

Chapter 35

Behavioral Adaptations to the Environment



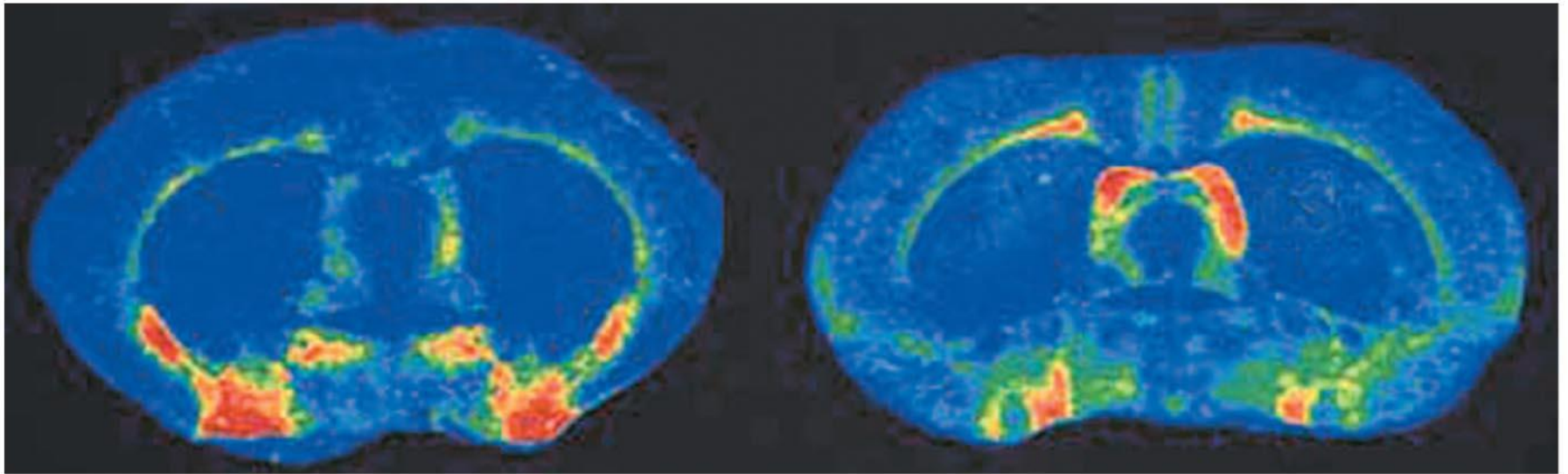
PowerPoint Lectures for
Biology: Concepts & Connections, Sixth Edition
Campbell, Reece, Taylor, Simon, and Dickey

Lecture by Brian R. Shmaefky

Introduction: *Of Mice and Monogamy*

- **Behavior** encompasses a wide range of activities
- Scientists study the mechanisms of behavior in an evolutionary context
- Learning has genetic and environmental behavioral aspects
- Behaviors are involved in survival and reproductive success
- Many animals exhibit social behavior
- Sociobiology is social behavior applied to humans





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THE SCIENTIFIC STUDY OF BEHAVIOR

35.1 Behavioral ecologists ask both proximate and ultimate questions

- Behavioral ecologists study what animals do when interacting with their environment
- Behavior can be interpreted in terms of proximate causes and ultimate causes with the environment
 - **Proximate causes** are immediate mechanisms for a behavior
 - **Ultimate causes** are the evolutionary explanations for behavior

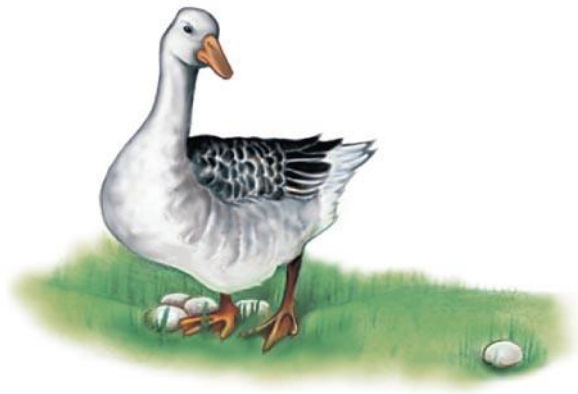


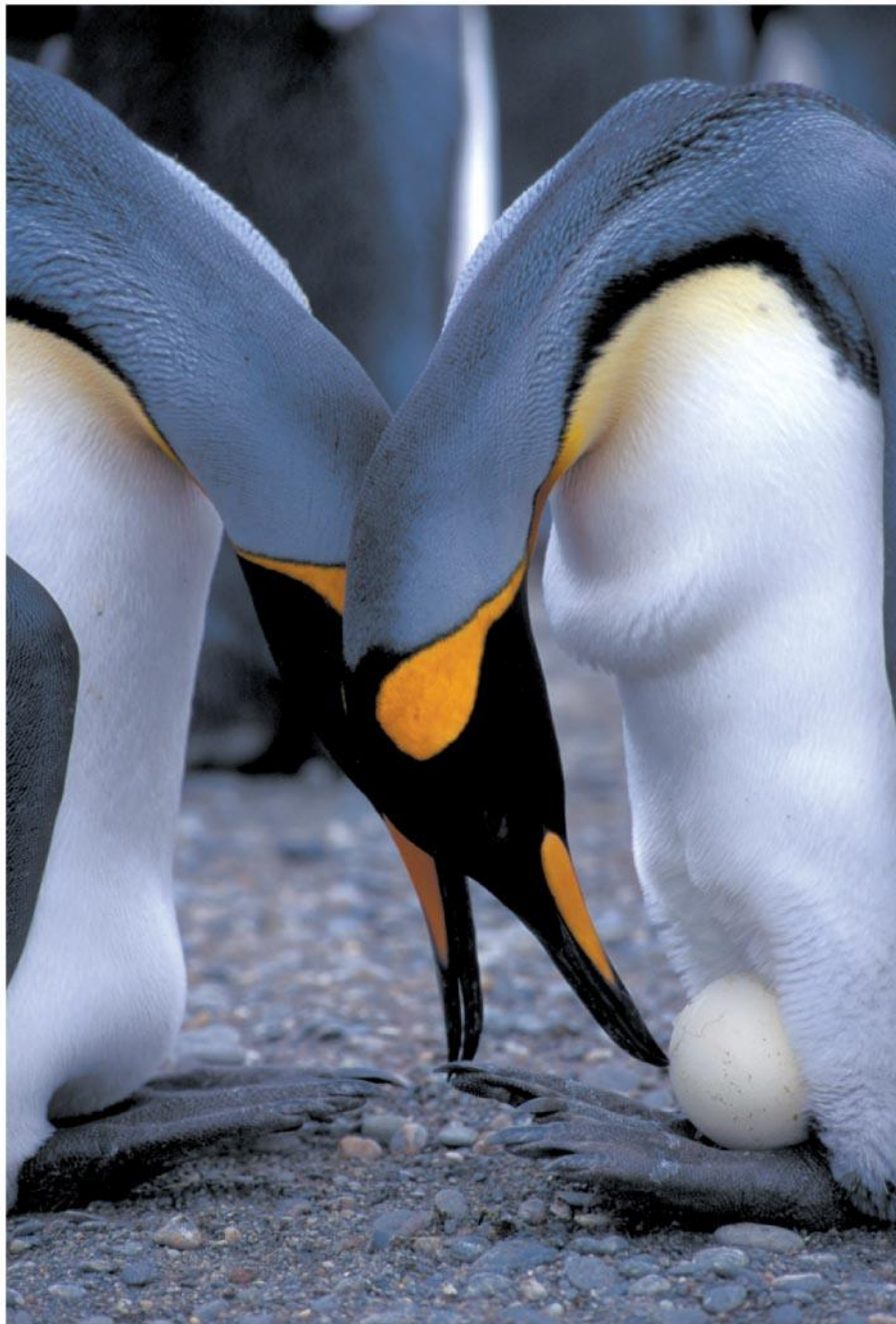
35.2 Fixed action patterns are innate behaviors

