomonas* cell to address the following **three** questions.



37. Which of the following statements **DOES NOT** correctly match a function or component with its labelled feature?

- A. Proteins destined for the plasma membrane can be found at **K**.
- B. Both  $O_2$  and  $CO_2$  transporters are found at **H**.
- C. The proteasome is found in **G**.
- D. Transcription factors are found in **J**.

38. Which of the following statements correctly identifies the location of various functions of the mitochondria and/or the chloroplast?

- A. While  $O_2$  is generated in **A**, it is consumed in **D**.
- B. When the rate of electron transport is high compartments **C** and **F** are acidic (lower pH).
- C. While  $CO_2$  is consumed in **C** it is generated in **F**.
- D. ATP is generated in **A**.

39. Which of the following statements correctly explains the biochemical interactions that occur between photosynthesis and cellular respiration during photoautotrophic growth?

- A. G3P synthesized in **C** is transported into **G**.
- B. Glycolysis, which occurs in **G**, consumes NADH.
- C. Growth requires transport of glucose from **G** into **D**.
- D. The high demand for chemical energy in **G** is met by ATP import from **A**.

40. *Chlamydomonas* has the ability to grow heterotrophically in the dark.

Which of the following biochemical processes is specific to heterotrophic growth in *Chlamydomonas*?

- A. ATP synthesis in the cytosol.
- B. Glucose breakdown in the chloroplast.
- C. Pyruvate transport into the mitochondria.
- D. Acetate transport at the plasma membrane.

41. Albert is trying to explain to Aiyun that one advantage enjoyed by plant cells is that they do not need to bring in CO<sub>2</sub> for photosynthesis. They can grow simply by using the CO<sub>2</sub> generated from cellular respiration.

How should Aiyun respond?

- A. YES! Since CO<sub>2</sub> is freely diffusible that makes total sense.
  - B. YES! This is a great example of thermodynamic equilibrium, or balance.
  - C. NO! Most plant cells do not photosynthesize and respire at the same time.
  - D. NO! To grow, the cell must bring in more CO<sub>2</sub> than it respire.
- 

42. Imagine that you are researching a particular question (e.g. "Can viruses survive in space?") online for an assignment and find two websites that provide information. Unfortunately, one site says the answer is "Yes", the other claims the answer is "No".

Which of the following is the best way to proceed with respect to this contradictory information?

- A. Trust the site with the most recently updated information.
  - B. Trust the site hosted by the more reliable organization, such as government.
  - C. Stop searching and report the answer in your assignment as "Some say Yes; some say No."
  - D. Resolve the contradiction by consulting peer-reviewed references.
- 

43. If Linda rejected her hypothesis in the lab, which of the following is **TRUE**?

- A. The experiment was a success, since she was probably testing her null hypothesis.
  - B. The experiment was done carelessly; data were too variable to support her hypothesis.
  - C. The experimental design was flawed, since she was not testing the alternate hypothesis.
  - D. The experiment was a success because her results matched with the published results.
- 

44. During the lab, you overhear Jun and a lab partner planning an experiment to test the effect of Chemical X and Chemical Y on the heart rate of black worms. They have collected 6 black worms and are now thinking about the order in which the two treatments will be given to all the black worms.

Which of the following experimental approaches would be most advisable since these students are **not** intending to divide the black worms between the two treatments?

- A. Pick one order at random, either X-Y or Y-X, and give all black worms the treatments in that order.
  - B. For each black worm, follow the TA's advice on the order in which to give the treatments.
  - C. Let her partner decide the random order in which they would prefer to give the treatments to each worm.
  - D. Give the treatments to half of the black worms in the order Y-X and to the other half in the order X-Y.
-