COMMUNICATION IN ANIMALS:

INTRODUCTION:

Animal communication is a process by which one animal provides information that other animals can incorporate into their decision making. **The vehicle for the provision of this information is called a signal.** The signal may be a **sound, colour pattern, posture, movement, electrical discharge, touch, release of an odorant, or some combination of these mediums.**

Animal communication is classically defined as occurring when **"the action of or cue given by one organism [the sender] is perceived by and thus alters the probability pattern of behaviour in another organism [the receiver] in a fashion adaptive to either one both of the participants".**

Communication is when one animal transmits information to another animal causing some kind of change in the animal that gets the information. **Communication is usually between animals of a single species, but it can also happen between two animals of different species.** Communication behaviors can help animals find mates, establish dominance, defend territory, coordinate group behavior, and care for young.

TYPES OF COMMUNICATION:

- Pheromones — chemicals.
- Auditory cues — sounds.
- Visual cues — body movement/light produced from within the body.
- Tactile cues — touch.
- Electric cues — electric impulse.
- Language — verbal communication.

DANCES OF HONEY BEES:

Social behavior in bees has a number of advantages. One of the most important of these is the ability to quickly mobilize a large number of foragers to gather floral resources that may only be available for a short period of time.

There are 2 types of bee dances (visual cues):

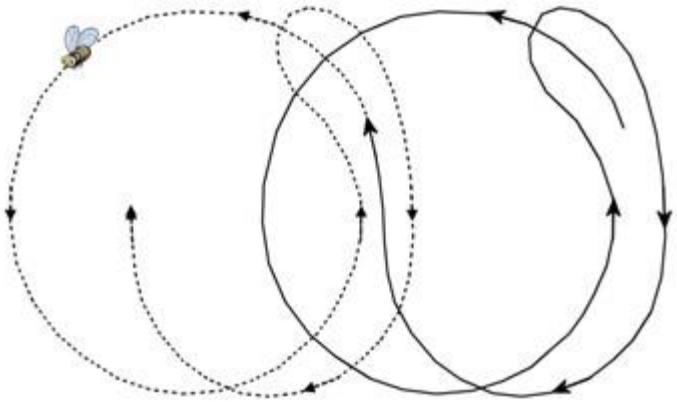
1. the round dance and
2. the tail-wagging or waggle dance, with a transitional form known as the sickle dance.

In both cases the quality and quantity of the food source determines the liveliness of the dances. If the nectar source is of excellent quality, nearly all foragers will dance enthusiastically and at length each time they return from

foraging. Food sources of lower quality will produce fewer, shorter, and less vigorous dances; recruiting fewer new foragers.

THE ROUND DANCE:

It's a type of dance performed by forager bee on the walls of hive where in a circular rotation pattern is observed in both directions (right and left).



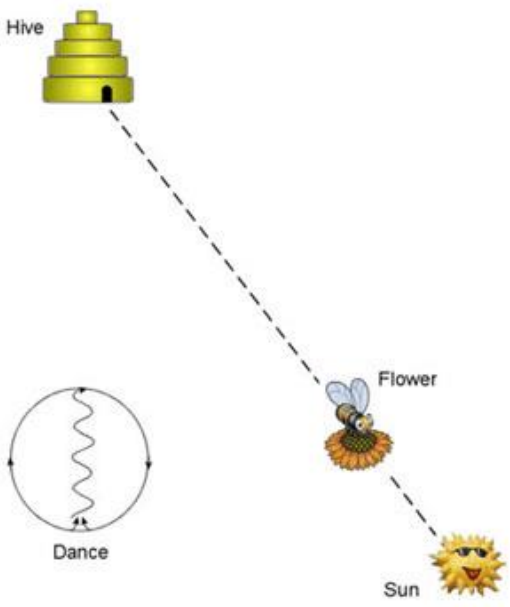
- The round dance is used for food sources 25-100 meters away from the hive or closer.
- Scout bee of the colony performs the circular dance.
- In a round dance, the forager bee first circles to the right and then to left.
- This round dance enables other members of the hive to understand the presence of food within 100 meters range.
- But circular dance does not give any indication about the direction of source.
- Round dance facilitates the fellow workers to search the correct food source by comparing the 2 smells (samples of smell provided by forager bees and the smell of target flower).