- Konrad Lorenz and Niko Tinbergen were among the first to demonstrate the importance of **innate behavior**
- Innate behaviors are under strong genetic control and are performed in virtually the same way by all individuals of a species
 - Many of Lorenz's and Tinbergen's studies were concerned with behavioral sequences called **fixed action patterns (FAPs)**
 - A FAP is an unchangeable series of actions triggered by a specific stimulus

35.2 Fixed action patterns are innate behaviors

- A **sign stimulus** triggers fixed action patterns
 - A sign stimulus is often a simple clue in an animal's environment
- The genetic programming underlying a FAP ensures that the activity is performed correctly without practice
 - Examples are
 - Mating behaviors
 - Parent-offspring interactions

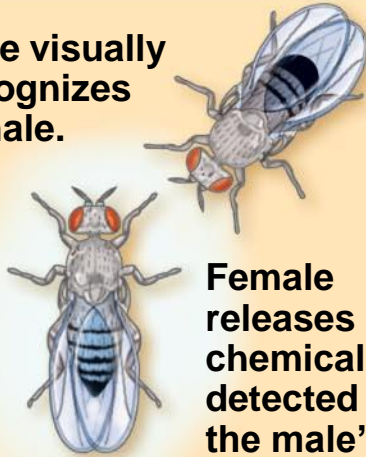




35.3 Behavior is the result of both genetic and environmental factors

- Animal behavior often involves a combination of genetic programming and environmental factors
 - Genetic programming includes innate behaviors
 - Environmental factors contribute to learning
- The nature-versus-nurture debate is not an either/or argument
 - It is about how both the genes and the environment interact to influence the development of phenotypic traits

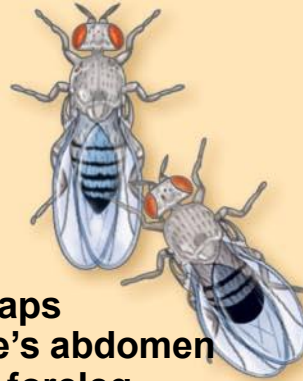
Male visually recognizes female.



Female releases chemicals detected by the male's sense of smell.

Orienting

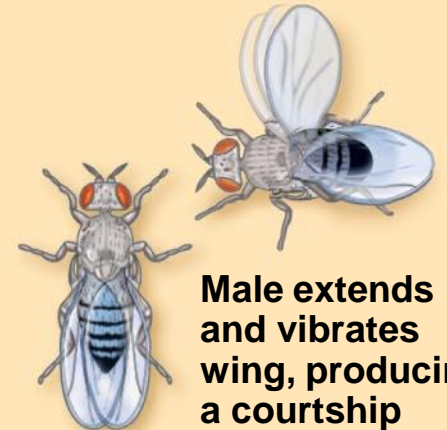
Male taps female's abdomen with a foreleg.



Tapping

"Singing"

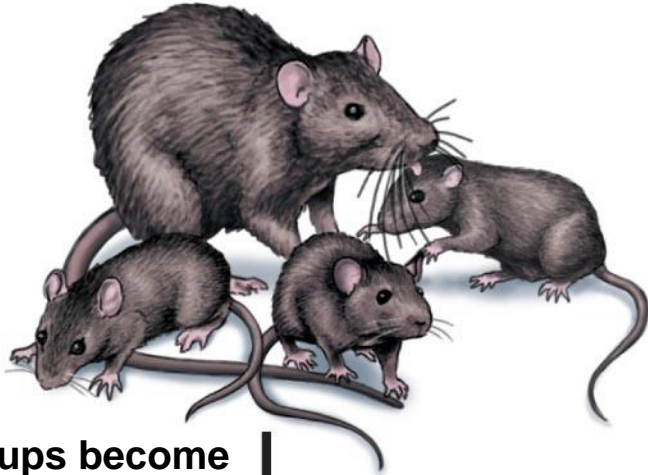
Male extends and vibrates wing, producing a courtship song.



35.3 Behavior is the result of both genetic and environmental factors

- Research on rats shows that interactions with the mother change the pattern of gene expression in the pups
- This experiment provides evidence that behavior is the product of both genetic and environmental factors
- The interaction of genes and the environment appears to determine most animal behaviors

High-interaction mother



Pups become relaxed adults

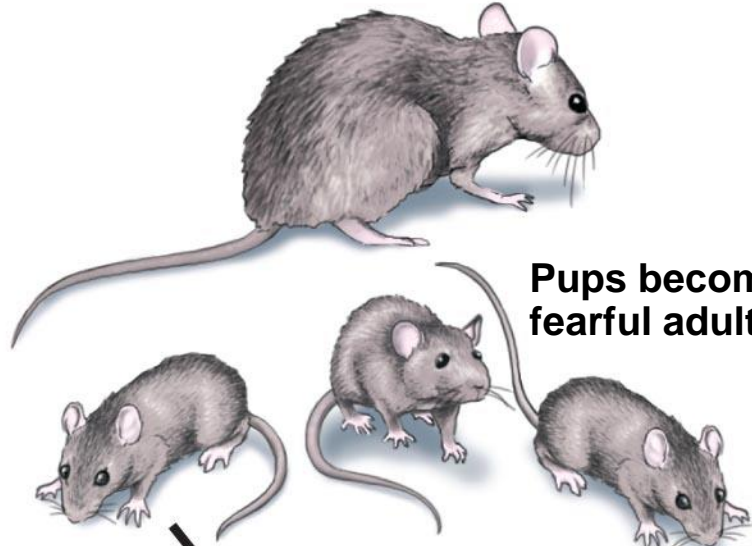


Female pups become high-interaction mothers



Pups become relaxed adults

Low-interaction mother



Pups become fearful adults

Female pups become low-interaction mothers



Cross-fostering experiment



Pups become fearful adults

LEARNING

35.4 Learning establishes specific links between experience and behavior

- **Learning** is modification of behavior as a result of specific experiences
- Learning enables animals to change their behaviors in response to changing environmental conditions
- There are various forms of learning
 - Simple behavioral change in response to a single stimulus
 - Complex problem solving involving entirely new behaviors

TABLE 35.4**TYPES OF LEARNING**

Learning Type	Defining Characteristic
Habituation	Loss of response to a stimulus after repeated exposure
Imprinting	Learning that is irreversible and limited to a sensitive time period in an animal's life
Spatial learning	Use of landmarks to learn the spatial structure of the environment
Cognitive mapping	An internal representation of the spatial relationships among objects in the environment
Associative learning	Behavioral change based on linking a stimulus or behavior with a reward or punishment; includes trial-and-error learning
Social learning	Learning by observing and mimicking others
Problem solving	Inventive behavior that arises in response to a new situation

35.4 Learning establishes specific links between experience and behavior

- **Habituation** is one of the simplest forms of learning
 - An animal learns not to respond to a repeated stimulus that conveys little or no information
 - In terms of ultimate causation, habituation may increase fitness by allowing an animal's nervous system to focus on stimuli that signal
 - Food
 - Mates
 - Real danger

