COURSE GUIDE

BIO 314
ANIMAL ECOLOGY

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INTRODUCTION

Animal Behaviour (BIO314) is a fundamental course for undergraduate students of Biology that deals with the theories and principles of adaptive behaviour and evolution of animals. The course contents are history of ethology. Reflex and complex behaviour. Orientation and taxes. Fixed action patterns, releasers, motivation and driver. Displays, displacement activities and conflict behaviour. Learning communication and social behaviour. The social behaviour of primates. Hierarchical organization. The physiology of behaviour. Habitat selection, homing and navigation. Courtship and parenthood. Biological clocks.

COURSE COMPETENCIES

This course aims to enable you to understand the theories and principles of adaptive behaviour and evolution of animals, Behavioural Patterns and Mechanism of Adaptation

COURSE OBJECTIVES

The Comprehensive Objectives of the Course are to;

1. Explain emotion in animals with examples
2. Explain the different forms of communication
3. Explain the different taxes according to their response to stimulus
4. The phenomenal behind biological clocks.

WORKING THROUGH THIS COURSE

To successfully complete this course, you are required to read each study unit, read the textbooks and other materials provided by the National Open University.

Reading the reference materials can also be of great assistance. Each unit has self –assessment exercise which you are advised to do.

There will be a final examination at the end of the course. The course should take you about 8 weeks to complete.

This course guide provides you with all the components of the course, how to go about studying and how you should allocate your time to each unit so as to finish on time and successfully.

STUDY UNITS

The course is divided into 3 modules and study units in this course are given below::

BIO 314 ANIMAL Behaviour (2 UNITS)

Module 1 History of Ethology

Unit 1 Historical Background of Ethology
Unit 2 Reflex and Complex bahaviour
Unit 3 Orientation in Animals
Unit 4 Taxes in Animals
Unit 5 Fixed action Pattern, Motivation and Drive

Module 2 Learning, Communication and Social Bahvaiour

Unit 1 Display, Displacement Behaviour and Conflict Behaviour
Unit 2 Learning and Communication in Animal
Unit 3 Social Behaviour
Unit 4 Social Behaviour of Primates
Unit 5 Hierarchical Organisation

Module 3 Habitat Selection, Homing and Navigation and Courtship Behaviour

Unit 1 Physiology of Behaviour
Unit 2 Habitat Selection
Unit 3 Homing and Navigation in Birds
Unit 4 Courtship bahviour and Parenthood
Unit 5 Biological Clocks

REFERENCES AND FURTHER READINGS

You would be required to read the recommended references and textbooks in each unit of the course materials.

PRESENTATION SCHEDULE

There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You

are required to submit all your assignments by the stipulated date and time. Avoid falling behind the schedule time.

ASSESSMENT

There are three aspects to the assessment of this course.

The first one is the in-text questions and the second is self-assessment exercises, while the third is the written examination or the examination to be taken at the end of the course.

Review the exercises or activities in the unit by applying the information and knowledge you acquired during the course.

The work submitted to your tutor for assessment will account for 30% of your total work.

At the end of this course you will have to sit for a final or end of course examination of about a three hour duration and this will account for 70% of your total course mark.

HOW TO GET THE MOST FROM THE COURSE

In this course, you have the course units and a course guide. The course guide will tell you briefly what the course is all about. It is a general overview of the course materials you will be using and how to use those materials. It also helps you to allocate the appropriate time to each unit so that you can successfully complete the course within the stipulated time limit.

The course guide also helps you to know how to go about your in-text questions and Self-assessment questions which will form part of your overall assessment at the end of the course. Also, there will be tutorial classes that are related to this course, where you can interact with your facilitators and other students. Please I encourage you to attend these tutorial classes.

This course exposes you to Animal Behaviour, a sub-discipline and very interesting field of Biology.

ONLINE FACILITATION

Eight weeks are provided for tutorials for this course. You will be notified of the dates, times and location for these tutorial classes.

As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.

The duties of your facilitator are to monitor your progress and provide any necessary assistance you need.

Do not delay to contact your facilitator by telephone or e-mail for necessary assistance if

- You do not understand any part of the study in the course material.
- You have difficulty with the self-assessment activities.
- You have a problem or question with an assignment or with the grading of the assignment.

It is important and necessary you attend the tutorial classes because this is the only chance to have face to face contact with your facilitator and to ask questions which will be answered instantly. It is also a period where you can point out any problem encountered in the course of your study.

COURSE INFORMATION
Course Code:BIO 314
Course Title: ANIMAL BEHAVIOUR
Credit Unit: 2
Course Status: ELECTIVE
Course Blub:
Semester: FIRST SEMESTER
Course Duration: EIGHT WEEKS
Required Hours for Study

ICE BREAKER

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Dr. Esenowo research interests are; physico-chemical aspects of freshwater and terrestrial ecosystem, fish biology and environmental toxicology.

MAIN COURSE

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Module 1 History of Ethology

Module Introduction

In Module One, deals with the historical aspects of ethology, emotions in animals, the different forms of communication in animals and how animal respond to emotions through communication.

Unit 1 Historical Background of Ethology
Unit 2 Reflex and Complex bahaviour
Unit 3 Orientation in Animals
Unit 4 Taxes in Animals
Unit 5 Fixed action Pattern, Motivation and Drive

Glossary

Unit 1 Historical Background of Ethology

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1.1 Introduction

Ethology (from Greek: ἦθος, *ethos*, "character"; and -λογία, *-logia*, "the study of") is the scientific study of animal behavior, and a sub-topic of zoology. Although many naturalists have studied aspects of animal behavior throughout history, the modern discipline of ethology is generally considered to have begun during the 1930s with the work of Dutch biologist Nikolaas Tinbergen and Austrian biologists Konrad Lorenz and Karl von Frisch, joint winners of the 1973 Nobel Prize in Physiology or Medicine. Ethology is a combination of laboratory and field science, with a strong relation to certain other disciplines e.g., neuroanatomy, ecology, evolution.

Ethologists are typically interested in a behavioral process rather than in a particular animal group and often study one type of behavior (e.g. aggression) in a number of unrelated animals. The desire to understand animals has made ethology a rapidly growing topic, and since the turn of the 21st century, many prior understandings related to diverse fields such as animal communication, personal symbolic name use, animal emotions, animal culture, learning, and even sexual conduct long thought to be well understood, have been modified, as have new fields such as neuroethology

1.2 Intended Learning Outcomes (ILOs)

At the end of unit, students should be able to:

- Define ethology
- State the Tinbergen's four questions for ethology.
- Explain emotion in animals under ethology.

1.3 Historical Background of Ethology

The first modern ethologist was Charles Darwin, whose book, *The Expression of the Emotions in Man and Animals*, influenced many ethologists. He pursued his interest in behaviour by encouraging his protégé George Romanes, who investigated animal learning and intelligence using an anthropomorphic method, anecdotal cognitivism, that did not gain scientific support.

The natural history approach of Darwin and his predecessors gradually evolved into the twin sciences of animal ecology, the study of the interactions between an animal and its environments and ethology the biological study of animal behaviour. The roots of ethology can be traced to the late 19th and early 20th centuries, when scientists from severalcountries began exploring the behaviours of selected vertebrate species: dogs by the Russian physiologist Ivan Pavlov; rodents by American psychologists John B. Watson, Edward Tolman, and Karl Lashley; birds by American psychologist B. F. Skinner; and primates by German American psychologist Wolfgang Köhler and American psychologist Robert Yerkes. The studies were carried out in laboratories, in the case of dogs, rodents and pigeons, or in artificial colonies and laboratories, in the case of primates. These studies were oriented toward psychological and physiological questions rather than ecological or evolutionary ones.

It was not until the 1930s that field naturalists—such as English biologist Julian Huxley, Austrian zoologist Konard Lorenz, and Dutch-born British zoologist and ethologist Nikolaas Tinbergen studying birds and Austrian zoologist Karl von Frisch and American entomologist William Morton Wheeler examining insects—gained prominence and returned to broadly biological studies of animal behaviour. These individuals, the founders of ethology had direct experience with the richness of the behavioural repertoires of animals living in their natural surroundings. Their "return to nature" approach was, to a large extent, a reaction against the tendency prevalent among psychologists to study just a few behavioral phenomena observed in a handful of species that were kept in impoverished laboratory environments.

One of Tinbergen's most important contributions to the study of animal behaviour was to stress that ethology is like any other branch of biology, in that a comprehensive study of any behaviour must address four categories of questions, which today are called "levels of analysis," including causation, ontogeny, function and evolutionary history. Although each of these four approaches requires a different kind of scientific investigation, all contribute to solving the enduring puzzle of how and why animals, including humans, behave as they do. A familiar example of animal behaviour—a dog wagging its tail—serves to illustrate the levels of analysis framework. When a dog senses the approach of a companion (dog or human), it stands still, fixates on the approaching individual, raises its tail, and begins swishing it from side to side. Why does this dog wag its tail? To answer this general question, four specific questions must be addressed.