WAGGLE DANCE:

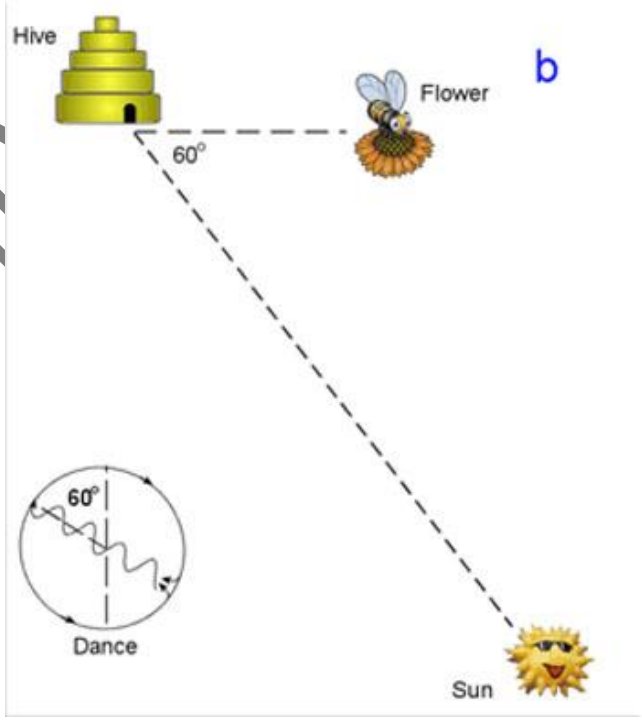
Waggle dance is another pattern of bee dance by forager bees on the hive wall where is the abdominal movement of bee varies greatly from round dance.

- If the food source is more distant from the hive (> 100 meters), the round dance is replaced by the waggle dance.
- There is a gradual transition between the round and waggle dance, taking place through either a figure eight or sickle shaped pattern.
- The waggle dance includes information about **the direction and energy required to fly to the goal.**

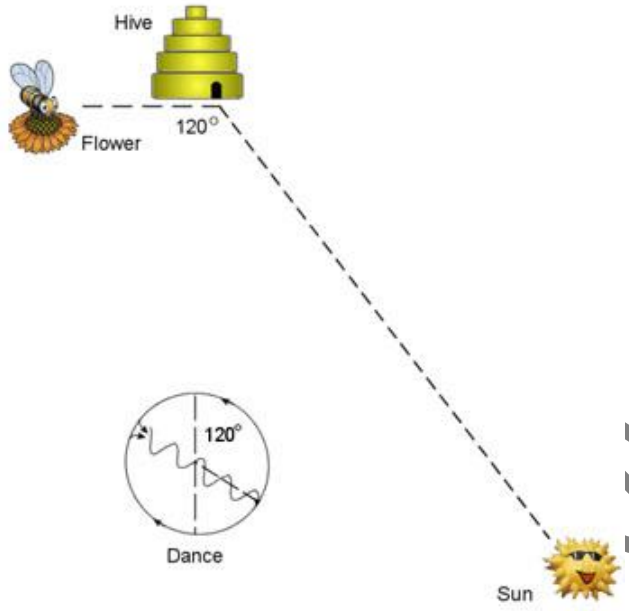
- Energy expenditure (or distance) is indicated by the length of time it takes to make one circuit.
- For example, a bee may dance 8-9 circuits in 15 seconds for a food source 200 meters away, 4-5 for a food source 1000 meters away, and 3 circuits in 15 seconds for a food source 2000 meters away.



- Direction of the food source is indicated by the direction the dancer faces during the straight portion of the dance when the bee is waggling.
- If the bee waggles while facing straight upward, then the food source may be found in the direction of the sun.



- If the bee waggles at an angle 60 degrees to the left of upward the food source may be found 60 degrees to the left of the sun.



- Similarly, if the dancer waggles 120 degrees to the right of upward, the food source may be found 210 degrees to the right of the sun.
- The dancer emits sounds during the waggle run that help the recruits determine direction in the darkness of the hive.

ALARM CALLS:

Alarm calls in animal communication is an alarm signal and is an antipredator adaptation in the form of signals emitted by social animals in response to danger.

