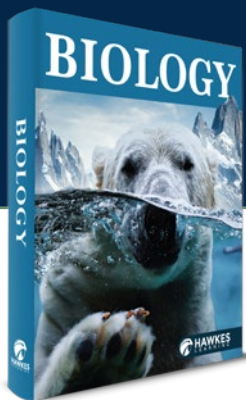


# 120 BIOLOGY

## REFLECTION QUESTIONS



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# BIOLOGY



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# 1 The Nature of Biology

## Reflection Questions

How does the scientific definition of a theory differ from society's notion of a theory? What issues result from these differences?

## Reflection Questions

Can an individual organism evolve? Why or why not?

# 2 Basic Chemistry for Biology

## Reflection Questions

Why do you think that jumping into a swimming pool on a hot summer's day helps your body cool off?

# 3 Biological Macromolecules

## Reflection Questions

Many people across the world are lactose intolerant. These individuals experience digestive discomfort when they consume foods containing lactose, such as milk and cheese, but they can consume lactose-free milk. What do you think has been added to the lactose-free milk to make it consumable by these individuals?

## Reflection Questions

How much salmon or other fish rich in omega-3 fatty acids do you eat in your diet? Do you think you eat enough to reap the benefits described?

# 4 Cell Structure

## Reflection Questions

Consider the activities you've done today. Identify one example of an activity that was made easier by the design of the space where you completed that activity. How is the relationship between the activity and the activity's specialized space similar to how eukaryotic cells function?

## Reflection Questions

As a scientist, how might you piece together the general pathway of the endomembrane system? What kinds of experimentation strategies or techniques might you want to use to determine where new proteins are synthesized, processed, and distributed?



 **Reflection Questions**

The fibrous protein keratin is an intermediate filament that strengthens hair. Slight keratin differences lead to different hair textures. How might the keratin in curly hair differ from that in straight hair?

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## 5 Structure and Function of Membranes

 **Reflection Questions**

We hear a lot in the news about cholesterol and its negative effects on our health. Do you think that cholesterol fully deserves its negative reputation? Why or why not?

 **Reflection Questions**

Why do you think channel proteins can transport substances much more quickly than carrier proteins can?

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## 6 Bioenergetics

 **Reflection Questions**

What do you think of when you consider the word *metabolism* as it's used in everyday language? In what ways does the biological definition align with the word's common usage? In what ways are the meanings different?

 **Reflection Questions**

Think about both the medications and the dietary supplements that you take or have taken. For the medications, what metabolic pathway is affected by each? For the dietary supplements, are they coenzymes? Cofactors? What enzymes or metabolic pathways do they each affect? Use the internet to research each medication and dietary supplement.

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## 7 Cellular Respiration

 **Reflection Questions**

ATP is an excellent energy currency for the cell. Can you come up with reasons why GTP is also made and used by the cell?

 **Reflection Questions**

Why do you think these different approaches to respiration (aerobic and different types of anaerobic) evolved across the natural world?

 **Reflection Questions**

Why do you think groups of amino acids enter or exit the respiration pathway at certain steps and not at other steps?

## 8 Photosynthesis

### Reflection Questions

Consider how trees near your home visibly change from summer to autumn. Briefly describe those changes. Based on what you've learned so far, what chemical changes might be happening inside the leaves?

## 10 Cell Reproduction

### Reflection Questions

Consider various types of cells in a human adult, including skin cells, intestinal cells, bone cells, and kidney cells. Which phase(s) of the cell cycle (interphase, mitotic phase, or  $G_0$ ) do you think various cell types are most typically in? Why?

### Reflection Questions

Why do you think a cell becomes physiologically inefficient as it increases in size? What might cause this?

### Reflection Questions

Why do you think the cell commonly has more than one mechanism controlling progression through a single cell-cycle checkpoint? What might have been the more likely outcome if the cell did not have multiple mechanisms in place?

### Reflection Questions

Describe a time when bacteria negatively impacted your life. How did the bacteria's ability to replicate quickly contribute to that situation? Conversely, describe a way in which bacteria positively impacted your life.

### Reflection Questions

A cell must be able to both tightly package and readily access its DNA. How might a household chore, such as doing laundry, provide an analogy for the storage and condensation of DNA?