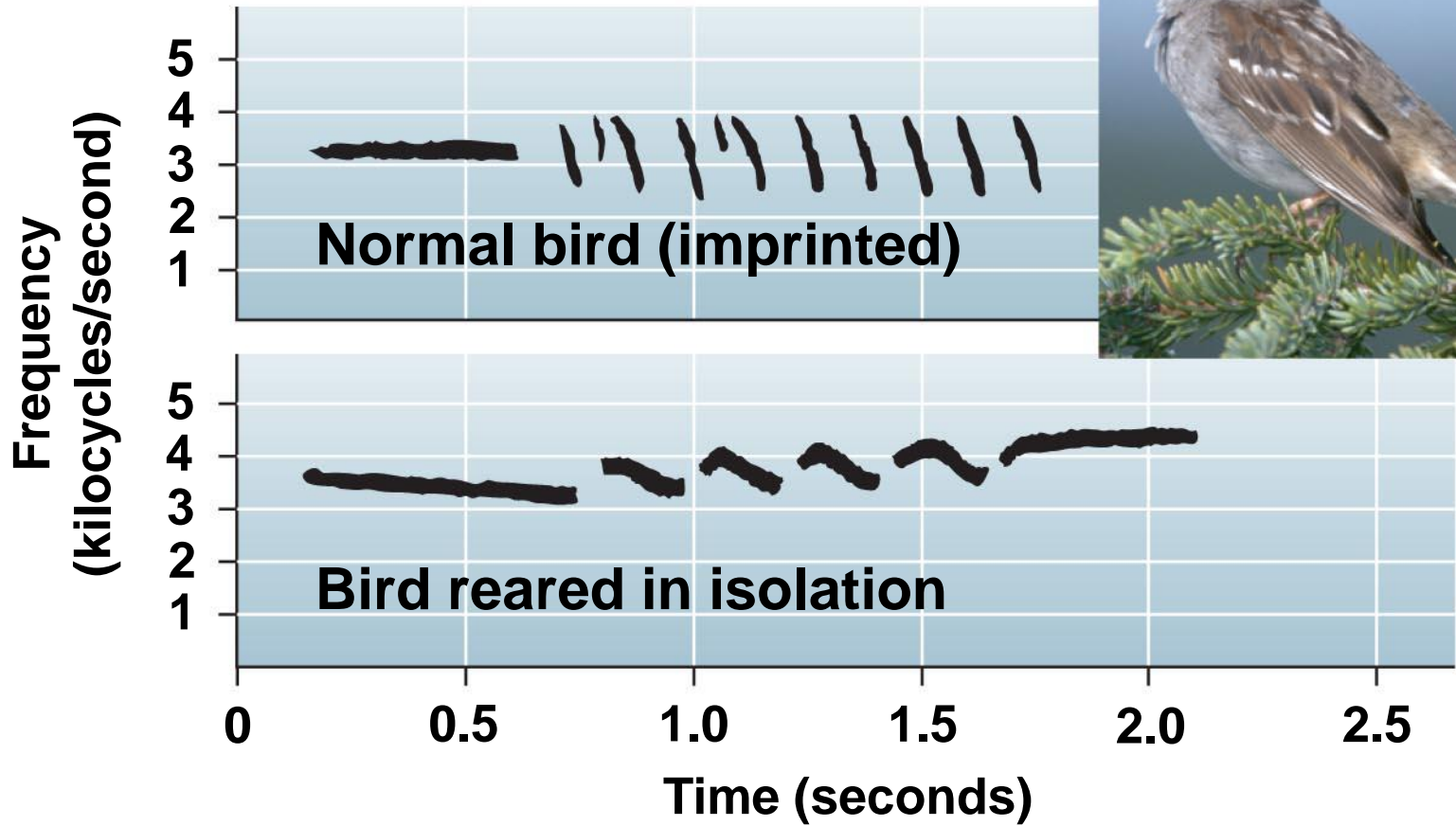
35.5 Imprinting requires both innate behavior and experience

- **Imprinting** is irreversible learning limited to a **sensitive period** in an animal's life
 - Imprinting enhances fitness by enabling rapid learning

PLAY

Video: Ducklings





35.6 CONNECTION: Imprinting poses problems and opportunities for conservation programs

- In attempting to save species that are at the edge of extinction, biologists sometimes try to increase their numbers in captivity
 - Rearing animals in captivity is often successful
 - But without parents available as models for imprinting, the offspring may not learn appropriate behaviors





35.7 Animal movement may be a simple response to stimuli or require spatial learning

- **Kinesis** is a random movement in response to a stimulus
 - A kinesis may be merely starting or stopping, changing speed, or turning more or less frequently
- **Taxis** is a response directed toward (positive taxis) or away from (negative taxis) a stimulus
 - Many stream fish, such as trout, exhibit positive taxis in the current; they automatically swim or orient in an upstream direction



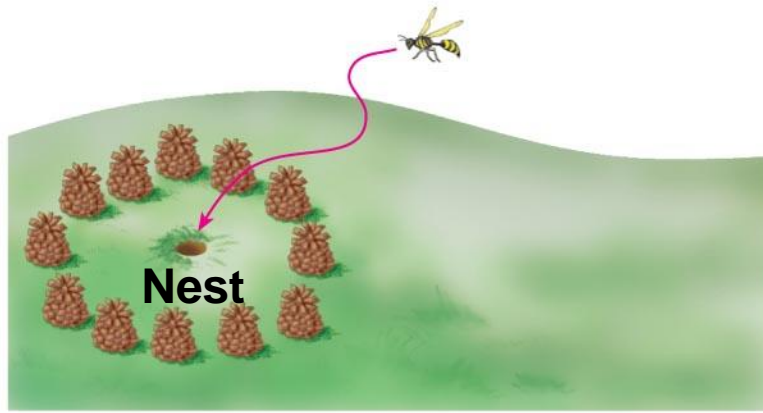
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**Direction
of river
current**

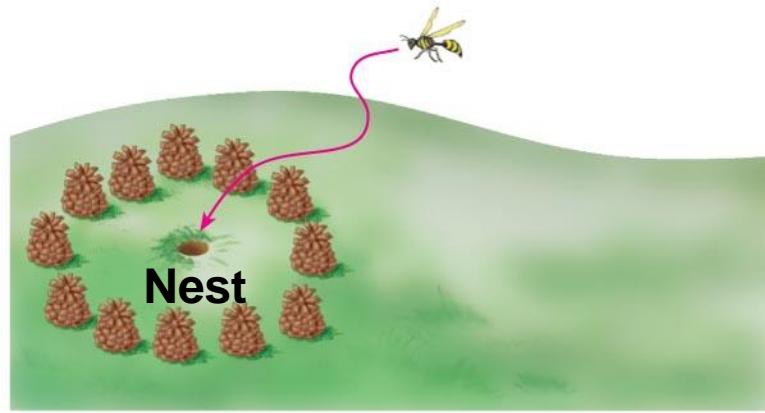


35.7 Animal movement may be a simple response to stimuli or require spatial learning

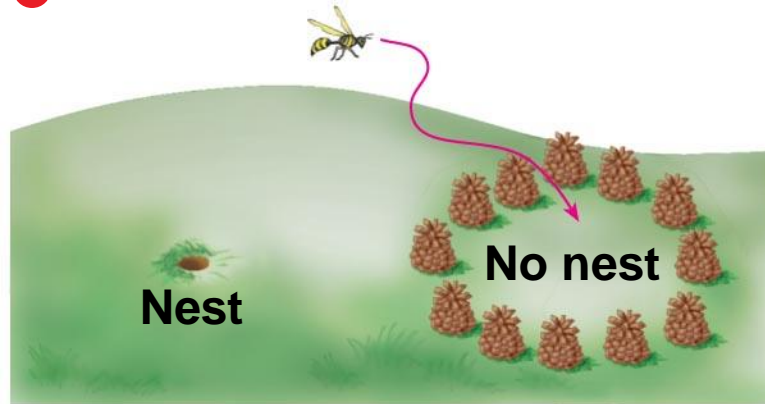
- In **spatial learning**, animals establish memories of landmarks in their environment
- Landmarks indicate the locations of food, nest sites, prospective mates, and potential hazards
 - The digger wasp uses landmarks to keep track of her nests



