Chapter 40: Basic Principles of Animal Form and Function

40.1 Identify the levels of organization within the animal body, and use examples to show how structure and function are related at each level.

40.2 Distinguish how negative feedback and positive feedback mechanisms regulate internal conditions.

40.3 Use examples to demonstrate how endotherms and ectotherms regulate body temperature.

40.4 Relate the energy requirements and metabolic rate of animals to their size, activity, and environment.

This chapter will build on information you have learned earlier in the course, as well as prepare you to better understand the workings of various animal systems. The important ideas of surface area/volume, regulation, and homeostatic mechanisms are fundamental to your understanding of biology. As you study, focus your attention on the larger picture of how evolution has shaped solutions to the same challenges in both plants and animals, showing both their unity and diversity.

Study Tip: Figure 40.1 in your text uses Emperor penguins to illustrate three types of adaptations that will help an animal maintain its internal environment. What are these three categories of adaptation?

Concept 40.1 Animal form and function are correlated at all levels of organization

LO 40.1: Identify the levels of organization within the animal body, and use examples to show how structure and function are related at each level.

1. Animals need to exchange nutrients, waste products, and gases with their environment. Exchange occurs as substances dissolved in an aqueous medium move across the plasma membrane of each cell. Regardless of size, every cell must be bathed in fluid and have access to oxygen, nutrients, and other resources. For each of the following organisms, describe and explain how this is possible. Try to relate your responses to what you learned in Chapter 7 about surface area/volume ratios.

   amoeba

   hydra

   tapeworm

   whale

2. What is *interstitial fluid* and how does it aid this exchange of materials?

3. Cells are organized into tissues. Define *tissues.*

4. There are four types of animal tissues, listed in the first column. Under each tissue type, give a general description of its unique features. Then, working from the more specific examples of each tissue, complete the chart by giving functions of the specific tissue and places it may be found.

Tissue type	Examples	General Function	Locations
Epithelial	cuboidal simple columnar simple squamous stratified squamous		
Connective	loose connective fibrous connective cartilage adipose blood bone		
Muscle	skeletal smooth cardiac		
Nervous	neurons glial cells		

5. Tissues are organized into *organs,* such as lungs or liver, and organs are arranged into *systems*. Table 40.1 in your text lists the organ systems in mammals, which organs compose the system, and functions of the system. You are likely familiar with all of these organ systems and organs, so just scan the table for any new terms that are unfamiliar. After you do this, test your knowledge with these questions:

   a. What are two respiratory organs?

   b. What is the primary function of the respiratory system?

6. Coordination and control require communication between different locations in an animal's body. The major systems that transmit information are the endocrine and nervous systems. How do they differ in the following?

	Endocrine	Nervous
Signal type		
Transmission		
Speed and duration		
Response		

Concept 40.2 Feedback control maintains the internal environment in many animals

LO 40.2: Distinguish how negative feedback and positive feedback mechanisms regulate internal conditions.

7. Explain the difference between animals that are *regulators* and those that are *conformers* for an environmental variable.

8. The example in the text is related to temperature regulation. Would an ectotherm, such as a snake, be a regulator or a conformer?

9. Throughout the text, a common theme is regulation of homeostasis by feedback loops. We will discuss feedback loops again as we look at hormone levels. What is meant by a *set point*?

10. Describe an example of a *negative feedback loop*. Clearly identify the *set point*, the *stimulus*, and the *response*.

11. We sometimes say that in negative feedback "more gets you less," and in positive feedback "more gets you more" (that is, the signal is amplified).

    a. Describe an example of a *positive feedback loop*.

    b. Positive feedback loops do not play a major role in _____ in animals, but instead help drive the process to _____.

12. Both plants and animals show *circadian rhythms*. What are some examples of human metabolic activities that show daily cycles? How can these be regulated or changed?

13. If you wanted to successfully summit a high mountain such as Kilimanjaro in Africa, *acclimatization* would be important. What physiological changes would be involved?

    Would this be adaptation in the evolutionary sense?

Concept 40.3 Homeostatic processes for thermoregulation involve form, function, and behavior

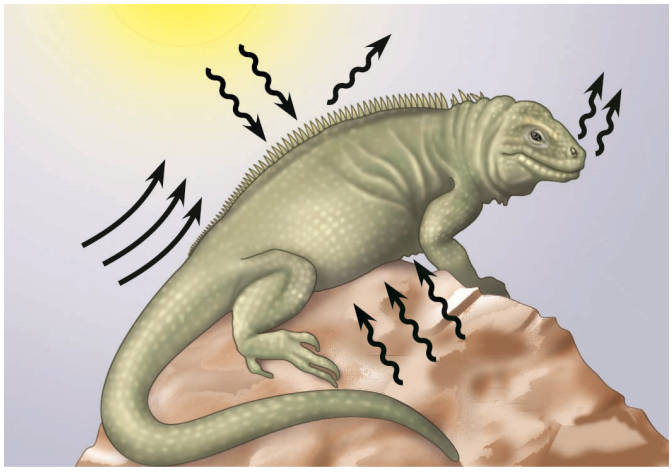
LO 40.3: Use examples to demonstrate how endotherms and ectotherms regulate body temperature.

14. What is *thermoregulation?*

15. Describe the difference between *endothermy* and *ectothermy* and give an example of each.

Property	Description	Example
Endothermy		
Exothermy		

16. What are the four processes by which heat is exchanged with the environment? Use this figure to name and explain each process.



17. Discuss how each of the following is a thermoregulatory adaptation:

feathers

adipose tissue

vasodilation/vasoconstriction

burrowing/sunning

18. *Countercurrent exchange* mechanisms help maintain homeostasis in several different systems. For example, heat loss in extremities is reduced by *countercurrent exchange*. Use this figure to explain how *countercurrent exchange* works by describing what occurs at each numbered point.

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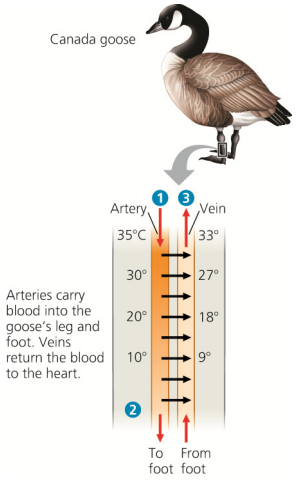

19. What is the role of the *hypothalamus* in temperature regulation?

Concept 40.4 Energy requirements are related to animal size, activity, and environment

LO 40.4: Relate the energy requirements and metabolic rate of animals to their size, activity, and environment.

20. What is the *metabolic rate*? In what units is it usually measured?

21. What is basal metabolic rate (BMR)?

22. What is the relationship between *BMR* and body mass?

23. What is the evolutionary advantages of *torpor?*

    Compare *hibernation* and *estivation*.

24. If a mouse and a small lizard of the same mass (both at rest) were placed in experimental chambers under identical environmental conditions, which animal would consume oxygen at a higher rate? Explain.

Make Connections Figure 40.23

It is important to always try to relate what you learn across domains. This figure is especially helpful in giving examples of life challenges common to plants and animals.

25. Multicellular organisms face common challenges, which are listed below. For each challenge, describe how the challenge has been solved in plants as well as animals.

Challenge	Plant Solution	Animal Solution
Nutritional mode		
Environmental response		
Growth and regulation		
Transport		
Reproduction		
Absorption		
Gas exchange		

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1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____

7. _____