## 11 Meiosis and Sexual Reproduction

### Reflection Questions

What do you think would happen to the genetic variation of the haploid cells resulting from meiosis if crossing over were inhibited? Would all of the haploid cells be genetically identical? Why or why not?

**Reflection Questions**

What cells in humans are analogous to gametophytes in plants?

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## 12 Mendelian Genetics

**Reflection Questions**

Why do you think that gametes have an equal likelihood of receiving either of the two parental alleles for a particular gene?

**Reflection Questions**

How might Mendel's results have been different if he had examined traits controlled by linked genes? Which, if any, of his conclusions do you think would have changed?

**Reflection Questions**

Why do you think that gametes have an equal likelihood of receiving either of the two parental alleles for a particular gene?

**Reflection Questions**

Think about some traits that you have. These traits could be physical (such as height and hair color) or related to personality, such as introversion or extroversion. Do you think these traits are under the control of a single gene or multiple genes? Do you think they are influenced by any other factors?

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## 13 Modern Genetics and Inheritance

**Reflection Questions**

Based on what you have learned about chromosomal arrangements, hypothesize one way in which these events have contributed to the evolution of animals across history. How would you test your hypothesis?

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## 14 DNA: Deoxyribonucleic Acid

**Reflection Questions**

What does Griffith's experiment show you about bacterial survival and change?

**Reflection Questions**

What do you think is the most likely model of DNA replication? Why?

 **Reflection Questions**

If the mode of DNA replication had been dispersive, what results would Meselson and Stahl have likely observed after the second generation of growth in the  $^{14}\text{N}$  medium? After later generations of growth?

 **Reflection Questions**

Do you think mutations are more likely to occur in prokaryotic cells or eukaryotic cells? Explain why you think that.

 **Reflection Questions**

Do you think that cancer-therapy treatments designed to inhibit telomerase activity could have any unintended side effects? How could such effects be mitigated?

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## 15 Genes and Proteins

 **Reflection Questions**

Can you think of reasons why having polycistronic genes would be beneficial to bacteria?

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## 16 Gene Expression

 **Reflection Questions**

Think about your body. What type of expressed genes do you think would be unique to your stomach lining, skin cells, and muscles?

 **Reflection Questions**

In casual conversation, what does it mean to say you “repress” something? Give an example of something you might repress. What does it mean to “activate” something? Give an example. Use your responses to explain the difference between a “repressor” and “activator” in the field of genetics.

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## 17 Biotechnology and Genomics

 **Reflection Questions**

What are some ways that you may have seen or interacted with genetically modified organisms over the last 24 hours? Don’t forget to consider the foods you’ve eaten as well as those you’ve seen.

**Reflection Questions**

Can you think of some reasons why constructing a genetic map is useful? What are some potential applications of genetic maps?

**Reflection Questions**

If you were offered the chance to have your entire genome sequenced, would you accept? Why or why not? What would you like to learn? Specify at least one thing you would like to learn about your genome. What are some concerns you would have? Specify at least one concern.

**Reflection Questions**

Imagine you have an identical twin. You and your twin participate in a proteomic comparison study. Based on what you have learned about the relationship between genes and proteins, do you expect your twin to have a proteome profile identical to your own? Why or why not?

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## 18 Evolution and the Origin of the Species

**Reflection Questions**

How do you think the definition of a species applies to asexually reproducing organisms, including prokaryotes?

**Reflection Questions**

What other types of environmental influences may bring about punctuated equilibrium?

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## 20 The Tree of Life and Phylogenetics

**Reflection Questions**

Antibiotics are drugs that can specifically target and kill prokaryotes, treating infections caused by dangerous bacteria. What do you think the endosymbiont theory means for the effect of these drugs on your own eukaryotic cells?

**Reflection Questions**

What do you think are some shared ancestral characteristics between humans and small mammals (rats, rabbits, etc.)? What about humans and fungi?



## 21 Viruses

### Reflection Questions

Which hypothesis do you find the most reasonable? Why do you think so?

### Reflection Questions

How might high rates of copying errors in RNA polymerase enzymes be beneficial or detrimental to the evolution of a pathogenic virus?

### Reflection Questions

Compare and contrast how animal viruses and plant and bacteria viruses enter the host cell. What features in how they enter the cell make them specific to their hosts?