Both the biological and the physical sciences seek explanations of natural phenomena in physicochemical terms. The biological sciences (which include the study of behaviour), however, have an extra dimension relative to the physical sciences. In biology, physicochemical explanations are addressed by Tinbergen's questions on causation and ontogeny, which taken together are known as "proximate" causes. The extra dimension of biology seeks explanations of biological phenomena in terms of function and evolutionary history, which together are known as "ultimate" causes. In biology, it is legitimate to ask questions concerning the use of this life process today (its function) and how it came to be over geologic time (its evolutionary history). More specifically, the words *use* and *came to be* are applied in special ways, namely "promoting genetic success" and "evolved by means of natural selection." In physics and chemistry, these types of questions are out of bounds. For example, questions concerning the use of the movements of a dog's tail are reasonable, whereas questions regarding the use of the movements of an ocean's tides are more metaphysical.

What is Ethology?

1.4 Emotion in Animals

There is no scientific consensus on emotion in animals, that is, what emotions certain species of animals, including humans, feel. Animal expressions of apparent pleasure are ambiguous as to whether this is emotion, or simply innate responses, perhaps for approval or other hard-wired cues. The ambiguity is a source of controversy as there is no certainty which views, if any, reflect reality. In recent years, research has become available which expands prior understandings of animal language, cognition and tool use, and even sexuality. Emotions arise in the mammalian brain, or the limbic system, which human beings share in common with other mammals as well as many other species.

1.4.1 Examples of emotion in animal

i. Primates

Primates and in particular great apes are candidates for highly developed capabilities for empathy and theories of mind. Great apes have highly complex social systems. Young apes and their mothers have very strong bonds of attachment. Often when a baby chimpanzee or gorilla dies, the mother will carry the body around for several days. Jane Goodall has described chimpanzees as exhibiting mournful behavior. See notably the example of the gorilla Koko, who expressed sadness over the death of her pet cat, All Ball.

ii. Fish

A 2007 study by the University of Guelph Scientists in Canada suggests that fish may have their own separate personalities. The study examined a group of trout that were visually identical. The study concluded that different fish within the same group exhibited different personality traits. Some fish were more willing to take risks in unknown waters than others when taken from their environment and introduced to a dark tube. Some fish were more social than others while some fish preferred being alone. Fish were also shown to have different preferences as far as eating habits.

iii. Felines

The emotions of cats have also been studied scientifically. It has been shown that cats can learn to manipulate their owners through vocalizations that are similar to the cries of human babies. Some cats learn to add a purr to the cry, which makes it less harmonious to humans and therefore harder to ignore. Individual cats learn to make these cries

through operant conditioning; when a particular cry elicits a positive response from a human, the cat is more likely to use that cry in the future.

iv. Canines

Research suggests that canines can experience negative emotions in a similar manner to people, including the equivalent of certain chronic and acute psychological conditions. The classic experiment for this was Martin Seligman's foundational experiments and theory of learned helplessness at the University of Pennsylvania in 1965, as an extension of his interest in depression:

A further series of experiments showed that under conditions of long term intense psychological stress, around 1/3 of dogs do not develop learned helplessness or long term depression. Instead these animals somehow managed to find a way to handle the unpleasant situation in spite of their past experience. The corresponding characteristic in humans has been found to correlate highly with an explanatory style and optimistic attitude and lower levels of emotion dog that had earlier been repeatedly conditioned to associate a sound with electric shocks did not try to escape the electric shocks after the warning was presented, even though all the dog would have had to do is jump over a low divider within ten seconds, more than enough time to respond. The dog didn't even try to avoid the "aversive stimulus"; it had previously "learned" that nothing it did mattered. A follow-up experiment involved three dogs affixed in harnesses, including one that received shocks of identical intensity and duration to the others, but the lever which would otherwise have allowed the dog a degree of control was left disconnected and didn't do anything. The first two dogs quickly recovered from the experience, but the third dog suffered chronic symptoms of clinical depression as a result of this perceived helplessness. Such studies highlighted similar distinctions between people who adapt and those who break down, under long term psychological pressure, which were conducted in the 1950s in the realm of brainwashing.

1.5 Animal Communication

Animal communication is any behavior on the part of one animal that has an effect on the current or future behaviour of another animal. The study of animal communication, sometimes called Zoosemiotics (defined as the study of sign communication or semiosis in animals; distinguishable from anthroposemiotics, the study of human communication) has played an important part in the methodology of ethology, sociobiology, and the study of animal cognition. The best

known form of communication involves the display of distinctive body parts, or distinctive bodily movements; often these occur in combination, so a distinctive movement acts to reveal or emphasize a distinctive body part.

Many animals communicate through vocalization. This is essential for many tasks including mating rituals, warning calls, conveying location of food sources, and social learning. Male mating calls are used to signal the female and to beat competitors in species such as hammer-headed bats, red deers, humpback whales and elephant seals. In whale species, whale song has been found to have different dialects based on location. Other instances of communication include the warning cries of the Campbell monkey, the territorial calls of gibbons, the use of frequency in Greater Spear-nosed bats to to distinguish between groups.

Less obvious (except in a few cases) is olfactory communication. Many mammals, in particular, have glands that generate distinctive and long-lasting smells, and have corresponding behaviours that leave these smells in places where they have been. Often the scented substance is introduced into urine or feces. Sometimes it is distributed through sweat, though this does not leave a semi-permanent mark as scents deposited on the ground do. Some animals have glands on their bodies whose sole function appears to be to deposit scent marks: for example Mongolian gerbils have a scent gland on their stomachs, and a characteristic ventral rubbing action that deposits scent from it. Golden hamsters and cats have scent glands on their flanks, and deposit scent by rubbing their sides against objects; cats also have scent glands on their foreheads. Bees carry with them a pouch of material from the hive which they release as they reenter, the smell of which indicates that they are a part of the hive and grants their safe entry. Ants use pheromones to create scent trails to food as well as for alarm calls, mate attraction and to distinguish between colonies. Additionally, they have pheromones that are used to confuse an enemy and manipulate them into fighting with themselves.

A rarer form of animal communication is electrocommunication. It is seen primarily in aquatic life, though some mammals, notably the platypus and echidnas are capable of electroreception and thus theoretically of electrocommunication.

1.5.1 Function of communication

i. **Agonistic interaction:** everything to do with contests and aggression between individuals. Many species have distinctive threat displays that are made during competition over food, mates or territory; much bird song functions in this way. Often there is a matched submission display, which the threatened individual will make if it is acknowledging the social dominance of the threatener; this has the effect of terminating the aggressive episode and allowing the dominant animal unrestricted access to the resource in dispute. Some species also have affiliative displays which are made to indicate that a dominant animal accepts the presence of another.

ii. **Courtship rituals:** signals made by members of one sex to attract or maintain the attention of potential mate, or to cement a pair bond. These frequently involve the display of body parts, body postures (gazelles assume characteristic poses as a signal to initiate mating), or the emission of scents or calls, that are unique to the species, thus allowing the individuals to avoid mating with members of another species which would be infertile. Animals that form lasting pair bonds often have symmetrical displays that they make to each other:

iii. **Food-related signals:** many animals make "food calls" that attract a mate, or offspring, or members of a social group generally to a food source. When parents are feeding offspring, the offspring often have begging responses (particularly when there are many offspring in a clutch or litter - this is well known in altricial songbirds, for example). Perhaps the most elaborate food-related signal is the dance language of honeybees studied.

iv. **Alarm calls:** signals made in the presence of a threat from a predator, allowing all members of a social group (and often members of other species) to run for cover, become immobile, or gather into a group to reduce the risk of attack.

v. Ownership / territorial: signals used to claim or defend a territory, food, or a mate.

vi. Metacommunications: signals that modify the meaning of subsequent signals. The best known example is the play face in dogs, which signals that a subsequent aggressive signal is part of a play fight rather than a serious aggressive episode
vii. What is animal communication?
viii. What is Zoosemiotics?

Self-Assessment Exercises 1

Attempt these exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. Briefly explain emotions in cat.
2. Write on courtship rituals

1.6 Summary

One of Tinbergen's most important contributions to the study of animal behaviour was to stress that ethology is like any other branch of biology, in that a comprehensive study of any behaviour must address four categories of questions, which today are called "levels of analysis," including causation, ontogeny, function and evolutionary history. Although each of these four approaches requires a different kind of scientific investigation, all contribute to solving the enduring puzzle of how and why animals, including humans, behave as they do.

The desire to understand animals has made ethology a rapidly growing topic, and since the turn of the 21st century, many prior understandings related to diverse fields such as animal communication, personal symbolic name use, animal emotions, animal culture, learning, and even sexual conduct long thought to be well understood, have been modified, as have new fields such as neuroethology

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1.8 Possible Answers to SAEs

Answers to SAEs 1

1. The emotions of cats have also been studied scientifically. It has been shown that cats can learn to manipulate their owners through vocalizations that are similar to the cries of human babies. Some cats learn to add a purr to the cry, which makes it less harmonious to humans and therefore harder to ignore. Individual cats learn to make these cries through operant conditioning; when a particular cry elicits a positive response from a human, the cat is more likely to use that cry in the future.

2. Courtship rituals are signals made by members of one sex to attract or maintain the attention of potential mate, or to cement a pair bond. These frequently involve the display of body parts, body postures (gazelles assume characteristic poses as a signal to initiate mating), or the emission of scents or calls, that are unique to the species, thus allowing the individuals to avoid mating with members of another species which would be infertile. Animals that form lasting pair bonds often have symmetrical displays that they make to each other

Unit 2 Reflex and Complex behaviour

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2.1 Introduction

The nervous system of vertebrate animals (including humans) is divided into the central nervous system (CNS) and peripheral nervous system (PNS); aneurone nervous system.