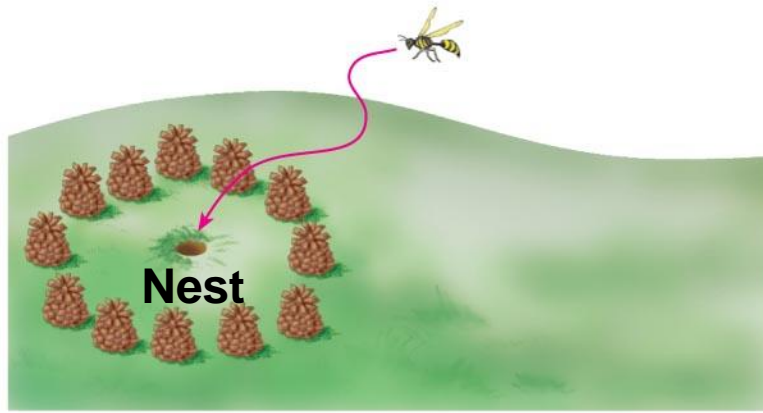
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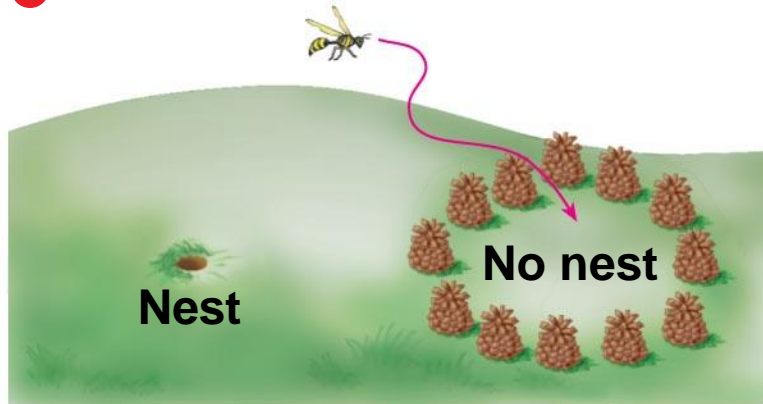
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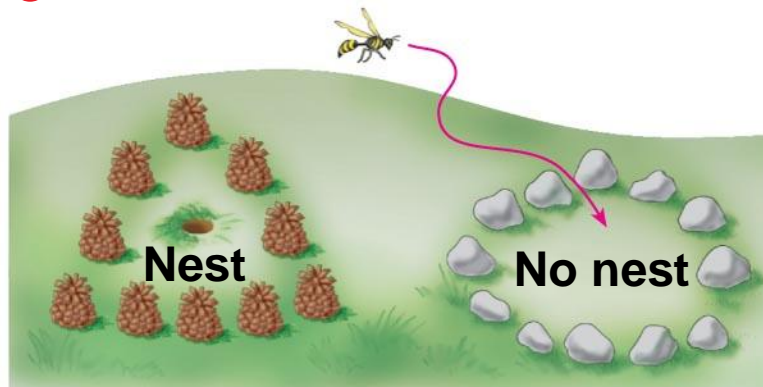
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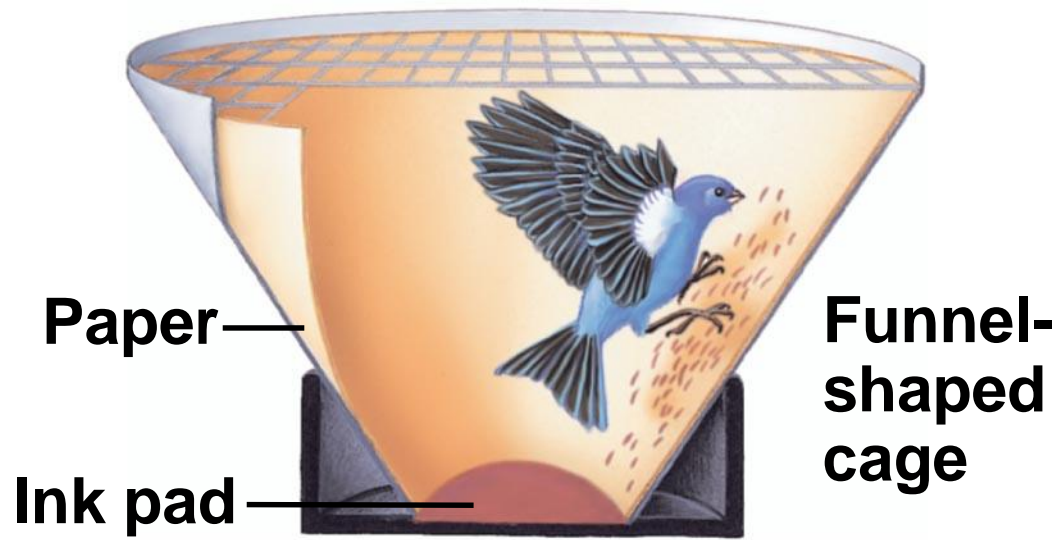
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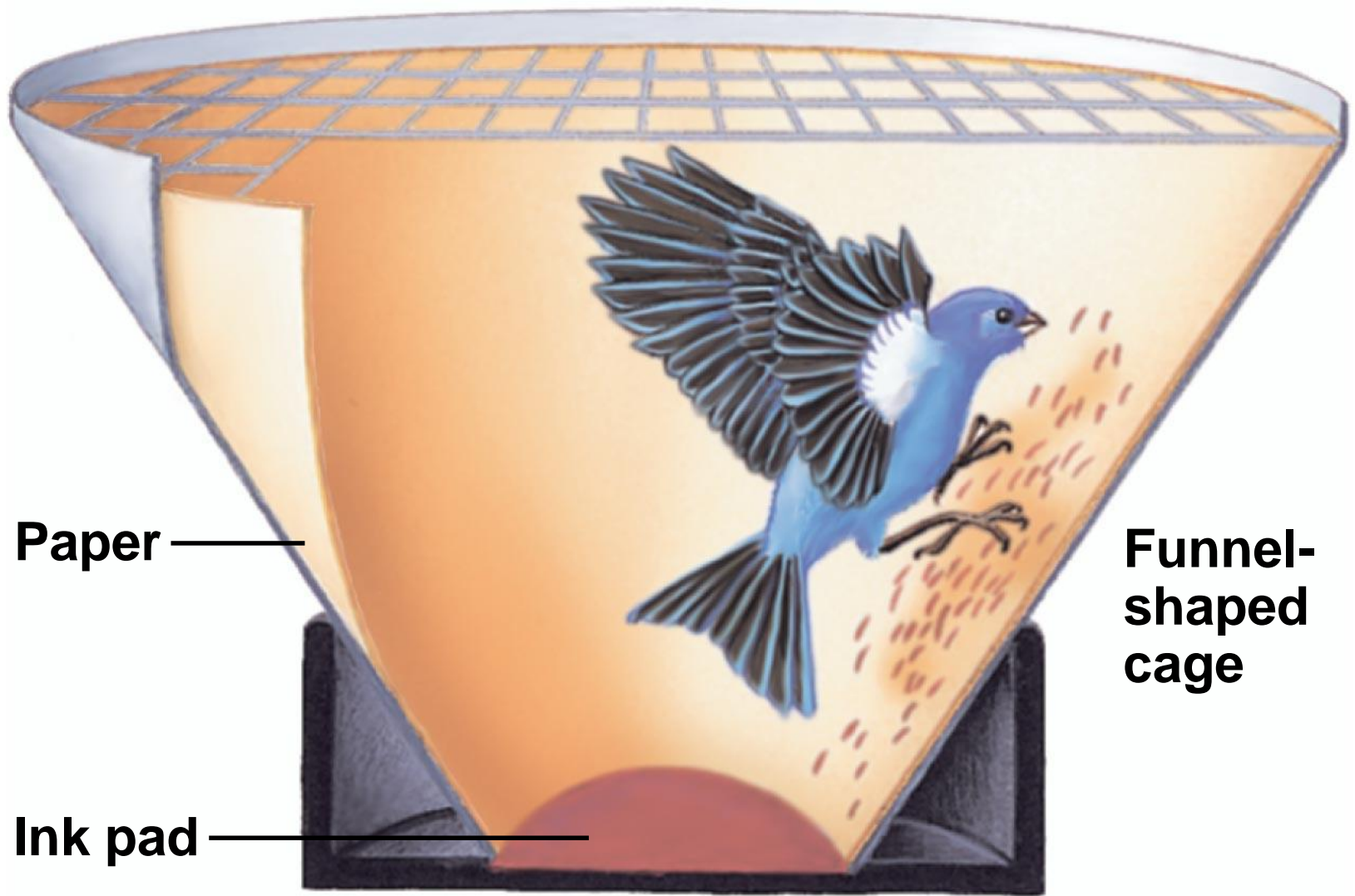