## 22 Prokaryotes: Bacteria and Archaea

### Reflection Questions

Scientists and science fiction writers alike have been discussing the possibility of finding life on Mars for decades. If bacterial life were to exist on Mars, what environmental conditions would it need to survive?

### Reflection Questions

Research hibernation in animals. Does the VBNC state share any similar purposes with hibernation?

### Reflection Questions

Think about the kinds of minerals and proteins that your metabolism needs to function. In what ways is your metabolism similar to or different from prokaryotes?

### Reflection Questions

Which kind of prokaryote mentioned (phototrophic, chemotrophic, chemoorganotrophic, or chemolithotrophic) would have survived well in early Earth environments? Why do you think so?

### Reflection Questions

Imagine if prokaryotes were removed from the carbon cycle. How would that affect the rest of the cycle? How would that affect humans?

### Reflection Questions

What are some actionable ways in which you and your family can prevent foodborne illnesses?

 **Reflection Questions**

What would happen to plants if there were no nitrogen-fixing bacteria to return nitrogen to the soil?

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## 23 Protists

 **Reflection Questions**

There are several characteristics in this list that are not always present with all eukaryotes, but it is concluded that their ancestors did have them. Why do you think some eukaryotes no longer exhibit some of these characteristics?

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## 24 Fungi

 **Reflection Questions**

Think about how you interact with fungi on a weekly basis (grocery store visits, on walks, and within your home). How often do you encounter fungi? Based on your interactions, why do you think scientists are still unable to identify the majority of fungus species?

 **Reflection Questions**

What do you think are the advantages and disadvantages for fungi to be obligate aerobes? How about obligate or facultative anaerobes? If you were a fungus and had the power to choose, which strategy would you select?

 **Reflection Questions**

Why do you think that sexual reproduction starts when environmental conditions become unfavorable?

 **Reflection Questions**

Orchids can be one of the hardest plants to grow. Why do you think this is?

 **Reflection Questions**

As fungi are eukaryotes, what do you think antifungals target to avoid damaging eukaryotic human cells?

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## 25 Seedless Plants

 **Reflection Questions**

Why do you think seedless plants still require a moist environment for reproduction?

 **Reflection Questions****Adaptations to Land**

What do you think are the advantages of resistance to desiccation over tolerance? What are the advantages of tolerance over resistance to desiccation?

 **Reflection Questions**

Besides understanding how species developed in the past, do you think paleobotanists analyzing fossils can forecast ecosystem events that will happen in the future?

 **Reflection Questions**

How do you think the bryophytes' ability to survive desiccation has evolved over time??

 **Reflection Questions**

Do you think that the fact that vascular plants have more advanced evolutive traits makes them more important for natural ecosystems than bryophytes?

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## 26 Seed Plants

 **Reflection Questions**

Consider the plant life in your community, such as around your home or school. Where might you find examples of bryophytes? Identify two specific locations. Based on what you've learned about the environments in which these plants thrive and their unique requirements, explain why they would likely grow in the area you specified.

 **Reflection Questions**

What are some of the monocots mentioned here that you recognize? What features do you observe in these monocots that are similar? How are they different?

 **Reflection Questions**

How do you feel about eating spicy food? Most spicy food gets its heat from the same chemical—capsaicin. Based on your experiences eating this kind of food, what evolutionary advantages might a plant obtain by producing this chemical?

 **Reflection Questions**

Plants employ many techniques for ensuring pollination occurs. What are some examples of plant pollination methods that you have seen for yourself? What are some ways that the plants in your area ensure that pollination occurs? In the course of a year, which seasons do you think see the most pollination-related activity?

## 27 Introduction to Animal Diversity

### Reflection Questions

What are some animals in your community that undergo metamorphosis?

### Reflection Questions

How might using only morphological characteristics and the fossil record lead to misunderstandings about the evolutionary history of animals?

### Reflection Questions

*Hox* genes control the developmental processes that lead to the formation of morphological features, such as limbs and appendages. Therefore, it has been hypothesized that the Cambrian explosion could be linked to the evolution of such genes.

How might the evolution of new genes allow diverse forms of life to emerge?

## 28 Invertebrates

### Reflection Questions

Of the cnidarians mentioned here, which ones have you heard of before? Do they have polyp or medusa forms or a combination of both? Research these cnidarians to find out.