The central nervous system (CNS) is the largest part, and includes the brain and spinal cord. The spinal cavity contains the spinal cord, while the head contains the brain. The CNS is enclosed and protected by meninges, a three-layered system of membranes, including a tough, leathery outer layer called the dura mater. The brain is also protected by the skull, and the spinal cord by the vertebrae.

The peripheral nervous system (PNS) is a collective term for the nervous system structures that do not lie within the CNS. The large majority of the axon bundles called nerves are considered to belong to the PNS, even when the cell bodies of the neurons to which they belong reside within the brain or spinal cord. The PNS is divided into somatic and visceral parts. The somatic part consists of the nerves that innervate the skin, joints, and muscles. The cell bodies of somatic sensory neurons lie in dorsal root ganglia of the spinal cord. The visceral part, also known as the autonomic nervous system, contains neurons that innervate the internal organs, blood vessels, and glands. The autonomic nervous system itself consists of two parts: the sympathetic nervous system and the parasympathetic nervous system. Some authors also include sensory neurons whose cell bodies lie in the periphery (for senses such as hearing) as part of the PNS; others, however, omit them.

The vertebrate nervous system can also be divided into areas called grey matter ("gray matter" in American spelling) and white matter. Grey

matter (which is only grey in preserved tissue, and is better described as pink or light brown in living tissue) contains a high proportion of cell bodies of neurons. White matter is composed mainly of myelinated axons, and takes its color from the myelin. White matter includes all of the peripheral nerves, and much of the interior of the brain and spinal cord. Grey matter is found in clusters of neurons in the brain and spinal cord, and in cortical layers that line their surfaces. There is an anatomical convention that a cluster of neurons in the brain or spinal cord is called a nucleus, whereas a cluster of neurons in the periphery is called a ganglion. There are, however, a few exceptions to this rule, notably including the part of the forebrain called the basal ganglia.

2.2 Intended Learning Outcomes (ILOs)

At the end of this unit, students should be able to;

- Explain the action of reflex in animals
- Explin the term identified neuron

2.3 Reflex

Reflex, in biology is an action consisting of comparatively segments of behaviour that usually occur as direct and immediate responses to particular stimuli uniquely correlated wit them.

Many reflexes of placental mammals appear to be innate. They are hereditary and are a common feature of the species and often of the genus. Reflexes include not only such simple acts as chewing, swallowing, blinking, the knee jerk, and the scratch reflex, but also stepping, standing, and mating. Built up into complex patterns of many coordinated muscular actions, reflexes form the basis of much instinctive behaviour in animals.

Humans also exhibit a variety of innate reflexes, which are involved with the adjustment of the musculature for optimum performance of the distance receptors (i.e., eye and ear), with the orientation of parts of the body in spatial relation to the head, and with the management of the complicated acts involved in ingesting food. Among the innate reflexes involving just the eyes, for example, are:

i) paired shifting of the eyeballs, often combined with turning of the head, to perceive an object in the field of vision;

ii) contraction of the intraocular muscles to adjust the focus of the retina for the viewing of near or far objects;

iii) constriction of the pupil to reduce excessive illumination of the retina; and

iv) blinking due to intense light or touching of the cornea.

In its simplest form, a reflex is viewed as a function of an idealized mechanism called the reflex arc. The primary components of the reflex arc are the sensory-nerve cells (or receptors) that receive stimulation, in turn connecting to other nerve cells that activate muscle cells (or effectors), which perform the reflex action. In most cases, however, the basic physiological mechanism behind a reflex is more complicated than the reflex arc theory would suggest. Additional nerve cells capable of communicating with other parts of the body (beyond the receptor and effector) are present in reflex circuits. As a result of the integrative action of the nervous system in higher organisms, behaviour is more than the simple sum of their reflexes; it is a unitary whole that exhibits coordination between many individual reflexes and is characterized by flexibility and adaptability to circumstances. Many automatic, unconditioned reflexes can thus be modified by or adapted to new stimuli, making possible the conditioning of reflex responses. The experiments of the Russian physiologist Ivan Petrovich Pavlov, for example, showed that if an animal salivates at the sight of food while another stimulus, such as the sound of a bell, occurs simultaneously, the sound alone can induce salivation after several trials. The animal's behaviour is no longer limited by fixed, inherited reflex arcs but can be modified by experience and exposure to an unlimited number of stimuli.

2.4 Identified Neuron

A neuron is called identified if it has properties that distinguish it from every other neuron in the same animal—properties such as location, neurotransmitter, gene expression pattern, and connectivity—and if every individual organism belonging to the same species has one and only one neuron with the same set of properties. In vertebrate nervous systems very few neurons are "identified" in this sense—in humans, there are believed to be none—but in simpler nervous systems, some or all neurons may be thus unique. In the roundworm C. elegans, whose nervous system is the most thoroughly described of any animal's, every neuron in the body is uniquely identifiable, with the same location and the same connections in every individual worm. One notable consequence of this fact is that the form of the C. elegans nervous

system is completely specified by the genome, with no experience-dependent plasticity.

The brains of many molluscs and insects also contain substantial numbers of identified neurons. In vertebrates, the best known identified neurons are the gigantic Mauthner cells of fish. Every fish has two Mauthner cells, located in the bottom part of the brainstem, one on the left side and one on the right. Each Mauthner cell has an axon that crosses over, innervating neurons at the same brain level and then travelling down through the spinal cord, making numerous connections as it goes. The synapses generated by a Mauthner cell are so powerful that a single action potential gives rise to a major behavioral response: within milliseconds the fish curves its body into a C-shape, then straightens, thereby propelling itself rapidly forward. Functionally this is a fast escape response, triggered most easily by a strong sound wave or pressure wave impinging on the lateral line organ of the fish. Mauther cells are not the only identified neurons in fish—there are about 20 more types, including pairs of "Mauthner cell analogs" in each spinal segmental nucleus. Although a Mauthner cell is capable of bringing about an escape response all by itself, in the context of ordinary behavior other types of cells usually contribute to shaping the amplitude and direction of the response. Mauthner cells have been described as command neurons. A command neuron is a special type of identified neuron, defined as a neuron that is capable of driving a specific behavior all by itself. such neurons appear most commonly in the fast escape systems of various species—the squid giant axon and squid giant synapse, used for pioneering experiments in neurophysiology because of their enormous size, both participate in the fast escape circuit of the squid. The concept of a command neuron has however, become controversial, because of studies showing that some neurons that initially appeared to fit the description were really only capable of evoking a response in a limited set of circumstances

i. Neural precursors in sponges

Sponges have no cells connected to each other by synaptic junctions, that is, no neurons, and therefore no nervous system. They do, however, have homologs of many genes that play key roles in synaptic function. Recent studies have shown that sponge cells express a group of proteins that cluster together to form a structure resembling a postsynaptic density (the signal-receiving part of a synapse). However,

the function of this structure is currently unclear. Although sponge cells do not show synaptic transmission, they do communicate with each other via calcium waves and other impulses, which mediate some simple actions such as whole-body contraction.

ii. Radiate

Jellyfish, comb jellies, and related animals have diffuse nerve nets rather than a central nervous system. In most jellyfish the nerve net is spread more or less evenly across the body; in comb jellies it is concentrated near the mouth. The nerve nets consist of sensory neurons that pick up chemical, tactile, and visual signals, motor neurons that can activate contractions of the body wall, and intermediate neurons that detect patterns of activity in the sensory neurons and send signals to groups of motor neurons as a result. In some cases groups of intermediate neurons are clustered into discrete ganglia.

iii. Bilateria

The vast majority of existing animals are bilaterians, meaning animals with left and right sides that are approximate mirror images of each other. All bilateria are thought to have descended from a common wormlike ancestor that appeared in the Cambrian period, 550–600 million years ago. The fundamental bilaterian body form is a tube with a hollow gut cavity running from mouth to anus, and a nerve cord with an enlargement (a "ganglion") for each body segment, with an especially large ganglion at the front, called the "brain". Even mammals, including humans, show the segmented bilaterian body plan at the level of the nervous system. The spinal cord contains a series of segmental ganglia, each giving rise to motor and sensory nerves that innervate a portion of the body surface and underlying musculature. On the limbs, the layout of the innervation pattern is complex, but on the trunk it gives rise to a series of narrow bands. The top three segments belong to the brain, giving rise to the forebrain, midbrain, and hindbrain.

Bilaterians can be divided, based on events that occur very early in embryonic development, into two groups (superphyla) called protostomes and deuterostomes. Deuterostomes include vertebrates as well as echinoderms, hemichordates (mainly acorn worms), and Xenoturbellidans. Protostomes, the more diverse group, include arthropods, molluscs, and numerous types of worms. There is a

basic difference between the two groups in the placement of the nervous system within the body: protostomes possess a nerve cord on the ventral (usually bottom) side of the body, whereas in deuterostomes the nerve cord is on the dorsal (usually top) side. In fact, numerous aspects of the body are inverted between the two groups, including the expression patterns of several genes that show dorsal-to-ventral gradients. Most anatomists now consider that the bodies of protostomes and deuterostomes are "flipped over" with respect to each other, a hypothesis that was first proposed by Geoffroy Saint-Hilaire for insects in comparison to vertebrates. Thus insects, for example, have nerve cords that run along the ventral midline of the body, while all vertebrates have spinal cords that run along the dorsal midline.

iv. Worms

Worms are the simplest bilaterian animals, and reveal the basic structure of the bilaterian nervous system in the most straightforward way. As an example, earthworms have dual nerve cords running along the length of the body and merging at the tail and the mouth. These nerve cords are connected by transverse nerves like the rungs of a ladder. These transverse nerves help coordinate the two sides of the animal. Two ganglia at the head end function similar to a simple brain.

