Ecology
Animal Behavior
Responding to a Changing Environment

1. **Physiological Responses**
   - changing the **functioning** of the body
   - acclimation (**dilating capillaries to release heat**)

2. **Morphological Responses**
   - changing the **anatomy (structure)** of the body
   - growing thicker fur or change in fur color in winter

3. **Behavioral Responses**
   - changing behavior to adapt to the change
   - moving to a more favorable location
   - cooperative behavior
   - agonistic behavior when threatened
• Genes and the environment **both** influence behavior

• **Innate behavior** is developmentally fixed, regardless of the environment, and under strong genetic influence (ex. agonistic behavior)

• **Learned behavior** is due to cognitive development, change with experience & environment (ex. Mother bears teach their cubs about hunting, berry picking, fishing, and the best places to find tasty grubs)
Proximate and Ultimate Questions

• **Proximate questions** focus on the *environmental stimuli that trigger* behavior
  – Physiological & genetic mechanisms of behavior
  – **How** does a behavior happen?

• **Ultimate questions** focus on the evolutionary *significance* of a behavior
  – **Why** does a behavior happen?
  – What is the evolutionary benefit of the behavior?
Cooperative behavior is when an animal invests resources in a common interest shared by other group members.
• **Agonistic behavior** is any social behavior that involves fighting, thus it is a contest involving threats.

• Agonistic behavior is made of a suite of three different divisions of behaviors: *threats, aggression, and submission*.

• Generally, no harm is done
Competitive Social Behaviors Often Represent Contests for Resources

- **Reconciliation behavior** often happens between conflicting individuals.
• **Dominance hierarchies** involve a ranking of individuals in a group (a “pecking order”).
  
  – Alpha and beta rankings exist, the alpha organisms control the behavior of others.
Fixed Action Patterns (FAP)

- FAP is a sequence of unlearned (innate), unchangeable behavioral acts, that once started, are carried out to completion.

- Triggered by a sign stimulus (external sensory stimulus).

- Ex: Agonistic (aggressive) behavior in 3-spined stickleback male fish in response to the red underside of an intruder fish.
A Recreation of Niko Tinbergen’s Experiment with Three-Spined Stickleback and Fixed Action Patterns
Niko Tinbergen was a pioneer in the study of animal behavior. He suggested that understanding any behavior requires answering FOUR questions:

1. What stimulus elicits the behavior, and what physiological mechanisms mediate the response?

2. How does the animal’s experience during growth and development influence the response?

3. How does the behavior aid survival and reproduction?

4. What is the behavior’s evolutionary history?
Imprinting is a type of behavior that includes both learning and innate components and is irreversible — limited phase early in an animal’s development, is the only time certain behaviors can be learned (critical period) — Incubator-hatched goslings imprinted on scientist (Konrad Lorenz) during first few hours of life and followed him.
Ever Seen the Movie “Fly Away Home”?

The movie involves Canadian Geese, but the concept is based on an organization named Operation Migration which has played a leading role in the reintroduction of endangered Whooping cranes into eastern North America since 2001. In the 1940s the species was reduced to just 15 birds.
Directed Movements

- Controlled by genes

**Kinesis** = change in activity rate in response to stimuli. Ex. Isopods live best in moist conditions; move more in dry areas to increases likelihood of encountering a moist area

**Taxis** = a more or less automatic, oriented movement toward or away from a stimulus

**Migration** - using sun (seasonal changes), stars, Earth’s magnetic field, etc.
• **Signal** - behavior that causes change in another’s behavior

• **Communication** involves the transmission of, reception of, and response to signals between animals

  – *Animal communication is any behavior on the part of one animal that has an effect on the current or future behavior of another animal.*
Animal Signals & Communication

– Chemical Communication:
  • Pheromones – important in reproduction behavior
  • Scents—important in marking territory or defense

– Auditory Communication (vocalization):
  • *Drosophila* males produce a characteristic “song” by beating their wings, insects (*innate, genetic*)
  • *Mating songs in birds* (*innate & learned*)
Environmental factors, such as the quality of the diet, the nature of social interactions, and opportunities for learning can influence the development of behaviors in every group of animals.

- Example: Variations in diet led to rejection of mates in *Drosophila*
Imprinting

Learning and problem solving

Cognition

Spatial learning

Associative learning

Social learning

Cognition

Learning and problem solving

Imprinting

Spatial learning

Associative learning

Social learning
Learning

- **Learning** is the modification of behavior based on specific experiences
  - **Maturation**: behavior due to developing physiological changes
  - **Habituation**: loss of responsiveness to stimuli that convey little or no information
  - **Spatial Learning**: the modification of behavior based on experience with the spatial structure of the environment, including the location of nest sites, hazards, food, and prospective mates
  - **Associative Learning**: behavior through trial and error
Associative Learning

- The ability of many animals to associate one feature of the environment with another

**Classical Conditioning**
- arbitrary stimulus associated with reward or punishment
- Pavlov’s Experiment

**Operant Conditioning**
- “trial-and-error learning”
- Associates behavior with reward or punishment, Skinner Box
Cognition & Problem Solving