In many cases **the signal is visual or vocal, but some animals—ants, bees, and certain fishes, for example—secrete chemical substances.** Alarm communications frequently cross species boundaries.

Alarm calls can transmit important information about predators through signals indicating the type, even species of predator, and graded signals designating the degree of threat a predator poses, or some combination of these.

Alarm signals are designed to transmit information among individuals within a species, they are also detectable by other species living in the same environment.

Alarm calls are innate or inbuilt type of behaviour which is carried from generation to generation and type of alarm call is always species specific.

FEATURES OF ALARM CALLS:

- These are special vocal communication calls which are different from normal vocal communications.
- Alarm calls are used only during threat conditions i.e., if any animal is attacked by its predators.
- The frequency of voice used during alarming time is high than the normal.
- Example: Generally, the bird song during normal time has frequency of around 0.7kHz while the same bird if attacked by the predator makes alarm call at around 7kHz frequency.
- Type of alarm call depends upon the nature of the predator attacked.
- If the predator poses less threat, the alarm call frequency is moderate while if high threat is observed to be high, the frequency of alarm calls reach maximum.
- Alarm calls informs other members of the same species about the threat that is posed.
- Alarm calls are of two types i.e., Short live alarm calls and Long-lived alarm calls.
- Short and Long-lived alarm calls depend upon the strength of predator.

Examples:

1. Many birds have more than one alarm calls. (Ex: **Crow, Pigeon, parrot** etc).
2. Each type of alarm call is used in response to a different kind of predator.
3. The **vervet monkey** has several distinct alarm calls, each signalling the presence of different predator.
4. Other members of vervet monkey colony make appropriate response to different alarm calls like, rushing up into trees in response to a leopard call, looking up in response to an eagle call and looking down in response to snake call.

ECHO-LOCATION OR SONAR IN BAT:

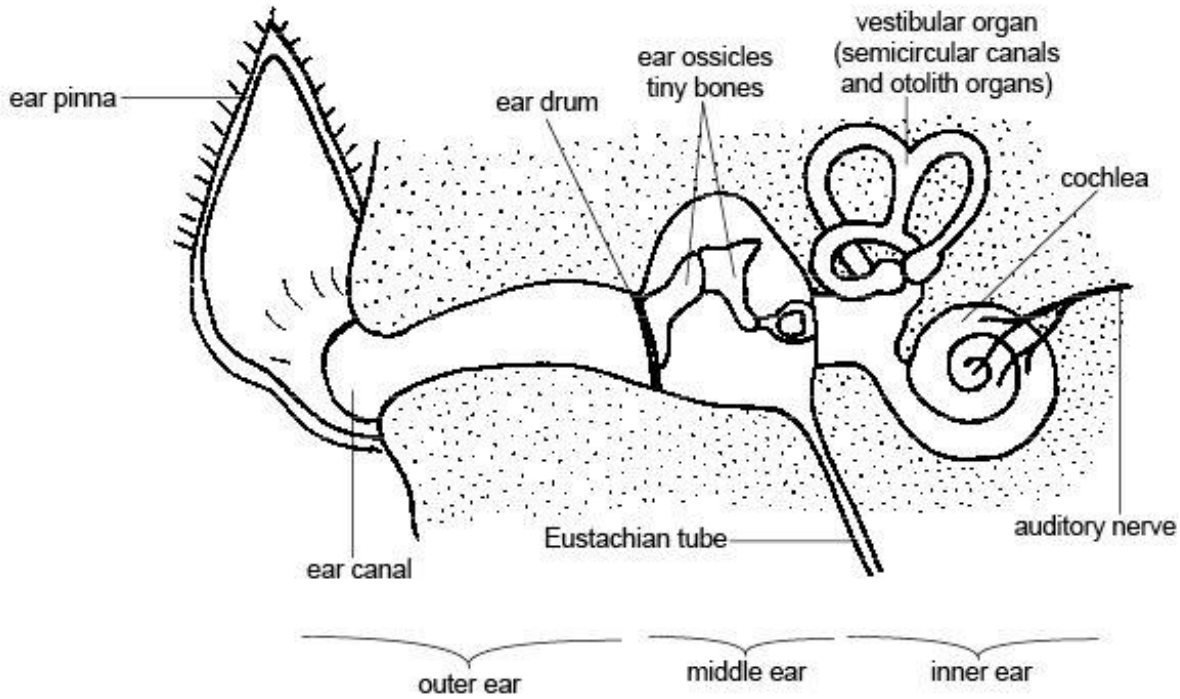
Echolocation or **SONAR** (Sound Navigation and Ranging) is a physiological process for **locating distant or invisible objects** (such as prey) **by means of sound waves reflected back to the emitter** (such as a bat) **by the objects.**