Photoreceptors on the animal's eyespots provide sensory information on light and dark. The nervous system of one very small worm, the roundworm Caenorhabditis elegans, has been mapped out down to the synaptic level. Every neuron and its cellular lineage has been recorded and most, if not all, of the neural connections are known. In this species, the nervous system is sexually dimorphic; the nervous systems of the two sexes, males and hermaphrodites, have different numbers of neurons and groups of neurons that perform sex-specific functions. In C. elegans, males have exactly 383 neurons, while hermaphrodites have exactly 302 neurons.

v. Arthropods

Arthropods, such as insects and crustaceans, have a nervous system made up of a series of ganglia, connected by a ventral nerve cord made up of two parallel connectives running along the length of the belly. Typically, each body segment has one ganglion on each side, though some ganglia are fused to form the brain and other large ganglia. The head segment contains the brain, also known as the supraesophageal ganglion. In the insect nervous system, the brain is anatomically divided into the protocerebrum, deutocerebrum, and tritocerebrum. Immediately behind the brain is the subesophageal ganglion, which is

composed of three pairs of fused ganglia. It controls the mouthparts, the salivary glands and certain muscles. Many arthropods have well-developed sensory organs, including compound eyes for vision and antennae for olfaction and pheromone sensation. The sensory information from these organs is processed by the brain. What is Reflex? The best known identified neurons are found inwhere?

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. What is identified neurons?
2. Write on neurons in radiate

2.5 Summary

A reflex is viewed as a function of an idealized mechanism called the reflex arc. The primary components of the reflex arc are the sensory-nerve cells (or receptors) that receive stimulation, in turn connecting to other nerve cells that activate muscle cells (or effectors), which perform the reflex action. Animal's behaviour is no longer limited by fixed, inherited reflex arcs but can be modified by experience and exposure to an unlimited number of stimuli.

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2.7 Possible Answers to SAEs

Answers to SAEs 1

1. A neuron is called identified if it has properties that distinguish it from every other neuron in the same animal—properties such as location, neurotransmitter, gene expression pattern, and connectivity—and if every individual organism belonging to the same species has one and only one neuron with the same set of properties

2. Jellyfish, comb jellies, and related animals have diffuse nerve nets rather than a central nervous system. In most jellyfish the nerve net is spread more or less evenly across the body; in comb jellies it is concentrated near the mouth. The nerve nets consist of sensory neurons that pick up chemical, tactile, and visual signals, motor neurons that can activate contractions of the body wall, and intermediate neurons that detect patterns of activity in the sensory neurons and send signals to groups of motor neurons as a result. In some cases groups of intermediate neurons are clustered into discrete ganglia.

Unit 3 Orientation in Animals

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3.1 Introduction

Orientation is the ability of an animal to determine its position in space and among individuals of the same or other species. Animal orientation is complex process that includes receiving information about the external world through various channels of communication, processing it, correlating it in the central nervous system, and forming a response. The reception and processing of signals consist of recognizing and locating an imagine (information content of the signal) that is determining by various receptor system the source of the signal in relation to the body (biolocation).

There are diiferent forms of orientation. Object orientation takes place when the animal tries to approach an object which may be food or water. Aquatic animals move vertically in pond or lake which is called strato-orientation. When the animals try to move from grassland to forests, deserts or mountains it is called zonal orientation. Animals which migrate long distances generally possess topographical or geographical orientation.

3.2 Intended Learning Outcomes (ILOs)

At the end of this course, students should be able to:

- Define orientation in animal
- Explain the different forms of orientation

3.3 Orientation in Animal

Orientation of locomotor behaviour is usually categorized as either kinesis or taxis. In kinesis, an animal's body is not oriented in relation to a sensory stimulus; rather, the stimulus causes an alteration in speed or direction of movement. In wood lice, for example, the kinetic response alters only the rate of movement. Because wood lice tend to aggregate in moist areas, their ambulatory activity increases or decreases as the relative humidity decreases or increases, respectively. In the planarian (an aquatic, ciliated flatworm), on the other hand, the kinetic response affects only the rate at which the planarian changes its direction. Because planaria tend to stay in or return to darker areas, an increase in light intensity causes an increase in their turning responses. Generally, however, animals tend to alter both direction and speed as a single kinetic response.

In taxis, an animal orients itself in a specific spatial relationship to a stimulus. The orientation may be simply an alteration of body position or it may be an alteration of locomotor direction so that the animal moves toward, away from, or at a fixed angle to the source of the stimulus. Sources that elicit a taxis response, which may cause a modification of speed, direction, or both, seem to encompass the entire range of environmental stimuli, such as gravity (geotaxis), temperature (thermotaxis), light (phototaxis), or chemicals (chemotaxis). If the response is negative, the animal moves away from the source; if it is positive, the animal moves toward the source.

The control of the response to a taxis is of two types. In open-system control, the initial response to a stimulus has no effect on subsequent responses to the same stimulus. A male firefly, for example, locates a female by the latter's brief flashes of light. When a male sees a female's flash, the male turns in the direction of the female, even though the source is no longer visible. If another female flashes, however, the male responds to the second flash in exactly the same manner as it did to the first. In close-system control, on the other hand, the response is progressively altered by feedback so that all subsequent responses are adjusted to the initial response. A bat chasing a flying insect will alter its flight path to intercept that of the insect. The bat's initial change in direction is only a general alteration of its course, but, as it approaches the insect, the bat constantly modifies its course to obtain an accurate interception.

Experiments have shown that the orientation of birds is based on celestial bearings. The Sun is the point of orientation during the day, and birds are able to compensate for the movement of the Sun throughout the day. A

so-called internal clock mechanism in birds involves the ability to gauge the angle of the Sun above the horizon. Similar mechanisms are known in many animals and are closely related to the rhythm of daylight, or photoperiodism. When the internal rhythm of birds is disturbed by subjecting them first to several days of irregular light–dark sequences, then to an artificial rhythm that is delayed or advanced in relation to the normal rhythm, corresponding anomalies occur in the homing behaviour.

Two theories have been formulated to explain how birds use the Sun for orientation. Neither, however, has so far been substantiated with proof. One theory holds that birds find the right direction by determining the horizontal angle measured on the horizon from the Sun's projection. They correct for the Sun's movement by compensating for the changing angle and thus are able to maintain the same direction. According to this theory, the Sun is a compass that enables the birds to find and maintain their direction. This theory does not explain, however, the manner in which a bird, transported and released in an experimental situation, determines the relationship between the point at which it is released and its goal.

The second theory, proposed by British ornithologist G.V.T. Matthews, is based on other aspects of the Sun's position, the most important of which is the arc of the Sun—i.e., the angle made by the plane through which the Sun is moving in relation to the horizontal. Each day in the Northern Hemisphere, the highest point reached by the Sun lies in the south, thus indicating direction; the highest point is reached at noon, thus indicating time. In its native area a bird is familiar with the characteristics of the Sun's movement. Placed in different surroundings, the bird can project the curve of the Sun's movement after watching only a small segment of its course. By measuring maximum altitude (the Sun's angle in relation to the horizontal) and comparing it with circumstances in the usual habitat, the bird obtains a sense of latitude. Details of longitude are provided by the Sun's position in relation to both the highest point and position it will reach—as revealed by a precise internal clock.

Migrant birds that travel at night are also capable of directional orientation. Studies have shown that these birds use the stars to determine their bearings. In clear weather, captive migrants head immediately in the right direction using only the stars. They are even able to orient themselves correctly to the arrangement of night skies projected on the dome of a planetarium; true celestial navigation is involved because the birds determine their latitude and longitude by the position of the stars. In a planetarium in Germany, blackcaps (*Sylvia atricapilla*) and garden warblers (*S. borin*), under an artificial autumn sky, headed "southwest," their normal direction; lesser whitethroats (*S. curruca*) headed "southeast," their normal direction of migration in that season.

It is known, then, that birds are able to navigate by two types of orientation. One, simple and directional, is compass orientation; the second, complex and directed to a point, is true navigation, or goal orientation. Both types apparently are based on celestial bearings, which provide a navigational "grid."

The methods of directional orientation used by birds are similar to those used by other animals. Orientation to the Sun has been demonstrated in various crustaceans, particularly in the sand flea (*Talitrus saltator*). Various insects, particularly bees and certain beetles (families Scarabaeidae, Tenebrionidae, and Carabidae), use the Sun to plot their course with remarkable accuracy.

Fishes also are able to use celestial bearings; salmon presumably use the Sun. Experiments with the parrot fish (*Scarus*) have demonstrated a Sun compass reaction that may also occur in other fishes. Localization of the Sun is, however, much more difficult in water than in the air, because of the characteristics of light rays passing through water. Experiments suggest that topographical clues are also used by fishes to recognize their range, particularly their spawning grounds. Visual bearings in this respect have great importance. It is possible that chemical substances also provide clues.