• The ability of animal’s nervous system to perceive, store, process, and use info gathered by sensory receptors

• Ex: monkey stacking boxes in order to reach bananas or the use of tools
Genetic components of behavior evolve through natural selection which favors behaviors that increase survival and reproductive success

- **Foraging behavior** – Balance between benefits of nutrition and cost of finding food (predation, energy, etc.)
  - Cost-benefit analysis
- **Mate selection**
  - Most animals are promiscuous – no strong pair bonds
  - Monogamous – one male with only one female
  - Polygamous – an individual of one sex mating with several of the other
    - Polygyny – one male with many females
    - Polyandry – one female with many males
Interpret This Data

The graph shows the average number of drops and total flight height for different drop heights (2 m, 3 m, 5 m, 7 m, 15 m). The drop height preferred by crows is 5.23 m. The data indicates that as the drop height increases, the average number of drops decreases, while the total flight height increases.
# Crow & Whelk Data

<table>
<thead>
<tr>
<th>Drop Height (m)</th>
<th>$N_{avg}$ Drops Required to Break Shell</th>
<th>$(\text{Drop Height} \times N_{avg} \text{ Drops}) = \text{“Cost–Benefit Analysis”}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>55</td>
<td>110</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>39</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>35</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>
Albatross Courtship
Mating Systems Differ Among Species.

- **Promiscuous**: no strong pair bonding between males and females

- **Monogamous**: one male mating with one female

- **Polygamous**: an individual of one sex mating with several of the other sex
  
  - **Polygyny** is a specific example of polygamy, where a single male mates with many females
  
  - **Polyandry** occurs in some species where one female mates with several females
Social Behavior

- **Agonistic behavior** – contest behavior determining access to resources

- **Dominance hierarchy** - pecking order

- **Territoriality** - defending an area against others
Agonistic behavior

Snakes Wrestle

Chimp Agnostic
Territorial animals defend areas that contain a nest, den or mating site and sufficient food resources for themselves and their young.

- Territoriality uses a great deal of an individual’s energy
  - In addition, an individual might die defending a territory, thus miss a reproductive opportunity

- Spraying behavior is a way for an individual to mark its territory
The downside of territoriality is that it expends a great deal of an individual’s energy.
Most social behaviors are selfish, so how do we account for behaviors that help others?

- **Altruism** is defined as behavior that might decrease individual fitness, but increase the fitness of others.

The Concept Of Inclusive Fitness Can Account For Most Altruistic Behavior
Altruistic behavior is common throughout the animal kingdom, particularly in species with complex social structures.

In social insect colonies (ants, wasps, bees and termites), sterile workers devote their whole lives to caring for the queen, constructing and protecting the nest, foraging for food, and tending the larvae.
The inclusive fitness of an organism is the sum of its classical fitness (how many of its own offspring it produces and supports) and the number of equivalents of its own offspring it can add to the population by supporting others.

Advocates of inclusive fitness theory say that an organism can improve its overall genetic success by cooperative social behavior.
• From the gene's point of view, evolutionary success ultimately depends on leaving behind the maximum number of copies of itself in the population which would translate into a maximum number of offspring.

• In 1964 W. D. Hamilton proved mathematically that, because close relatives of an organism share some identical genes, a gene can also increase its evolutionary success by promoting the reproduction and survival of these related or otherwise similar individuals.
Kin selection refers to natural selection that favors altruistic behavior by enhancing reproductive success of relatives.
The basic idea of kin selection is simple. Imagine a gene which causes its bearer to behave altruistically towards other organisms, e.g. by sharing food with them. Organisms without the gene are selfish — they keep all their food for themselves, and sometimes get handouts from the altruists. Clearly the altruists will be at a fitness disadvantage, so we should expect the altruistic gene to be eliminated from the population. However, suppose that altruists are *discriminating* in who they share food with. They do not share with just anybody, but only with their relatives..
• So when an organism carrying the altruistic gene shares his food, there is a certain probability that the recipients of the food will also carry copies of that gene.

• This means that the altruistic gene can in principle spread by natural selection.

• The gene causes an organism to behave in a way which reduces its own fitness but boosts the fitness of its relatives — who have a greater than average chance of carrying the gene themselves.

• So the overall effect of the behavior may be to increase the number of copies of the altruistic gene found in the next generation, and thus the incidence of the altruistic behavior itself.
Defining animal signals and communication.

- A **signal** is a behavior that causes a change in the behavior of another animal.
- The transmission of, reception of, and response to signals make up **communication**.
- Examples include the following:
  - Displays such as singing, and howling.
  - Information can be transmitted in other ways, such as chemical, tactile, electrical.
All three of these behaviors must occur in order for the fruit flies to mate.
Male orients towards female.
Blue-Footed Booby Courtship
What type of behavior is involved when an animal is exposed to a new situation without any prior relevant experience and performs a behavior that generates a desired outcome?
What type of behavior is involved when one child teaches others a new game?
What type of behavior is involved when a rat pushes a lever to obtain food?