Bats are group of animals that fall under the class mammalia. These are the only mammals that have capacity to fly. The wings of bat are made of patagium, a protein that enables the bat to take active flight.

Bats are nocturnal animals which are active during night times. They have poorly developed vision and therefore detection of prey at night becomes a problem. Hence, the bats have adopted unique way of capturing the prey. It is by the use of echo which is produced by the larynx and which is sensed back by the ears. **The process by which the bat uses echo or SONAR to detect the prey is called Echolocation.**

Echolocation is used for orientation, obstacle avoidance, food procurement, and social interactions. Echolocation is known to be employed by most bats.

Echolocation pulses consist of short bursts of sound at frequencies ranging from about 1,000 hertz in birds to at least 2,00,000 hertz in whales. **Bats utilize frequencies from as low as 11,000 hertz to as high as 2,12,000 hertz.** The pulses are repeated at varying rates, beginning at about one per second. The rate may reach several hundred per second.



AUDITORY SYSTEM OF BAT:

THE PROCESS OF ECHO-LOCATION:

- Bats produce sounds with the larynx, an organ in the throat that has undergone certain adaptations that make it unusually effective in producing intense, high-frequency sounds.
- The character of the sounds varies with the species and also with the particular activity.

- The sound waves produced by larynx are transmitted out of the body and these waves strike the objects and reflect back.
- On striking a small object such as a flying insect, the emitted sounds are reflected with only a small fraction of their original energy; the sound is further weakened before reaching the ears of the bat when it must travel some distance through the air.
- The sound that is reflected back, is sensed by auditory nerve which situated in the inner ear.
- Ear pinna of bat is designed in such a way that it traps almost every sound wave that has hit the object.
- Depending upon the intensity of sound wave that has reached back to the bat, it judges the size and type of prey.

DETECTION AND ANALYSIS OF SOUNDS:

- The nervous system of bats has many specialised components for the detection and analysis of auditory information.
- Sound waves in the environment, including echoes from vocalisations produced by bat, pass through the ear openings and along the middle ear canal to the inner ear.
- There, these waves strike a membrane covering the end of the ear channel, causing the membrane to vibrate.
- Ultimately these vibrations move specific portions of the basilar membrane of cochlea in tune with the frequency of sound waves entering the ear.
- The mechanical energy present in these movements deforms receptor cells or hair cells attached to basilar membrane; this energy is transformed into a receptor signal that is relayed to sensory neurons associated with each receptor when these neurons fire, their messages are carried away from the cochlea along the fibres that constitute the auditory nerve (VIII nerve).
- This nerve runs to specific regions of the bat's brain, including the lateral lemniscus and inferior colliculus.
- The brain cells analyse input from the auditory sensory system and make decisions that control the movements of bat which determine its success in capturing of the prey.

AGGRESSION:

Aggression, **is a group of behavioural activities including threat postures, rituals and occasionally physical attacks on other organisms, other than those associated with predation.**

They are usually directed towards members of the same sex and species and have various functions including the displacement of other animals from an area usually a territory or a source of food, the defence of a mate or offspring or establishment of rank in a social hierarchy.

The term '**aggression**' is controversial and suggested an existence of unnecessary violence within animal groups; the alternative term "**agonistic**" is preferable.

AGGRESSION BEHAVIOUR:

- Psychologists have defined aggression as behaviour that appears to be intended to inflict noxious stimulation or destruction on another organism.
- Agonistic behaviour is a system of behaviour patterns with the common function of adjustment to situation of conflict among conspecifics.
- The term includes all aspects of conflicts, such as threats, submissions, chases, and physical combat, but it specifically excludes predatory aggression.

