Africanized honeybees have an aggressive response to alarm pheromones – signal molecules that affect others of the same species.
44.1 Behavioral Genetics

- Genes affect behavior
  - Genes that affect structure and activity of the nervous system affect the way animals react to a stimulus
  - Mutations that affect metabolism or structural traits also affect behavior
Studying Variation Within a Species

- Garter snakes and food preferences
  - Coastal garter snakes prefer to eat banana slugs
  - Inland garter snakes ignore banana slugs
  - Hybrids have an intermediate response

- Inland snakes lack a genetically determined ability to associate the scent of slugs with food
Garter Snakes and Food Preferences
Foraging behavior in fruit flies

- 70% of wild fruit flies are “rovers”, 30% “sitters”
- Genotype at the \textit{foraging} (\textit{for}) gene determines whether a fly is a rover (\textit{FF} or \textit{Ff}) or a sitter (\textit{ff})
- The \textit{for} gene encodes an enzyme (PKG) active in intercellular signaling pathways
- Learning and memory are also affected
## Foraging Behavior in Fruit Flies

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Rover</th>
<th>Sitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foraging behavior</td>
<td>Switches feeding area frequently</td>
<td>Tends to feed in one area</td>
</tr>
<tr>
<td>Genotype</td>
<td>$FF$ or $Ff$</td>
<td>$ff$</td>
</tr>
<tr>
<td>PKG (enzyme) level</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Speed of learning olfactory cues</td>
<td>Faster</td>
<td>Slower</td>
</tr>
<tr>
<td>Long-term memory for olfactory cues</td>
<td>Shorter</td>
<td>Longer</td>
</tr>
</tbody>
</table>
Comparisons Among Species

- Pair-bonding in prairie voles
  - Prairie voles mate for life
  - Mountain voles are promiscuous
  - Prairie voles have more oxytocin receptors than mountain voles
  - Prairie voles injected with a drug that blocks action of oxytocin dumped their partners
Oxytocin Receptors in Prairie Voles
Knockouts and Other Mutations

- Maternal behavior in mice
  - Mice with oxytocin receptors knocked out do not lactate, and are less likely to retrieve pups removed from the nest

- Male fruit flies with a mutation in the *fruitless* gene lack certain brain neurons
  - Do not perform normal courtship movements
  - Court other males as well as females
44.2 Instinct and Learning

- **Instinctive behavior** is inborn and can be performed without any prior experience.

- **Fixed action pattern**
  - A series of instinctive movements, triggered by a specific stimulus, that (once started) is carried to completion without further cues.
The cuckoo bird is a social parasite that lays its egg in other birds’ nests

- The newly hatched cuckoo eliminates competition by instinctively rolling other eggs out of the nest
- The foster parents instinctively respond to the cuckoo’s open mouth by feeding it
Cuckoo Bird: Instinctive Behaviors
Time-Sensitive Learning

- **Learned behavior**
  - Behavior that is altered by experience
  - Some instinctive behavior can be modified by learning (such as avoiding unpalatable prey)

- **Imprinting**
  - A form of learning that occurs during a genetically determined time period
  - *Example*: Songbirds learn their species-specific song during a limited period early in life
Konrad Lorenz and Imprinted Geese

- Baby geese follow the first large object that bends over them
Conditioned Responses

- **Classical conditioning**
  - An animal’s involuntary response to a stimulus becomes associated with another stimulus presented at the same time
  - *Example*: Salivation in Pavlov’s dogs

- **Operant conditioning**
  - An animal modifies its voluntary behavior in response to consequences of that behavior
  - *Example*: Reward of food for pressing a lever
Habituation

- Habituation
  - An animal learns by experience not to respond to a stimulus that has neither positive nor negative effects
  - *Example:* Pigeons in cities learn to ignore people walking past
Observational Learning

- **Observational learning**
  - One animal imitates the behavior of another
  - *Example:* Marmoset opening a container
Physical and Social Recognition

- Animals learn landmarks in their environment, and recognize mates, offspring and competitors
  - *Example:* Once male lobsters have fought, the loser recognizes and avoids the winner
44.3 Adaptive Behavior

- If a behavior varies, and some of that variation has a genetic basis, then it will be subject to natural selection.

- Behavior that increases the reproductive success of an individual or their relatives is adaptive.
Adaptive Behavior

- For starlings, adding wild carrot to their nest is adaptive because it reduces the number of blood-sucking mites that feed on chicks.
44.1-44.3 Key Concepts
Foundations for Behavior

- Behavioral variations within or among species often have a genetic basis

- Behavior can also be modified by learning

- When behavioral traits have a heritable basis, they may evolve by way of natural selection
44.4 Communication Signals

- Communication signals transmit information between members of the same species
  - Chemical signals such as **pheromones**
  - Acoustical signals such as bird songs
  - Visual signals such as threat displays
  - Tactile signals such as honeybee dances

- Potential costs: Individuals of a different species may intercept or mimic signals
Some Visual Signals

- Threat display, courtship display, play bow
**Tactile Display: Honeybee Dances**

**Figure 44.11 Animated** Honeybee dances, an example of a tactile display.  
(a) Bees that have visited a source of food close to their hive return and perform a *round* dance on the hive’s vertically oriented honeycomb. The bees that maintain contact with the dancer later fly out and search for food near the hive.

(b) A bee that visits a feeding source more than 100 meters (110 yards) from her hive performs a *waggle* dance. Orientation of an abdomen-wagging dancer in the straight run of her dance informs other bees about the direction of the food.