Visible landmarks are used by mammals, at least for orientation within short distances. Scented trails are probably helpful within a limited area, proportionate to the size of the animal; olfaction plays an important role in the life of mammals. Some mammals, however, migrate over enormous distances and are able to return after being taken far away from their home territory; bats, for example, have returned 265 kilometres (165 miles) to their caves. Random exploration plays a part in such movements, but it is possible that some type of true navigation is involved in certain of these movements.

3.3.1 Steering

Animals obtain accurate directional response (steering) by changing their propulsive response. Because steering relies heavily on continuous feedback (the communication cycle in which the motor output, or behaviour, is constantly being modified by the sensory input, or stimulus), it requires a precise integration of the central and peripheral nervous systems. (The central nervous system—in vertebrates, the brain and spinal cord—is that part of the nervous system that receives sensory impulses and sends out motor impulses; the peripheral nervous system consists of all the nerves that carry impulses between the central nervous system and other parts of the body.) Exteroceptive stimuli (those that originate

outside the body) received by the peripheral nervous system establish the animal's spatial position in the environment; proprioceptive stimuli (those that originate inside the body), also received by the peripheral nervous system, establish the relative position of the body units to each other. Through integration of these two sets of stimuli, the central nervous system continuously adjusts the contraction of the motor units (e.g., muscles) to obtain the desired orientation.

During locomotion, steering is a continual process. The direction of movements must be constantly adjusted to counteract environmentally produced deviations of direction. The apparently simple act of a bird flying from a tree to the ground illustrates the complexity of directional control. As the bird flies to the ground, it must be constantly aware of its height above the ground, the orientation of its body axis relative to the ground, deviations in flight direction resulting from air currents, and its speed of fall. All these parameters are determined primarily by exteroceptive stimuli received through the eyes and inner ears. The downward flight is constantly adjusted in response to these exteroceptive stimuli, and the fine control necessary for these adjustments is obtained by proprioceptive feedback. What is Orientation?
Birds traveling of flying at night are capable of what?

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. Birds are able to navigate with how many types of orientation?

3.4 Summary

Orientation is the position of the animal with reference to gravity or resource. This is the position the animal maintains in order to reach the resource. The ability of invertebrate and especially vertebrate to see individual objects makes orientation in an enviroenmnet much easier. This is particularly important for every mobile animals. Invertebrates and lower vertebrate are not capable of a detailed and coplex analysis of the visble world. They discern only a few biologically important signals against an undifferentiated background.

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3.6 Possible Answers to SAEs

Answers to SAEs 1

1. Birds are able to navigate by two types of orientation. One, simple and directional, is compass orientation; the second, complex and directed to a point, is true navigation, or goal orientation

Unit 4 Taxes in Animals

Contents

4.1 Introduction
4.2 Intended Learning Outcomes (ILOs)
4.3 Taxes
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4.6 Possible Answers to Self-Assessment Exercises

4.1 Introduction

A taxis (plural taxes, pronounced / tæksi z/) is an innate behavioral response by an organism to a directional stimulus or gradient of stimulus intensity. A taxis differs from a tropism (turning response, often growth towards or away from a stimulus) in that the organism has motility and demonstrates guided movement towards or away from the stimulus source. It is sometimes distinguished from a kinesis, a non-directional change in activity in response to a stimulus.

4.2 Intended Learning Outcomes (ILOs)

At the end of this course, students should be able to:

- Define taxes in animal
- Explain the different forms of taxes in animals

4.3 Taxes

4.3.1 Examples of Taxes in Animals

i. Aerotaxis

Aerotaxis is the response of an organism to variation in oxygen concentration, and is mainly found in aerobic bacteria.

ii. Chemotaxis

Chemotaxis is a migratory response elicited by chemicals: that is, a response to a chemical concentration gradient. For example, chemotaxis in response to a sugar gradient has been observed in motile bacteria such

as E. Coli. Chemotaxis also occurs in the antherozoids of liverworts, ferns, and mosses in response to chemicals secreted by the archegonia, also in higher animals e.g Dogs for sexual attraction. Unicellular (e.g. protozoa) or multicellular (e.g. worms) organisms are targets of chemotactic substances. A concentration gradient of chemicals developed in a fluid phase guides the vectorial movement of responder cells or organisms. Inducers of locomotion towards increasing steps of concentrations are considered as chemoattractants, while chemorepellents result moving off the chemical. Chemotaxis is described in prokaryotic and eukaryotic cells, but signalling mechanisms (receptors, intracellular signaling) and effectors are significantly different.

iii. Energy taxis

Energy taxis is the orientation of bacteria towards conditions of optimal metabolic activity by sensing the internal energetic conditions of cell. Therefore in contrast to chemotaxis (taxis towards or away from a specific extracellular compound), energy taxis responds on an intracellular stimulus (e.g. proton motive force, activity of NDPH- 1) and requires metabolic activity.

iv. Phototaxis

Phototaxis is the movement of an organism in response to light: that is, the response to variation in light intensity and direction.
Negative phototaxis, or movement away from a light source, is demonstrated in some insects, such as cockroaches.

Positive phototaxis, or movement towards a light source, is advantageous for phototrophic organisms as they can orient themselves most efficiently to receive light for photosynthesis. Many phytoflagellates, e.g. *Euglena*, and the chloroplasts of higher plants positively phototactic, moving towards a light source. Two types of positive phototaxis are observed in prokaryotes.

Scotophototaxis is observable as the movement of a bacterium out of the area illuminated by a microscope. Entering darkness signals the cell to reverse direction and reenter the light. A second type of positive phototaxis is true phototaxis, which is a directed movement up a gradient to an increasing amount of light.

v. Thermotaxis

Thermotaxis is a migration along a gradient of temperature. Some slime molds and small nematodes can migrate along amazingly small

temperature gradients of less than 0.1C/cm. They apparently use this behavior to move to an optimal level in soil.

vi. Geotaxis

Geotaxis is a response to the attraction due to gravity. The planktonic larvae of the king crab *Lithodes aequispinus* use a combination of positive phototaxis (movement towards the light) and negative geotaxis (upward movement). Both positive and negative geotaxes are found in a variety of protozoans.

vii. Rheotaxis

Rheotaxis is a response to a current in a fluid. Positive rheotaxis is shown by fish turning to face against the current. In a flowing stream, this behavior leads them to hold their position in a stream rather than being swept downstream. Some fish will exhibit negative rheotaxis where they will avoid currents.

viii. Magnetotaxis

Magnetotaxis is the ability to sense a magnetic field and coordinate movement in response. However, the term is commonly applied to bacteria that contain magnets and are physically rotated by the force of the Earth's magnetic field. In this case, the "behavior" has nothing to do with sensation, and the bacteria are more accurately described as "magnetic bacteria".

ix. Phonotaxis

Phonotaxis is the movement of an organism in response to sound

x. Galvanotaxis / electrotaxis

Galvanotaxis or electrotaxis is directional movement of motile cells in response to an electric field. It has been suggested that by detecting and orientating themselves toward the electric fields, cells are able to direct their movement towards the damages or wounds to repair the defect. It also is suggested that such a movement may contribute to directional growth of cells and tissues during development and regeneration. This notion is based on

a . the existence of measurable electric fields that naturally occur during wound healing, development and regeneration; and
b . cells in cultures respond to applied electric fields by directional cell migration – electrotaxis / galvanotaxis.

What is Taxis? What is Aerotaxis

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1 Write on Energy taxis
2. What is Scotophototaxis?

4.4 Summary

A taxis differs from a tropism (turning response, often growth towards or away from a stimulus) in that the organism has motility and demonstrates guided movement towards or away from the stimulus source. It is sometimes distinguished from a kinesis, a non-directional change in activity in response to a stimulus.

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4.6 Possible Answers to SAEs

Answers to SAEs 1

2. Energy taxis is the orientation of bacteria towards conditions of optimal metabolic activity by sensing the internal energetic conditions of cell. Therefore in contrast to chemotaxis (taxis towards or away from a specific extracellular compound), energy taxis responds on an intracellular stimulus (e.g. proton motive force, activity of NDPH- 1) and requires metabolic activity.

3. Scotophototaxis is observable as the movement of a bacterium out of the area illuminated by a microscope

Unit 5 Fixed Action Pattern, Motivation and Drive

Contents

5.1 Introduction
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5.3 Fixed Action Pattern
5.4 Motivation and Drive
5.4.1 Drive or Urge in Animals
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5.6 References/Further Readings/Web sources
5.7 Possible Answers to Self-Assessment Exercises

Glossary

5.1 Introduction

In ethology, a Fixed Action Pattern (FAP) is an instinctive behavioral sequence that is indivisible and runs to completion. Fixed action patterns are invariant and are produced by a neural network known as the innate releasing mechanism in response to an external sensory stimulus known as a sign stimulus or releaser (a signal from one individual to another). A fixed action pattern is one of the few types of behaviors which can be said to be hard-wired and instinctive

5.2 Intended Learning Outcomes (ILOs)

At the end of this topic students should be able to;

- Explain Fxed Action Pattern
- Define motivation
- Explain theories types of motivation and emotion.