Ethologists have listed the following forms of aggressive behaviour. They are;

1) **Territorial aggressive behaviour** in which takes place exclusion of others from some physical space.
2) **Dominance:** In this type of aggressive behaviour control of a conspecific as a result of a previous encounter is done.
3) **Sexual aggressive behaviour:** In this case, use of threats and physical punishment, usually by males, to obtain and retain mates.
4) **Parental aggressive behaviour:** In this case, attacks are made on intruders when young are present.
5) **Parent-offspring aggressive behaviour:** This is disciplinary action by parent against offspring.
6) **Predatory aggressive behaviour:** It includes the act of predation, possibly including cannibalism.
7) **Antipredatory aggressive behaviour:** It includes defensive attack by prey on predator, such as mobbing.

CAUSES OF AGGRESSION:

The various causes of aggression have been categorized under the following two headings.

1) Endogenous factors of aggression,
2) Exogenous factors of aggression.

I. ENDOGENOUS FACTORS OF AGGRESSION:

Endogenous factors include the typical change in the **hormonal and neural** signals within the organism which enrages the aggregation behaviour in them.

a. ROLE OF HORMONES:

- Aggressive behaviour in animals appears to be associated with the breeding periodicity.
- Males become comparatively more aggressive with the onset of the breeding activity.
- Androgen levels are responsible for aggressive behaviour in many species.
- The effects of androgen on aggressiveness are via its effects on lowering the threshold for aggression.
- Injections of testosterone restore aggression in castrated animals.
- In some species, elevated levels of oestrogen also play important role in arousal of aggression.
- Luteinizing Hormone (LH) too plays vital role in aggression in case of African Weaver bird.
- In case of invertebrates, role of hormones in arousal of aggression is not clear.
- But in case of female grasshopper, juvenile hormone plays important role in making it aggressive during reproduction or copulation.

b. ROLE OF NEURONS/NEURAL MECHANISMS:

The vertebrate brain structures most involved in aggression are part of limbic system which includes **amygdala** and **hypothalamus.**

1) Hypothalamus role in aggression:

- Hypothalamus is involved in defence and escape behaviour in vertebrates ranging from fishes to primates.
- Electrical stimulation of neurons in hypothalamus of brain causes aggressive behaviour in animals.

- Example: In cats, stimulation of ventro-medial nucleus of hypothalamus produces growling, hissing, attacking with claws type of aggressive behaviour.
- Similarly, stimulation of lateral hypothalamus area produces a biting attack behaviour in cats.

2) Amygdala role in aggression:

- Amygdala region of brain are evolved in predatory and attack behaviour in case of cats.
- Central gray matter of brain too is associated with predatory behaviour.
- Electrical stimulation in amygdala region of cats enables them to attack and kill the rats.

II. EXOGENOUS FACTORS OF AGGRESSION.

These are the physical factors that mostly influence the animal to become aggressive. The exogenous factors are time dependant and situation dependant and lasts for very short period of time.

1) **Starvation** is one such factor. Hungry animals fight vigorously.
2) **Frustration** is another factor which elicits aggression. Frustration is motivation for aggressive behaviour and leads to fighting in hungry animals.
3) **Role of experience in aggression:** Aggression is influenced by experience. Experience Shapes levels of aggressiveness. Animals reared in isolation are relatively more aggressive.
4) **Role of appetite:** when an animal is hungry, they tend to become more aggressive and sometimes the animals even fight with animals of same species for sharing the food. Once the stomach is full, the aggressive behaviour relatively falls down.
5) **Sex:** The relationship between sex hormones, particularly testosterone, and aggression is striking in seasonally breeding species. Males become aggressive on other males and come time fight with each other to prove their fitness for copulation.

BIOLUMINESCENCE:

Bioluminescence is light produced by a chemical reaction within a living organism. Bioluminescence is a type of chemiluminescence, which is simply the term for a chemical reaction where light is produced.

The light emitted by a bioluminescent organism is produced by energy released from chemical reactions occurring inside (or ejected by) the organism. For a reaction to occur, a species must contain **luciferin,** a molecule that, when it reacts with oxygen, produces light. There are different types of luciferin, which vary depending on the animal hosting the reaction. Many organisms also produce the catalyst luciferase, which helps to speed up the reaction.