### Reflection Questions

Can you think of any other animals that we have previously discussed that have only one orifice from which to ingest nutrients and expel waste?

### Reflection Questions

What benefit would a squid have if it could detect light via its skin?

### Reflection Questions

What are some animals that you know of that go through a molting process? Are there any advantages or disadvantages to having a life cycle that requires molting?

### Reflection Questions

Why are tardigrades able to survive in outer space?

### Reflection Questions

Why do you think arthropods have dominated the animal kingdom for the past 500 million years?

**🔗 Reflection Questions**

Why do you think it is advantageous for some echinoderms to reproduce via fragmentation?

**🔗 Reflection Questions**

What do you think is the advantage of having hemoglobin for some sea cucumbers? Research this topic to find out!

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## 29 Vertebrates

**🔗 Reflection Questions**

Bilateral symmetry is commonly seen across vertebrate species. Can you think of why bilateral symmetry might be an advantageous body plan that was selected for by evolutionary processes?

**🔗 Reflection Questions**

Why do you think frogs with toxic skin secretions display bright warning coloration?

**🔗 Reflection Questions**

What do you think are the advantages and disadvantages of the two different ways that turtles can retract their necks? Research the two groups and determine why that type of neck retraction was selected for in those species.

**🔗 Reflection Questions**

Which hypothesis do you think is more probable: the arboreal hypothesis or the terrestrial hypothesis?

**🔗 Reflection Questions**

Why do you think the quadrate and articular bones are located in the middle ear of mammals rather than as part of the jaw and skull? What advantage does this have for mammals?

**🔗 Reflection Questions**

Why do you think we are the only surviving species of hominin?

**🔗 Reflection Questions**

Scientists cite similarities in anatomy and genetics as evidence for our similarity to our primate cousins. Yet, we humans tend to separate ourselves from our closest relatives, the chimpanzees and the bonobos, by citing our emotion and higher-order thinking. Consider what an emotion is and whether or not chimps and bonobos have complex emotions such as those seen in humans. Does this affect whether or not you hold humans in a unique position in the primate kingdom?



## 30 Plant Physiology

### Reflection Questions

What do you think are the advantages and disadvantages of the different types of cells found in stems?

### Reflection Questions

Why do you think monocot stems have a scattered arrangement and dicot stems have a ring arrangement of vascular bundles? Research the differences between monocots and dicots to help you formulate your answer.

### Reflection Questions

Remember, water moves from areas of high water potential to areas of low water potential. When water potential is high inside the cell and low outside of the cell, water flows out of the cell and the pressure potential in the cell decreases, leading to wilting.

What are some situations in which water potential would be higher inside the cell than out? What mechanism do plants have to decrease water potential in their cells to prevent water loss?

### Reflection Questions

Why do you think some plants prefer longer days and some plants prefer shorter days?

## 31 Soil and Plant Nutrition

### Reflection Questions

Jan Baptist van Helmont (1580–1644) conducted one of the earliest experiments on plant nutrition and growth. Research this experiment. What did it show? How do van Helmont's conclusions compare to what we now know about plant growth?

## 34 The Digestive System

### Reflection Questions

What effect would a cholecystectomy (surgical removal of the gallbladder) have on the digestive system of a human?

### Reflection Questions

Based on what you know about constipation versus diarrhea, how do you think antidiarrheal medications function?

### Reflection Questions

Imagine eating your favorite food. What are you eating? Does the thought of the food make you salivate?

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## 35 The Circulatory System

### Reflection Questions

Imagine how humans might be different if we evolved to have an open circulatory system. Come up with three ways the human body would be different. For example, would a human with an open circulatory system need to be bigger, smaller, or about the same size as a human with a closed circulatory system? Which would demand more energy? If humans had an open circulatory system, do you think we could have accomplished the same feats and technological achievements we have?

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## 36 The Respiratory System

### Reflection Questions

Why do you think that inhaling a gust of campfire smoke makes you cough? Which parts of the respiratory system do you think are responsible for the coughing reaction?

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## 37 The Immune System

### Reflection Questions

Some bacteria are very good at evading the human immune system. What characteristics might these bacteria have that enable them to avoid detection by macrophages?

### Reflection Questions

Consider that antibodies are produced by the splicing and recombination of many possible gene segments. What benefit might this mode of antibody production have to an organism?