3

35.8 Movements of animals may depend on internal maps

- An animal can move around its environment using landmarks alone
 - A **cognitive map** is an internal representation, or code, of the spatial relationships among objects in an animal's surroundings





Paper —

Funnel-shaped cage

Ink pad —



35.8 Movements of animals may depend on internal maps

- Movement in a directed way enables animals to
 - Avoid predators
 - Migrate to a more favorable environment
 - Obtain food
 - Find mates and nest sites

35.9 Animals may learn to associate a stimulus or behavior with a response

- **Associative learning** is learning that a particular stimulus or response is linked to a reward or punishment
 - **Trial-and-error learning** is an animal's ability to learn to associate one of its own behaviors with a positive or negative effect



35.10 Social learning employs observation and imitation of others

- **Social learning** is learning by observing the behavior of others
 - Many predators learn some of their basic hunting tactics by observing and imitating their mothers



35.11 Problem-solving behavior relies on cognition

- **Cognition** is the ability of an animal's nervous system to perceive, store, process, and use information
 - Some animals have complex cognitive abilities that include problem solving
 - **Problem solving** is the ability to apply past experience to novel situations
 - Problem-solving behavior is highly developed in some mammals, especially dolphins and primates

PLAY

Video: Chimp Cracking Nut





SURVIVAL AND REPRODUCTIVE SUCCESS

35.12 Behavioral ecologists use cost-benefit analysis in studying foraging

- Animals are generally selective and efficient in their food choices
 - Some animals, such as crows, are feeding “generalists”
 - Other animals, such as koalas, are feeding “specialists”
- Natural selection seems to have shaped feeding behavior to maximize energy gain and minimize the expenditure of time and energy
 - This is the **theory of optimal foraging**

35.12 Behavioral ecologists use cost-benefit analysis in studying foraging

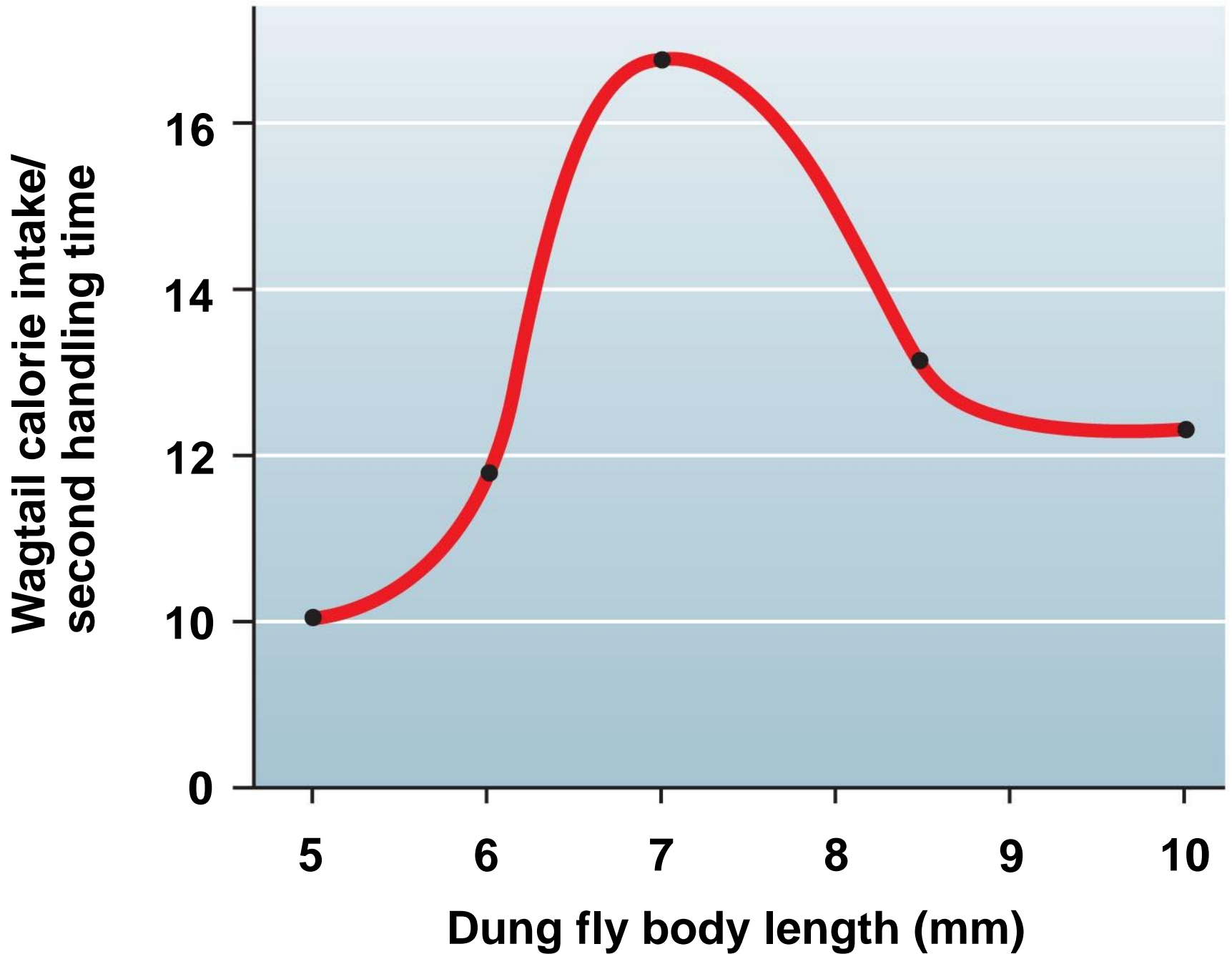
- The mechanism that enables an animal to find particular foods efficiently is called a **search image**