Most bioluminescent organisms are found in the ocean. These bioluminescent marine species include **fish, bacteria, and jelly fishes.** Some bioluminescent organisms, including **fireflies and fungi,** are found on land. There are almost no bioluminescent organisms native to freshwater habitats.

Bioluminescence is also a form of animal communication wherein the light produced from the animal body is used to communicate among the members of the same group, attract opposite sex, utilize the light produced to attract the prey and also fight against the predators.

MECHANISM OF BIOLUMINESCENCE:

- The chemical reaction that results in bioluminescence requires two unique chemicals: luciferin and either luciferase or photoprotein.
- Luciferin is the compound that actually produces light.
- In a chemical reaction, luciferin is called the substrate. The bioluminescent color (yellow in fireflies, greenish in lanternfish) is a result of the arrangement of luciferin molecules.
- Some bioluminescent organisms produce luciferin on their own. Ex: Dinoflagellates, for instance, bio luminesce in a bluish-green color.
- **Bioluminescent dinoflagellates are a type of plankton—that can sometimes cause the surface of the ocean to sparkle at night.**
- Some bioluminescent organisms do not synthesize luciferin. Instead, they absorb it through other organisms, either as food or in a symbiotic relationship.
- **Luciferase is an enzyme.** The interaction of the luciferase with oxidized luciferin creates a by-product, called **oxyluciferin.** More importantly, the chemical reaction creates light.
- Bioluminescent dinoflagellates produce light using a luciferin-luciferase reaction. The luciferase found in dinoflagellates is related to the green chemical chlorophyll found in plants.

BIOLUMINESCENT LIGHT:

- The appearance of bioluminescent light varies greatly, depending on the habitat and organism in which it is found.
- Most marine bioluminescence, is expressed in the blue-green part of the visible light spectrum. These colors are more easily visible in the deep ocean.
- Most land organisms also exhibit blue-green bioluminescence. However, many glows in the yellow spectrum, including fireflies and the only known land snail to bio luminesce.
- Few organisms can glow in more than one color. The so-called railroad worm may be the most familiar. **The head of the railroad worm glows red, while its body glows green.** Different luciferases cause the bioluminescence to be expressed differently.

ADAPTATIONS USING BIOLUMINESCENT LIGHT:

Bioluminescence is used by living things to hunt prey, defend against predators, find mates, and execute other vital activities.

There are two main types of adaptations. They are

1) Defensive adaptation and
2) Offensive adaptation.

I. DEFENSIVE ADAPTATIONS:

- Some species luminesce to confuse attackers.
- Many species of squid, for instance, flash to startle predators, such as fish.
- With the startled fish caught off guard, the squid tries to quickly escape.
- Many marine species use a technique called counterillumination to protect themselves. Counterillumination is a type of camouflage against this predatory behavior.
- Some bioluminescent animals, such as brittle stars, can detach body parts to distract predators. The predator follows the glowing arm of the brittle star, while the rest of the animal crawls away in the dark.
- Glow worms light up to warn predators that they are toxic. Toads, birds, and other predators know that consuming these larvae will result in illness and possible death.

II. OFFENSIVE ADAPTATIONS:

- Bioluminescence may be used to lure prey or search for prey.
- The most famous predator to use bioluminescence may be the anglerfish, which uses bioluminescence to lure prey.

- The angular fish uses the end of tail region which appears as a ball which is lit up with light. Other small fishes which are curious about the light move toward the angular fish and these tiny fishes are eaten up by the angular fish.
- Other fish, such as a type of dragonfish called loosejaws, use bioluminescence to search for prey.

ATTRACTION:

- Adult fireflies, also called lightning bugs, are bioluminescent.
- They light up to attract mates.
- Although both male and female fireflies can luminesce, most flashing fireflies are male.
- The pattern of their flashes tells nearby females what species of firefly they are and that they're interested in mating.

OTHER BIOLUMINESCENCE:

- Organisms can luminesce when they are disturbed.
- Changes in the environment, such as a drop in salinity, can force bioluminescent algae to glow, for instance.
- These living lanterns can be seen as spots of pink or green in the dark ocean.
- "**Milky seas**" are another example of bioluminescence.
- Unlike bioluminescent algae, which flash when their environment is disturbed, milky seas are continuous glows, sometimes bright and large enough to be visible from satellites in orbit above the Earth.