5.3 Fixed Action Pattern

Many mating dances, commonly carried out by birds, are examples of fixed action patterns. In these cases, the sign stimulus is typically the presence of the female. Another example of fixed action patterns is aggression towards other males during mating season in the red-bellied stickleback. A series of experiments carried out by Niko Tinbergen showed that the aggressive behavior of the males is a FAP triggered

by anything red, the sign stimulus. The threat display of male stickleback is also a fixed action pattern triggered by a stimulus.

Another well-known case are the classic experiments by Tinbergen and Lorenz on the Graylag Goose. Like similar waterfowl, it will roll a displaced egg near its nest back to the others with its beak. The sight of the displaced egg triggers this mechanism. If the egg is taken away, the animal continues with the behavior, pulling its head back as if an imaginary egg is still being maneuvered by the underside of its beak. However, it will also attempt to move other egg shaped objects, such as a golf ball, door knob, or even an egg too large to have possibly been laid by the goose itself (a supernormal stimulus). Kelp Gull chicks are stimulated by a red spot on the mother's beak to peck at spot, which induces regurgitation. Some moths instantly fold their wings and drop to the ground if they encounters ultrasonic signals such as those produced by bats; see ultrasound avoidance. Mayflies drop their eggs when they encounter a certain pattern of light polarization which indicates they are over water.

i. Important/Significant of Fixed Action Pattern

A Fixed Action Pattern (FAP) is significant in animal behavior because it represents the simplest type of behavior, in which a readily defined stimulus nearly always results in an invariable behavioral response. A FAP can truly be said to be "hard-wired." FAPs are also unusual in that almost behaviors are modulated by the environment; a fixed response can lead to maladaptive results, whereas flexible behaviors are generally more useful. Because of this, most behaviors which are both FAPs and occur in more complex animals are usually essential to the animal's fitness or in which speed is a factor. For instance, the Greylag Goose's egg rolling behavior is so essential to the survival of its chicks that its fitness is increased by this behavior being hard-wired. A chick which cannot consistently feed will die. A moth's response to encountering echolocation needs to be immediate in order to avoid predation. An attacking stickleback is placed at an advantage if it reacts quickly to a threat. However, because these behaviors are hard-wired, they are also predictable. This can lead to their exploitation by humans or other animals.

ii. Exploitation of Fixed Action Pattern

Some species have evolved to exploit the fixed action patterns of other species by mimicry of their sign stimulus. Replicating the releasing mechanism required to trigger a FAP is known as **code-breaking**. A well-known example of this is brood parasitism, where one species will lay its eggs in the nest of another species, which will then parent its young. A young North American cowbird, for example, provides a supernormal

stimulus to its foster parent, which will cause it to forage rapidly in order to satisfy the larger bird's demands. In a natural situation a nestling will provide higher levels of stimulus with noisier, more energetic behavior, communicating its urgent need for food. Parents in this situation should work extra hard to provide food, otherwise their own offspring are likely to die of starvation.
What is Fixed Action Pattern?

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. What is the important of fixed action pattern?

5.4 Motivation and Drives

Motivation is the various internal factors that contribute to an animal behaving in a particlur way. Motivation is an intervening variable used to account for factors with in the organism that arouse, maintain and channel behaviour towards a goal. Motivated behaviour is a drive that leads to goal oriented behaviour and satiation.

The term motivation defines some kind of internal variable which influences the relationship between stimulus and response. Motivation was previously described as drives, which build up, the animals threshold of response to functionally related groups of environmental stimuli. (Thus the buildup of feeding drive resulted in an increased responsiveness to stimuli connected with food, like the sight or smell of prey). Motivation or drive was resulted in rise or fall in threshold levels of responsiveness to functionally related stimuli. Behaviours which depend on an internal state are said to be motivated, and the study of animal motivation is an important part of ethology.
Motivated behaviour has 3 distinct phases,

(1) searching phase or phase of appetitive behaviour,
(2) orientation phase or phase of consummatory behaviour and
(3) quiescent phase.

i. Lorenz' psychohydraulic model.

Lorenz’s hydraulic model, one of the earliest attempts to model motivation used the analogy of a hydraulic flow system. The fluid in its resting state, the valve blocks the next centre in the hierarchy and inhibits the performance of behaviours beyond that point. When it is excited, the

block is removed and the centre is freed for propagation. Impulses can now travel down to lower centres controlling for e g; brood care, resting and fighting but each of these centers is blocked until their appropriate or key stimulus appears. In the case of fighting the key stimulus would be a rival. The rival must be then providing a range of further key stimuli to elicit particular fighting behaviours like biting or chasing, etc.

ii. Deutsch's model.

An early attempt at the kind of motivational model which has proved very powerful in recent years is the loop system proposed by deutsch. Although deutsch's model was designated to cover much wider aspects of behaviour, only the part representing motivation is reproduced here. The model operates in the following way. A deficit or imbalance in the animals physiology is detected by and excites 'central structure 'or 'link'. The persistence and strength of this excitation depends on the magnitude of the imbalance. The excited link then activated an appropriate motor system which makes corrective behaviour in motion. As a result of the animal's behaviour some aspect of its internal and external environment changes. (For example it has eaten and its stomach is now full of food), the change in the environment is registered by the analyzer which inhibits the link so that it no longer responds to inputs from the internal/external environment. This inhibition slowly decays until the link is once again sensitive to excitation.

5.4.1 Drive or Urge in Animals

The term Drive was introduced by Woodworth (1918) as motivational concept. Animals experienced drive as biological needs such as eating and drinking and alteration in their behaviour. Drive theories were later given by Sigmund Freud (1915) and Clark Hull (1943). Freud, who was physiologist by training, believed that drives and urges such as hunger were recurring conditions in the body of animal that produced energy build up in the nervous system.

This energy build up caused psychological discomfort and restlessness that kept on increasing unless the urge was satisfied. Drive arose from a range of bodily disturbances, such as deprivation of food, water, air, sleep or temperature regulation, injury or activities like nest building. Freudian drive theory was based on the following three principles:

a.) Drive emerged from bodily needs of the animal.
b.) Drive energized the behaviour of animal due to restlessness.
c.) Reduction of drive by satisfying needs produced learning.

Konrad Lorenz (1950) proposed the Psycho-hydraulic **model** or **Flush toilet model** to explain the drive and consummatory behaviour, which has three steps:

1.) Drive causes action specific energy to accumulate with time and causes increased restlessness in the animal, which results in searching behaviour for food, water, mate etc.
2.) Consummatory behaviour starts after achieving the goal such as food or any other sign stimuli. The innate release mechanism releases the accumulated energy in the animal.
3.) After consummatory behaviour there is a quiescent period in the animal as the accumulated energy has been released and the action stoped. This is called refractory behaviour of the animal.

The following are the different forms of Drive in Animal.

i. Hunger & Thirst Drive

Hunger drive is controlled by lateral hypothalamus and ventro-median nucleus, the former is stimulatory in function while the latter is inhibitory. Glucocorticoids inhibit the hunger drive. Lateral hypothalamus can be stimulated by epinephrine. The hunger and thirst drives depend on hours of deprivation of feeding on dry food.

ii. Hoarding Drive

Many mammals such as male gerbil and squirrels possess hoarding drive as the lean season approaches. Low estrogens and testosterone levels stimulate hoarding drive in mammals. Castrated individuals show increased hoarding drive, which can be reduced by giving testosterone treatment.

iii. Migratory Drive

Migratory drive occurs in fishes and birds and may be seasonal or related to reproduction. Pineal glands, which is affected by day-light hours, affects migration in birds. In warblers pituitary gland influences migratory urge as well as excessive eating to deposit fat energy in the body. In stickleback fish thyroxin injection caused them to migrate. In ***Salmon*** and ***Anguilla***, maturation of gonads produces migratory drive, so much so that they stop eating and set out to the course of migration crossing all obstacles on the way.

iv. Aggression Drive

Aggression is controlled by amygdala of the limbic system of brain and posterior hypothalamus is also involved to some extent. In most of the male mammals testosterone causes aggression while in females high oestrogen levels reduce aggression and make the female peaceful. Hydrocortisone also increases aggression while hydroxydione decreases it. In ringed dove implants of testosterone propionate at specific sites of hypothalamus causes aggressiveness.

v. Territorial Drive

Many vertebrates mark and defend their territory. Dogs, hyenas and some prosimians mark their territory by their own urine. Monotremes and marsupials have anal glands which they rub on the ground to mark territory. In tigers and cheetahs also there are anal glands which spray the secretion on the trees to mark their territory. Gazelles possess orbital glands below the eyes which secrete a tar-like substance that they apply on grasses and bushes. Territorial behaviour is also hormone dependent. Yahr & Thiessen (1972) isolated 11 different hormones that influence territorial behaviour in vertebrates.

vi. Sexual Drive

Sexual drive involves courtship behaviour such as singing and dancing in birds, croaking in frogs and fighting in males of many vertebrates. In insects courtship behaviour is stopped if corpora allata are removed. Hormonal levels increase in breeding season. Castrated males and females do not show sexual behaviour in vertebrates while testosterone injections elicit sexual behaviour. According to Johnson (1976) oestrogen enhances female attractiveness and receptivity and causes oestrous in females. Hypothalamic Releasing Factor (LH-RF) and ACTH are known to affect copulatory behaviour in many animals.

vii. Parental Care Drive

Gonadotropin secretion by pituitary gland cause not only courtship display but also parental care in birds. Progesteron injections made the birds sit on the eggs to incubate within 20 minutes. In pigeons, secretion of prolactin from pituitary causes enlargement of crop to produce pigeon-milk which is fed to the chicks. Prolactin also acts directly on brain and makes the preoptic nucleus of hypothalamus in birds to respond to chicks calls. What is Motivation?