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## 38 The Urinary System

### Reflection Questions

Why do you think the presence of red blood cells and/or protein in the urine is a sign of kidney dysfunction?

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## 41 Sensory Systems

### Reflection Questions

Do you like the taste of cilantro? To some individuals, cilantro tastes tangy and citrusy; to others, it tastes like soap. How might genetic differences in sensory receptors account for these individual differences in the perception of cilantro's flavor?

**↗ Reflection Questions**

Vertigo (a sensation of spinning) is often caused by one or more calcium carbonate ( $\text{CaCO}_3$ ) crystals getting stuck or falling into a different part of the semicircular canals. This cause of vertigo is often treated by a series of head movements. Why do you think mislocated crystals cause dizziness or spinning?

**↗ Reflection Questions**

How do you think eyeglasses work to correct refractive errors such as myopia and hyperopia?

**↗ Reflection Questions**

Why do you think it is important for some visual information to cross to the opposite side of the brain at the optic chiasma?

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## 42 The Nervous System

**↗ Reflection Questions**

What are some behaviors that can lower the onset of a stroke?

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## 43 The Musculoskeletal System

**↗ Reflection Questions**

Based on what you know, which type of muscle tissue do you think makes up the highest percentage of muscle in the human body? Which might make up the lowest percentage? Explain your answer.

**↗ Reflection Questions**

Even with exercise, humans generally don't make new muscle cells. The appearance of bulging muscles is caused by muscle cells getting bulkier, not by an increase in muscle cells. Why do you think muscle cells grow bigger? Consider the different proteins and components of muscle cells. Then, use your knowledge to make an educated guess. Finally, discuss your ideas with your classmates.

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## 44 Ecology and the Biosphere

**↗ Reflection Questions**

The tropics near the equator have more species than environments towards the pole of the Earth. Can you think of why that might be?

**↪ Reflection Questions**

*Homo sapiens* evolved as a species a few hundred thousand years ago. Which biome(s) do you think would suit the early human? Which biome(s) would not?

**↪ Reflection Questions**

What are some evolutionary or behavioral adaptations that fish living in the abyssal zone might need to have to survive the harsh conditions near the bottom of the ocean?

**↪ Reflection Questions**

Current models of climate change predict significant impacts on flora and fauna within our lifetime. What are some actionable changes that we should make at the (1) individual and (2) policy level to limit (or arrest) the damage being caused by climate change?

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## 45 Population and Community Ecology

**↪ Reflection Questions**

The birth rate in the United States has been declining for over a decade, but life expectancy has continuously increased. How do you think this will affect the population?

**↪ Reflection Questions**

What do you think are the most significant factors regulating the growth of animal and/or plant populations in your local ecosystem today?

**↪ Reflection Questions**

Think about the organisms that are common where you live. What is another example of this predator-prey cycle in your area?

**↪ Reflection Questions**

Do humans form mutualistic relationships with other species? How would each species benefit in those relationships?

**↪ Reflection Questions**

What are some examples of human courtship displays? What about aggressive displays?

**↪ Reflection Question**

So far, we've discussed behaviors directed towards members of the same species. Seemingly altruistic behaviors can also occur between members of different species. Experience this account of dolphins helping a human ([hawkes.biz/dolphinhelp](http://hawkes.biz/dolphinhelp)). Do you think this is an example of true altruism, or do you have another explanation for why the dolphins exhibited this behavior?

 **Reflection Questions**

What do you think about sociobiology? Do you think that animal and human behavior has a genetic component and that some behaviors can be explained in terms of natural selection? Explain why or why not.

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## 46 Ecosystems

 **Reflection Questions**

Humans, like all animals, are a part of the phosphorus and nitrogen cycles. Can you think of ways phosphorus and nitrogen would be important to human biology?

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## 47 Conservation Biology and Biodiversity

 **Reflection Questions**

What types of stimulants, drugs, or medicines have you consumed that you think are secondary plant compounds? Have you gotten these from natural or synthetic sources?

 **Reflection Questions**

Genetically modified crops have been developed and used with increasing frequency in recent years. These are breeds of crops that have new genetic material added, sometimes from very different species, that endow them with new abilities (such as pest or drought resistance).

In what ways does the use of genetically modified crops represent a solution to biodiversity problems? In what ways does it exacerbate the problem?