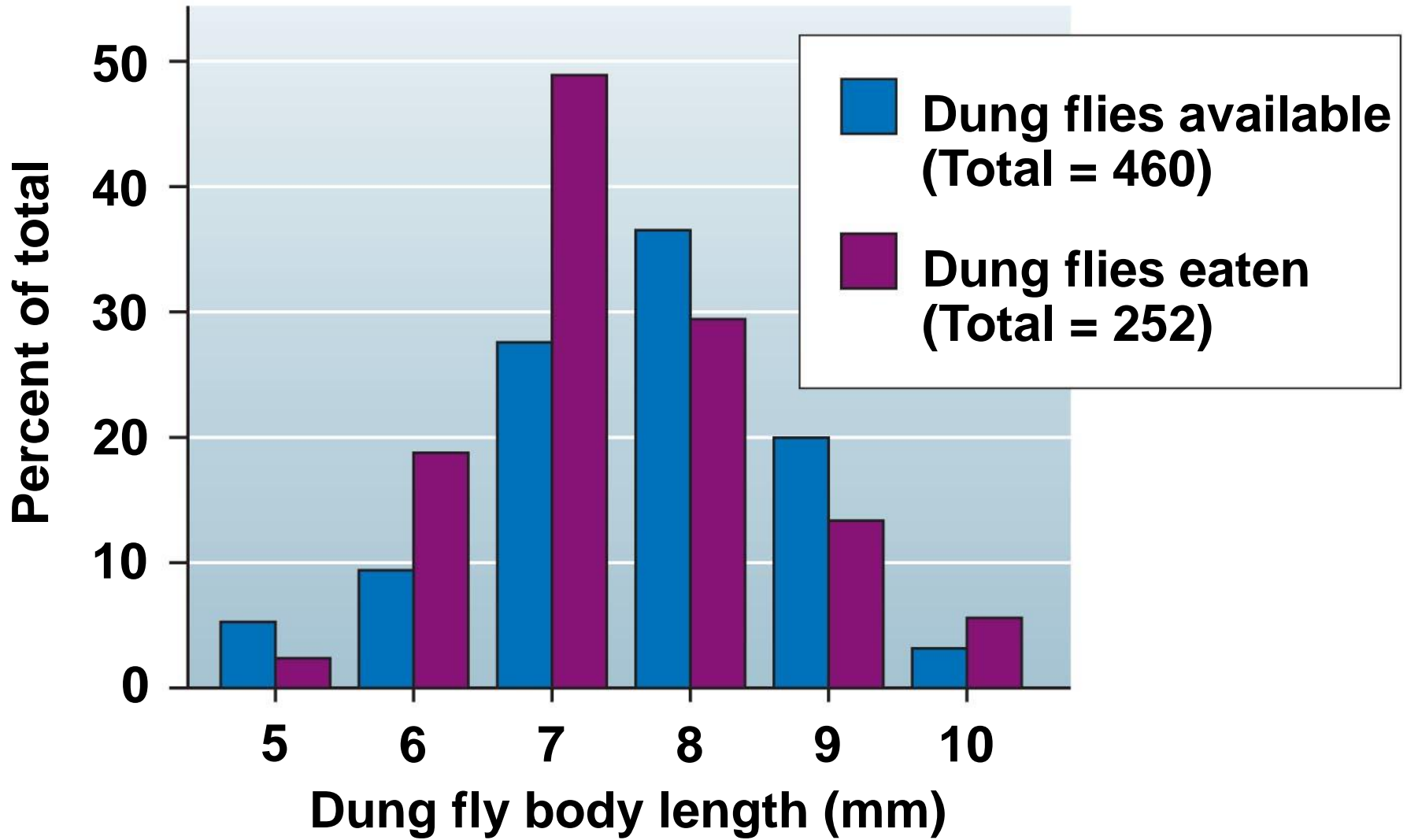


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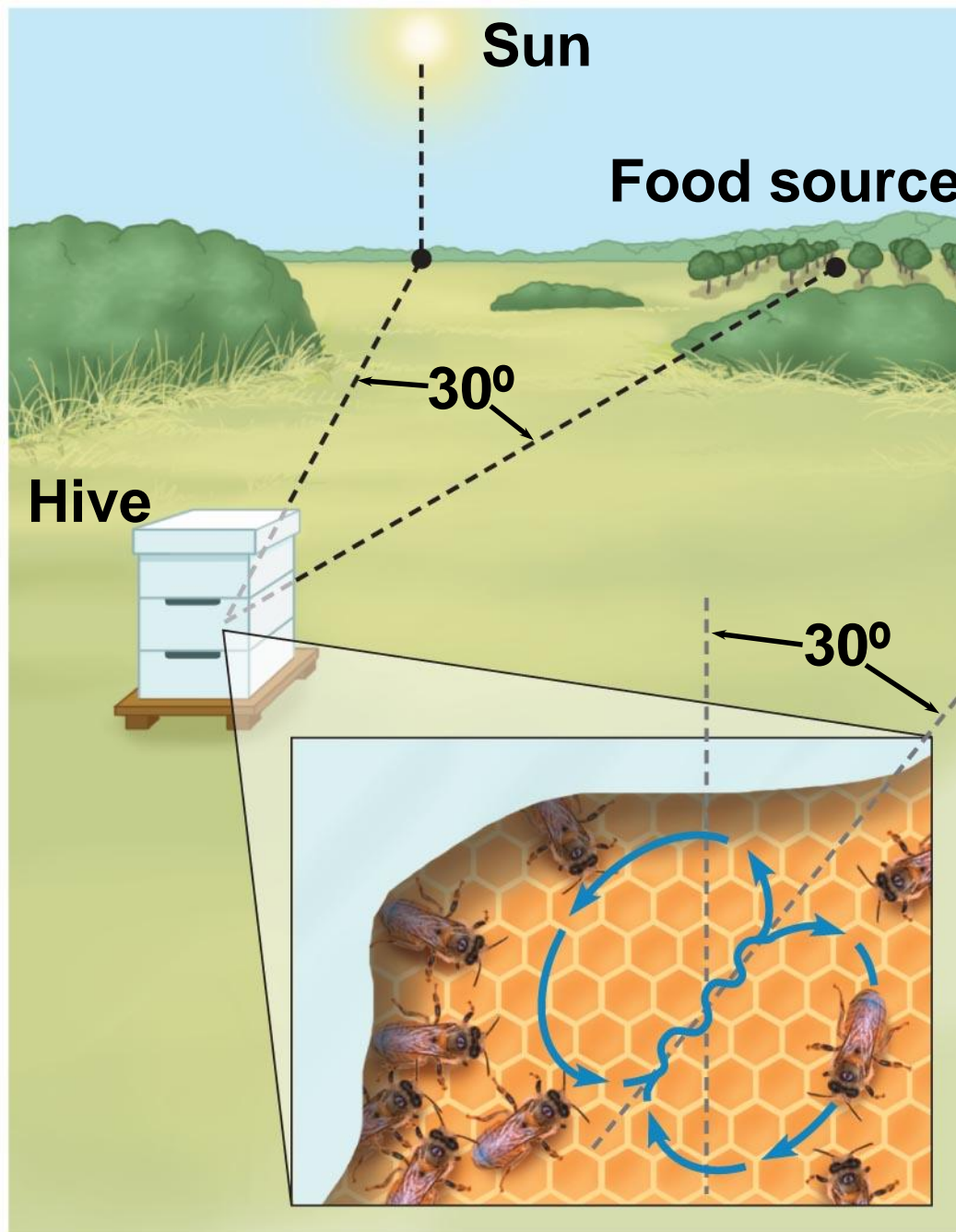
35.13 Communication is an essential element of interactions between animals

- **Communication** is an essential element of interactions between individuals
 - Communication is a signal stimulus transmitted by one animal to another animal
 - The more complex the social organization of a species, the more complex the signaling required to sustain it

PLAY

Video: Bee Pollinating





35.13 Communication is an essential element of interactions between animals

- Animal communication can use the following types of signaling
 - Sounds
 - Scents
 - Displays
 - Touches



35.14 Mating behavior often involves elaborate courtship rituals

- Careful communication is an essential prerequisite for mating
 - In many species, prospective mates must perform an elaborate courtship ritual
 - The ritual confirms that individuals are of the same species, of the opposite sex