Answer: Motivation is the various internal factors that contribute to an animal behaving in a particlur way. Motivation is an intervening

variable used to account for factors with in the organism that arouse, maintain and channel behaviour towards a goal. What is Drive?

Self-Assessment Exercises 2

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. List the three step involves in expliaing the drive and consummatory bahaviour?
2. Write on hunger and thrist drive.

A fixed action pattern is one of the few types of behaviors which can be said to be **hard-wired** and instinctive. They are modulated by the environment; a fixed response can lead to maladaptive results, whereas flexible behaviors are generally more useful.

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5.7 Possible Answers to SAEs

Answers to SAEs 1

1. A FAP is significant in animal behavior because it represents the simplest type of behavior, in which a readily defined stimulus nearly always results in an invariable behavioral response. A FAP can truly be said to be "hard-wired." FAPs are also unusual in that almost behaviors are modulated by the environment; a fixed response can lead to maladaptive results, whereas flexible behaviors are generally more useful.

Answers to SAEs 2

1. Drive causes action specific energy to accumulate with time and causes increased restlessness in the animal, which results in searching behaviour for food, water, mate etc.

   Consummatory behaviour starts after achieving the goal such as food or any other sign stimuli. The innate release mechanism releases the accumulated energy in the animal.

After consummatory behaviour there is a quiescent period in the animal as the accumulated energy has been released and the action stoped. This is called refractory behaviour of the animal.

2. Hunger drive is controlled by lateral hypothalamus and ventro-median nucleus, the former is stimulatory in function while the latter is inhibitory. Glucocorticoids inhibit the hunger drive. Lateral hypothalamus can be stimulated by epinephrine. The hunger and thirst drives depend on hours of deprivation of feeding on dry food

Glossary

°C = degrees Celsius
cm = centimeters
CNS = Central nervous system
CH4 = Methane
CO = Carbon
CH_4 = methane (CH_4)
DNA = Deoxyribonucleic acid

E. coli = Escherichia coli
FAP = Fixed Action Pattern
°F = degree Fahrenheit
Ft = feet
h = hour
in = inches
Kgs = kilograms.
km = kilometers
kph = kilometer per hour
m = meters
mm = millimeters
mph = meter per hour
NH2OH = Hdroxylamine
NH3 = Ammonia
O_2 = Oxygen
PNS = Peripheral Nervous System
PRC = Phase Response Curve
RNA = Ribonucleic acid
L = length
HIV = Human immunodeficiency virus
% = percentage
g = grams
spp = species
UV = Ultraviolet

End of the Module Questions

1. What is animal communication?
2. What is courtship rituals?
3. What is reflex?
4. What is object orientation?
5. What is Phototaxis?

Module 2 Learning, Communication and Social Behaviour

Module Introduction

In Module two, unit one deals with Display and displacement of animal behavior, types of conflict behavior. While unit two deal with learning and communication in Animal and the different types of learning behavior exhibited by different organism.

Unit 1 Display and displacement behavior and conflct behavior
Unit 2 Learning and Communication in Animal
Unit 3 Social Behaviour
Unit 4 Social Behaviour of Primates
Unit 5 Hierarchical Organisation

Glossary

Unit 1 Displays, Displacemnet Behaviour and Conflict Behaviour

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1.2 Intended Learning Outcomes (ILOs)
1.3 Display and Displacement behvaiour in Animal
1.3.1 Displacement activities
1.3.2 Examples of Displacement behavior in animal
1.4 Conflict Behaviour
1.4.1 Types of Conflict behavior in animal
1.5 Summary
1.6 References/Further Readings/Web sources
1.7 Possible Answers to Self-Assessment Exercises

1.1 Introduction

Display behaviour is a ritualized behaviour by which an animal provides specific information to others, usually members of its own species while displacement behavior is usually thought of as self-grooming, touching, or scratching, which is displayed when an animal has a conflict between two drives, such as the desire to approach an object, while at the same time being fearful of that object.

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1.2 Intended Learning Outcomes (ILOs)

At the end of this unit, students should be able to:

- Explain displacement behavior in animals
- List examples of displacement behvaiour in animal
- Explain conflict behaviour

1.3 Display and Displacement behvaiour in Animal

Virtually all higher animals use displays to some extent. The best-known displays are visual ones—and some biologists restrict the term display to visual signals or gestures—but many also incorporate sound, smell, or even touch. Displays evolve through the ritualization of specific behaviour patterns. Some mating displays evolve from food-giving behaviours; the male bobwhite quail gives a food call and offers a tidbit to his potential mate. In many birds the food-giving behaviour is completely ritualized and proceeds without any exchange of food; domestic cocks, for example, call and peck at bare ground to attract a hen.

Agonistic (aggressive) displays usually occur near the borders of a territory. When a strange howler monkey approaches the territory of others, resident males set up a tremendous din, warning the intruder off. Many songbirds sit on highly visible perches while singing, providing both auditory and visual displays. Agonistic display is adaptive in conserving energy, making it unnecessary for the resident animal to chase others away. Furthermore, where display occurs, injury is rare, as physical contact is rarely required. An impending threat to the group may provoke display behaviour that is protective, signaling danger at the approach of a predator.

Another type of display behaviour is that designed to deceive a predator or lure it away from vulnerable young. An example is the broken-wing display-where the parent flutters along the ground as if injured-used by many birds to lure predators away from the nests. *See also* alarm signal; courtship; territorial behaviour.

1.3.1 Displacement activities

Displacement activities as described by Lorenz are motor programs that seem to discharge tension or anxiety. For example, if one is trying to entice a squirrel to come up and take a peanut, the squirrel becomes conflicted-caught between two incompatible drives. It wants the nut, but it fears humans. The squirrel is caught between *approach* and *avoidance*

tendencies, but it cannot do both at once. It becomes visibly edgy. It may take a few hops toward the human holding the peanut, then scratch itself suddenly or make a few digging movements. This does not mean the squirrel itches or needs to dig a hole. Lorenz suggested it was "breaking the tension" caused by competing urges

In 1940 Tinbergen and Kortlandt independently drew attention to a behavioural phenomenon which has since been called displacement activity and has received a good deal of attention. Although no binding rules exist by which displacement behaviour can be recognized, the term is applied to behaviour patterns which appear to be out of context with the behaviour which closely precedes or follows them either in the sense that they do not seem functionally integrated with the preceding or following behaviour or that they occur in situations in which causal factors usually responsible for them appear to be absent or at least weak compared with those determining the behavioural envelope.

Displacement activities occur in three
situations:

i. Conflict
ii. frustration of consummator acts
iii. physical thwarting of performance

.

1.3.2 Examples of displacement behaviour in animals

i) Displacement behaviour in dog

There are basically two types of displacement behaviours: those that are self- directed to something the dog does to himself, and those that are re-directed to something external. A common example of a self-directed displacement behaviour in dogs is self-grooming, most often licking the genital area. Another common self-directed behaviour is yawning.

Common examples of re-directed displacement behaviours are finding, picking up and carrying a toy, barking, circling, grazing grass and gulping water as the reader describes. In a multi-dog household, re-directed behaviour often takes the form of one dog jumping onto and engaging in play with another dog, grabbing, wrestling and the like. This is what displacement behaviours are; now to the bigger question of why dogs and other animals (including us) engage in them.

Displacement behaviour occurs at times of emotional conflict, serving as an outlet to dissipate energy. Using the reader's question for example, the behaviours that are in conflict have to do with excitement and expression of greeting behaviour. Let's explore what normal greeting

behaviour is, and why a dog might have conflicting emotions about it: For a dog, greeting involves two major areas and behaviours: licking the mouth of the returning pack member (or visitor), and sniffing the genital area. While both these behaviours are normal for dogs, most of us humans discourage such expressions of friendship.

Jumping up on us in greeting is because the dog is trying to lick us around the mouth. Since we are upright rather than on all fours, dogs can't reach our mouths without jumping up. Most of us don't want our dogs to jump on us, so we discourage this normal dog behaviour. In most cases, such discouragement is a verbal reprimand or scolding, and sometimes involves some form of physical punishment such as applying a knee to the dog's chest. Embarrassing sniffing behaviour, as well, is most often strongly reproached.

Reprimanding or punishing what is normal behaviour for a dog (inappropriate though we may consider it) makes the dog feel anxious and stressed. Over time, these feelings become intrinsically associated with the situation that triggers them, so even once the dog has learned to not jump up, he is conditioned to feel anxious in this situation.

Just as importantly, chastising the dog for what is normal does not provide an alternative outlet for the energy of this behaviour. For example, teaching the dog to sit or get a toy and carry it around when someone comes to the door creates an alternative behaviour outlet for his energy. Displacement behaviour occurs in the absence of learning a positively reinforced alternative behavior to replace his normal greeting behaviour.