(c) If the food is in line with the sun, the dancer’s wagging run proceeds straight up the honeycomb. (d) If food is in the opposite direction from the sun, the dancer’s waggle run is straight down. (e) If food is 90 degrees to the right of the direction of the sun, the waggle run is offset by 90 degrees to the right of vertical.

The speed of the dance and the number of waggles in the straight run provide information about distance to the food. A dance inspired by food that is 200 meters away is much faster and has more waggles per straight run, than a dance inspired by a food source that is 500 meters away.

**Figure It Out:** Do the dances shown in parts c–e indicate different distances from the hive?  
Answer: No, the number of waggles in the straight run does not vary.

- **C:** When bee moves straight up comb, recruits fly straight toward the sun.
- **D:** When bee moves straight down comb, recruits fly to source directly away from the sun.
- **E:** When bee moves to right of vertical, recruits fly at 90° angle to right of the sun.
When bee moves straight up comb, recruits fly straight toward the sun.

When bee moves straight down comb, recruits fly to source directly away from the sun.

When bee moves to right of vertical, recruits fly at 90° angle to right of the sun.
Animation: Honeybee dances
44.4 Key Concepts
Animal Communication

- *Interactions between members of a species depend on evolved modes of communication*

- *Communication signals hold clear meaning for both the sender and the receiver of signals*
Males and females behave in ways that maximize their own reproductive success

- Males compete for females and seek many mates
- Females select for quality of a mate, not quantity

**Sexual selection**

- Microevolutionary process that favors characteristics that provide an advantage in obtaining and keeping mates
Some Mating Behaviors

Examples of sexual selection

- Female hangingflies mate only with males that supply food
- Female fiddler crabs judge a male’s burrow-building skill before selecting a mate
- Male sage grouse display at a lek to be chosen by females
- Male bison fight for access to females
Examples of Sexual Selection
Examples of Sexual Selection
Parental Care

- Parenting requires time and energy
  - Increase in survival of young may outweigh costs

- Examples of parenting
  - Male midwife toad cares for eggs
  - Crocodiles bury eggs and care for hatchlings
  - Most birds are monogamous; both parents care for young
  - In mammals, males typically leave after breeding
Examples of Parenting
44.5 Key Concepts
Mating and Parental Care

- Behavioral traits that affect the ability to attract and hold a mate are shaped by sexual selection

- Males and females are subject to different selective pressure

- Parental care can increase reproductive success, but it has energetic costs
44.6 Living in Groups

- Animals that live in social groups may benefit by cooperating in predator detection, defense, and rearing the young.

- A **selfish herd** forms when animals hide behind one another to avoid predators.
Group Defenses
Improved Feeding Opportunities

- Many mammals live in social groups and cooperate in hunts, but cooperative hunters are not always more successful than solitary ones.

- Groups are more successful at fending off scavengers, caring for young, protecting territory.
Benefits of group living are often distributed unequally.

Wolves cooperate in hunting, caring for young and defending territory, but only the alpha male and alpha female breed.
Cooperative Hunting in Wolf Packs
Group living allows transmission of cultural traits, or behaviors learned by imitation, such as termite “fishing” among chimpanzees.
Costs of Group Living

- In most habitats, the costs of living in large groups outweigh the benefits
  - Large groups attract predators
  - Increased competition for space and food
  - Increased vulnerability to disease and parasites
  - Risk of being killed or exploited by others
Costs of Group Living

- A crowded cormorant breeding colony
44.7 Why Sacrifice Yourself?

- Extreme cases of sterility and self-sacrifice have evolved in only a few groups
  - Insects such as honeybees, ants, and termites
  - Two species of mammals (mole-rats)
Eusocial Animals

- Eusocial animals live in colonies with overlapping generations, and have a reproductive division of labor.
- Most colony members do not reproduce; they assist their relatives instead.
Honeybees

- **Queen honeybee**
  - The only fertile female in her hive; she secretes a pheromone that makes all other females sterile

- **Worker bees**
  - Females that develop from fertilized eggs; they collect food and maintain the hive

- **Drones**
  - Stingless males that develop from unfertilized eggs; they mate with a virgin queen and die
Mole-Rats

- Mole-rats are the only eusocial mammals

- A reproductive mole-rat queen mates with one to three kings

- Their nonbreeding worker offspring feed the clan, dig burrows, and protect against predators
Three Queens

- Honeybee, mole-rat, and termite
Evolution of Altruism

- **Altruistic behavior**
  - Behavior that enhances another individual’s reproductive success at the altruist’s expense

- **Theory of inclusive fitness**
  - Altruistic behavior is perpetuated because altruistic individuals share genes with their reproducing relatives
44.8 Human Behavior

- Hormones and possibly pheromones influence human behavior – but humans alone can make moral choices about their actions.

- A behavior that is adaptive in the evolutionary sense may still be judged by society to be morally wrong; science does not address morality.
44.6-44.8 Key Concepts
Costs and Benefits of Social Behavior

- Life in social groups has reproductive benefits and costs

- Selfsacrificing behavior has evolved among a few kinds of animals that live in large family groups

- Human behavior is influenced by evolutionary factors, but humans alone make moral choices
Animation: Adaptive behavior in starlings
Animation: Cuckoo and foster parent
Animation: Development and elicitation of bird song

- XY (female) without estrogen leads to feminized brain.
- XX (male) with estrogen results in masculinized brain.

Before hatching
Animation: Hormonal control of behavior
Animation: Instinctive behavior in infants
Animation: Sawfly defense
Animation: Snake taste preference
Video: My pheromones made me do it
Video: Bird song
Video: Bumblebee
Video: Ducklings following
Video: Schooling fish
Video: Migratory flock of geese
Video: Wolf pack
Video: Woodpecker feeding young