PLAY

Video: Albatross Courtship Ritual

PLAY

Video: Blue-footed Boobies Courtship Ritual

PLAY

Video: Giraffe Courtship Ritual



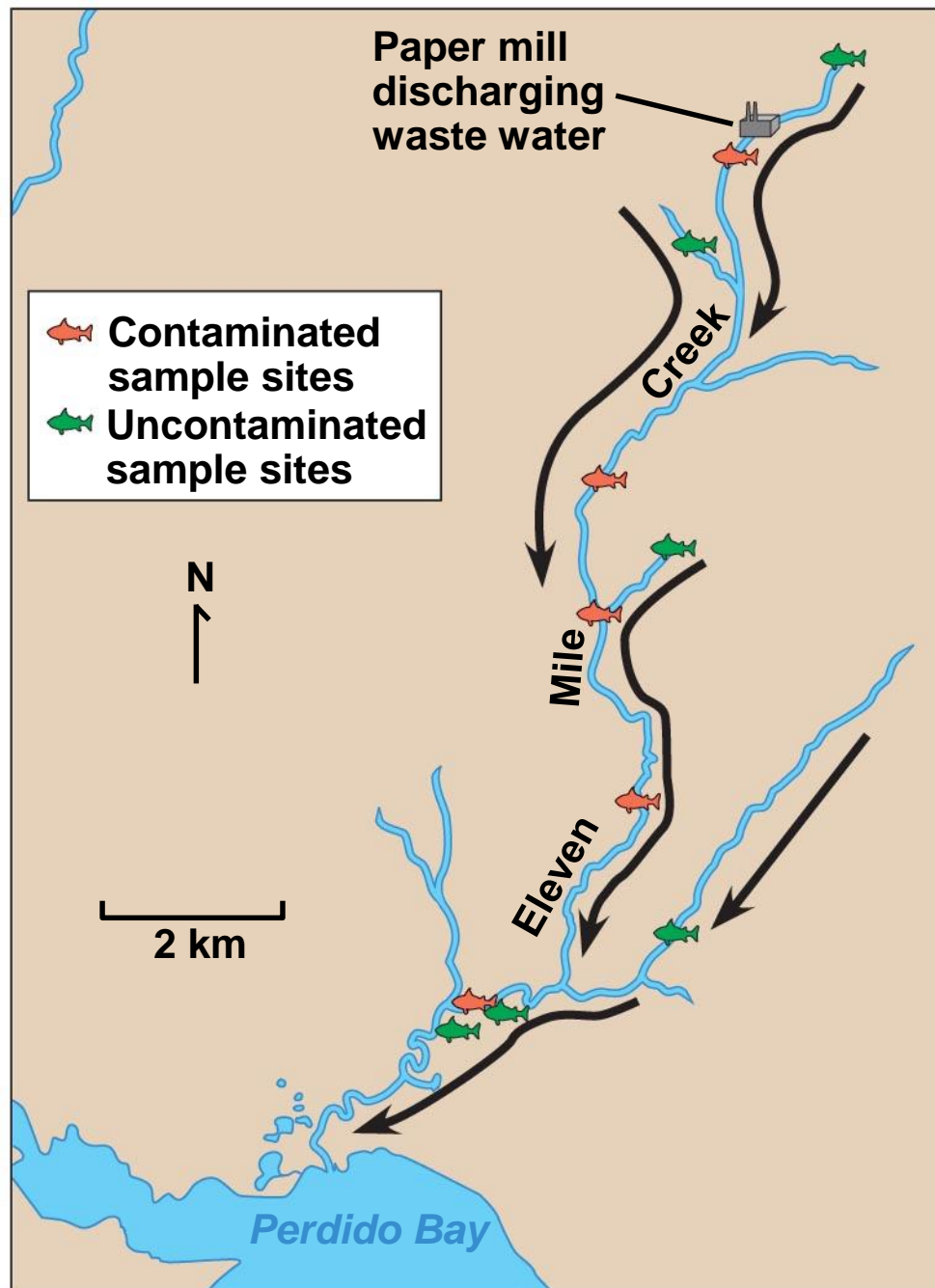
35.15 Mating behaviors and parental care enhance reproductive success

- Natural selection favors mating behaviors that enhance reproductive success
 - The needs of the young are an important factor in the evolution of mating systems
 - Individuals with genes for favorable mating behaviors reproduce more successfully and pass those genes on to the next generation



35.16 CONNECTION: Chemical pollutants can cause abnormal behavior

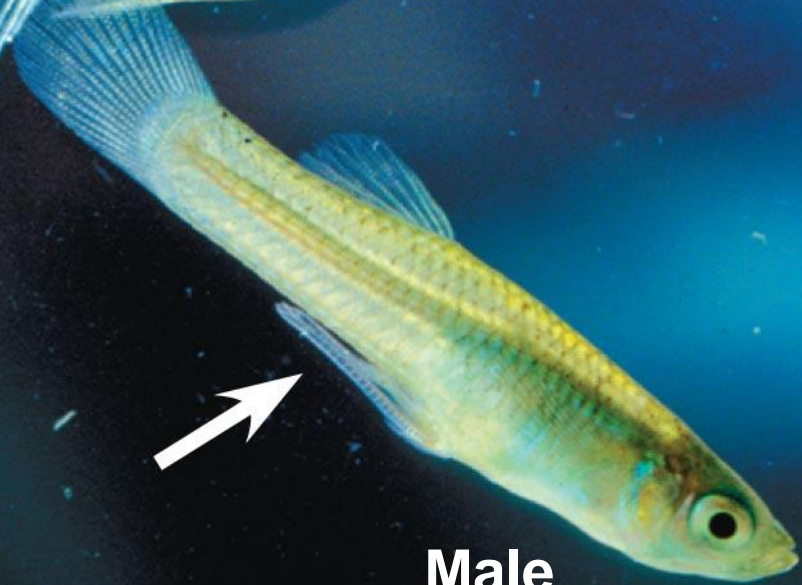
- Scientists have linked observations of these abnormal behaviors to **endocrine disrupting** chemicals
 - Like hormones, endocrine disruptors also affect behavior
 - For example, some male fish defend territories to attract females during the breeding season; males have high levels of androgens (male hormones) during this time
 - Researchers showed that the intensity of nest-guarding behavior in certain male fish dropped after they were exposed to pollutants that mimic the female hormone estrogen



Female



Male



SOCIAL BEHAVIOR AND SOCIOBIOLOGY

35.17 Sociobiology places social behavior in an evolutionary context

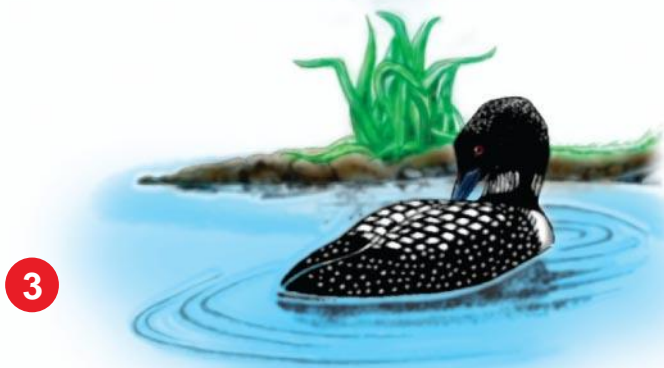
- Biologists define social behavior as any kind of interaction between two or more animals, usually of the same species
 - **Sociobiology** applies evolutionary theory to the study and interpretation of social behavior
 - Sociobiology explains how social behaviors are adaptive and how they could have evolved by natural selection



1



2



3

35.18 Territorial behavior parcels space and resources

- Many animals exhibit territorial behavior
 - A **territory** is an area, usually fixed in location, which individuals defend and from which other members of the same species are usually excluded
 - Territory behavior is a form of social behavior that partitions resources





35.19 Agonistic behavior often resolves confrontations between competitors

- Conflicts that arise over limited resources, such as food, mates, or territories, are settled by agonistic behavior
 - **Agonistic behavior** is social behavior that consists of threats and combat that settles disputes between individuals in a population
 - Agonistic behavior can directly affect an individual's evolutionary fitness
 - The victor often gains first or exclusive access to the resources

35.19 Agonistic behavior often resolves confrontations between competitors

PLAY

Video: Chimp Agonistic Behavior

PLAY

Video: Snake Ritual Wrestling

PLAY

Video: Wolves Agonistic Behavior



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35.20 Dominance hierarchies are maintained by agonistic behavior

- Many animals live in social groups maintained by agonistic behaviors
- **Dominance hierarchy** is the ranking of individuals based on social interactions
 - Pecking order in chickens is an example of a dominance hierarchy



35.21 TALKING ABOUT SCIENCE: Behavioral biologist Jane Goodall discusses dominance hierarchies and reconciliation behavior in chimpanzees

- Dr. Jane Goodall has studied the behavior of chimpanzees in their natural habitat, in East Africa, since the early 1960s
- Her research indicates that dominance hierarchies and reconciliation behaviors are integral parts of the lives of many primates
 - Social primates seem to spend substantial time in reconciliation and pacification-type behavior





35.22 EVOLUTION CONNECTION: Altruistic acts can often be explained by the concept of inclusive fitness

- Many social behaviors are selfish
 - These behaviors maximize an individual's survival and reproductive success
 - These behaviors must be favored by selection
- Many social animals also exhibit altruism
 - **Altruism** is a behavior that reduces an individual's fitness while increasing the fitness of others in the population

35.22 EVOLUTION CONNECTION: Altruistic acts can often be explained by the concept of inclusive fitness

- Some altruistic acts can be explained in terms of kin selection
 - An animal can increase the survival of genes like its own by helping relatives
- In reciprocal altruism, a favor may be repaid later by the beneficiary or another member of the social system
 - This explains altruistic acts by nonrelatives





35.23 Human behavior is the result of both genetic and environmental factors

- Sociobiology is based on the concept that social behavior evolves, like anatomical traits, as an expression of genes
- Sociobiologists believe that natural selection underlies many human behaviors
 - Twins provide a natural laboratory for investigating the origins of complex behavioral traits

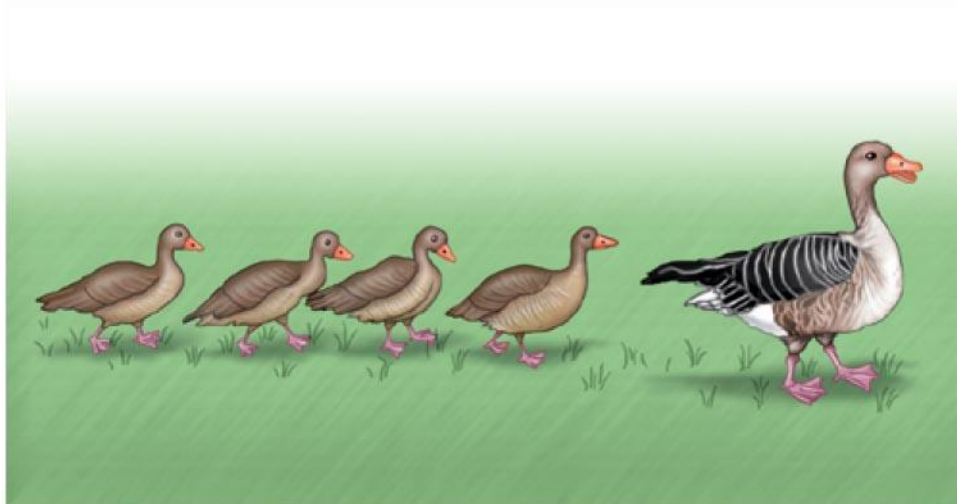




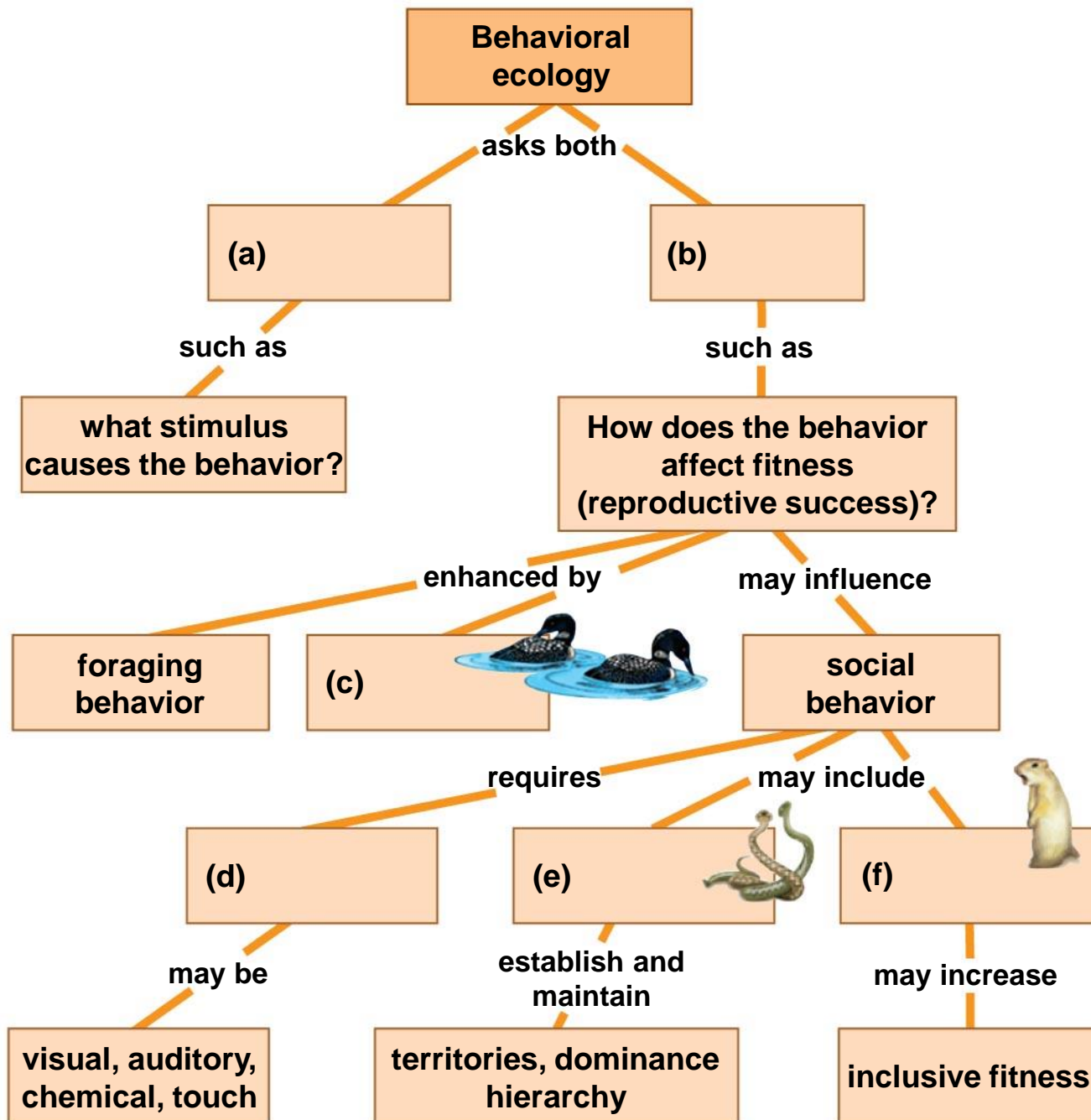
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Height of drop (m)	Average number of drops required to break shell	Total flight height (number of drops × height per drop)
2	55	110
3	13	39
5	6	30
7	5	35
15	4	60

You should now be able to

1. Distinguish between proximate and ultimate questions
2. Describe the characteristics of an innate behavior
3. Explain the genetic and environmental factors of behavior
4. Describe the role of imprinting on learning
5. Explain the genetic and learned aspects of cognition

You should now be able to

6. Use a cost-benefit analysis to explain animal mating behaviors
7. Describe how sociobiology is used to explain territorial behaviors
8. Define altruism and how it relates to the survival of populations