It isn't just dogs that operate this way. Consider how you would feel if you suddenly find yourself in an unfamiliar culture, with different, unknown greeting rituals. You offer your hand to shake hands and the person looks at you with disgust and turns away. Standing there foolishly with your hand outstretched you might laugh uncomfortably, cough and cover your mouth with your outstretched hand, or reach to pick up something, as if that's what you intended all along all displacement behaviour.

Now think of how much better you would feel when you have been forewarned as to proper greeting in this unfamiliar culture. Feeling no anxiety you would offer the appropriate behaviour. This is just how we should approach greeting behaviour, or any other "normal" dog behaviour that we consider inappropriate or unacceptable in our society and culture. Rather than simply expressing our dismay or disgust, the best approach is to teach your dog an alternative, acceptable behaviour so his emotions will no longer be in conflict.

While the reader's dog doesn't seem too terribly upset, and has found an acceptable displacement behaviour, the reader could ask the dog to sit, lie down, or offer another learned behaviour during greeting, and see if it doesn't change her need to drink water.

And finally, I want to thank the reader for noticing that I invite questions. I try to answer all emails I receive, and am most appreciative of getting them. Readers' questions often trigger column topics I hadn't thought of, and I'm always grateful for new ideas!

ii) Displacement behaviou in cat

In the cat Parmeggiani stimulated several different and separate areas of the forebrain and brainstem and obtained a behavioural complex consisting of sniffing, grooming, **yawning**, lying down, curling up, dozing and sleeping. He emphasizes that this behaviour is normal in unstimulated cats. Rowland and Gluck present some evidence that in a certain conditioning procedure grooming replaced the synchronization of the electroencephalogram shown by sleeping cats when those were tested awake. Again, Leyhausen lists grooming, sniffing and lying down as displacement behaviour for the cat.

For the rat, Caspers has shown that grooming and some other unfortunately unspecified "motorautomatisms" are associated with shifts in the cortical d.c. potential making the surface positive, which otherwise are typical of sloop, while shifts towards a negative surface are characteristic of the waking animal. Grant mentions grooming, digging and sniffing as typical displacement activities of rats.

These facts suggest that grooming or preening and certain other movements are largely controlled by neurophysiological mechanisms which are also responsible for **de-arousal and sleep**. On the other hand they are often involved in displacement behaviour. There is little doubt, however, that the behavioural situations loading to displacement, that is, conflict, frustration and thwarting, are effective in increasing arousal. I suggest that the occurrence of at least some displacement activities is the reflexion of a homeostatic process operating towards cancelling the arousal increment so generated, through the activation of an arousal inhibiting system. The existence of arousal homeotasis has been suggested by Borlyne, who also marshals supporting empirical evidence. Such regulation appears logically necessary if arousal is correlated with the rate at which information is handled and if the nervous system is considered as a communication channel of restricted and specific capacity whore for maximum efficiency the information handling rate must be hold within certain
What is Displacement activities?

What are the common examples of re-directed displacement behavior

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. What is Display behavior?
2. Mention the three situation in which displacement activities occur.

Conflict behavior is a state of motivation in which tendencies to perform more than one activity are expressed simultaneously. At any particular moment, an animal has many different incipient tendencies, but by a process of decision-making, one of these becomes dominant. Generally, only one tendency becomes dominant, but in certain circumstances more than one competes for dominance, and conflict arises.

1.4.1 Types of conflict behavior in animals

Conflict has traditionally been divided into three main types:

i) ***Approach–approach***: conflict occurs when two tendencies in conflict are directed towards different goals. In such a case the animal may reach a point where the two tendencies are in balance. However, the tendency to approach a goal generally increases with proximity to the goal. This makes approach– approach conflict unstable, because any slight departure from the point of balance, towards one goal, will result in an increased tendency towards the other, thus resolving the conflict.

ii) ***Avoidance–avoidance:*** conflict occurs when the two tendencies in conflict are directed away from different points. Since the tendency to avoid objects generally increases with proximity to the object, movement toward either object is likely to result in a return to the point of balance. Such situations are not normally stable, because the animal can escape in a direction at right angles to the line between the two objects.

iii) ***Approach–avoidance***: conflict occurs when one activity is directed towards a goal, and another away from it. For example, an animal may have a tendency to approach food, but be frightened of the strange food dish. The nearer it approaches the food, the stronger the approach tendency, but the nearer it gets to the dish the stronger the avoidance tendency. The animal can reach the food, only when the approach tendency is larger than the avoidance tendency. Often there is an equilibrium point, some distance from the goal. When the animal approaches beyond

this point, avoidance is greater than approach. When the animal retreats, approach is larger than avoidance. Such situations tend to be stable, because the animal is always pulled towards the equilibrium point.

Approach–avoidance conflict is by far the most important and most common form of conflict in animal behaviour. Typically such conflict is characterized by compromise and ambivalence, especially near the point of equilibrium. Irrelevant behaviour, such as displacement activity, is also common, as are various forms of display and ritualization. Ritualized conflict behaviour often occurs in territorial disputes, and often forms the basis of threat display.
What is conflict behavior?

Self-Assessment Exercises 2

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. Write on Avoidance – avoidance as a form of conflict behavior.

1.4 Summary

Display behaviour is a ritualized behaviour by which an animal provides specific information to others, usually members of its own species while displacement behavior is usually thought of as self-grooming, touching, or scratching, which is displayed when an animal has a conflict between two drives.

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1.6 Possible Answers to SAEs

Answers to SAEs 1

1. Display behaviour is a ritualized behaviour by which an animal provides specific information to others, usually members of its own species.
2. Displacement activities occur in three situations:

i. Conflict
ii. frustration of consummator acts
iii. physical thwarting of performance

Answers to SAEs 2

1. Drive causes action specific energy to accumulate with time and causes increased restlessness in the animal, which results in searching behaviour for food, water, mate etc.bababab ***Avoidance–avoidance:*** conflict occurs when the two tendencies in conflict are directed away from different points. Since the tendency to avoid objects generally increases with proximity to the object, movement toward either object is likely to result in a return to the point of balance. Such situations are not normally stable, because the animal can escape in a direction at right angles to the line between the two objects

Unit 2 Learning and Communication in Animal

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2.1 Introduction

Through learning, animals can adjust quickly to changes in their environment. Learning is adaptive for animals in an environment where changes are not predictable. Learning produces changes in the behavior of an individual that are due to experience. Once an animal learns something, its behavioral choices increase.

An animal's ability to learn may correlate with the predictability of certain characteristics of its environment. Where certain changes in the habitat occur regularly and are predictable, the animal may rapidly respond to a stimulus with an unmodified instinctive behavior. An animal would not necessarily benefit from learning in this situation. However, where certain environmental changes are unpredictable and cannot be anticipated, an animal may modify its behavioral responses through learning or experience. This modification is adaptive because it allows an animal to not only change its response to fit a given situation, but also to improve its response to subsequent, similar environmental changes.

2.2 Intended Learning Outcomes (ILOs)

At the end of lecture, the students should be to:

- Understand the biological meaning of learning and the categories of learning.
- Define communication and the different types of communication.

- Modalities for communication in animals

2.3 Learning and Communication in Animal

2.3.1 Types of Learning Behaviour in Animals

i. Habituation

Habituation is the simplest and perhaps most common type of behavior in many different animals. It involves a waning or decrease in response to repeated or continuous stimulation. Simply an animal learns not to respond to stimuli in its environment that are constant and probably relatively unimportant thereby saving time as well as conserving energy. For example, after time, birds learn to ignore scarecrows that previously cause them to flee. Squirrels in a city park adjust to the movements of humans and automobiles. Habituation is believed to be controlled through central nervous system and should be distinguished from sensory adaptation. Sensory adaptation involves repeated stimulation of receptors until they stop responding. For example, if you enter a room with an odor, your olfactory sense organs soon stop responding to these odors.

ii. Classical conditioning

Classical conditioning is a type of learning documented by Russian physiologist, Ivan Pavlov (1849-1936). In his classic experiment on the salivary reflex in dogs, Pavlon presented food right after the sound of bell. After a number of such presentations, the dogs were conditioned--- they associated the sound of the bell with food. It was then possible to elicit the dog's usual response to food – salivation—with just the sound of the bell. The food was a positive reinforcement for salivating behavior, but responses could also be conditioned using negative reinforcement. Classical conditioning is very common in the animal kingdom. For example, birds learn to avoid certain brightly colored caterpillars that have a noxious taste. Because birds associate the color pattern with the bad taste, they may also avoid animals with a similar color pattern.

iii. Instrumental conditioning

In instrumental conditioning (also known as trial-and-error learning), the animal learns while carrying out certain searching actions, such as walking and moving about. For example, if the animal finds food during these activities, the food reinforces the behavior and the animal

associates the reward the reward with the behavior. If this association is repeated several times, the animal learns that the behavior leads to reinforcement; the animal then tends to repeat or avoid that behavior, depending on whether the reinforcement is positive or negative. For example, an American psychologist B.F. Skinner placed a rat in a "Skinner box'' which have a choice of various levers it might push, some of which reward the animal by releasing food. The animal's choices may be random at first, but quickly learns to choose those levers that provide food. Such learning is the basis for most of the animal training done by humans, in which the trainer typically induces a particular behavior at first by rewarding the animal.

Instrumental conditioning is undoubtedly very common in nature. For example, animals quickly learn to associate eating particular food items with good or bad tastes and modify their behavior accordingly. In some cases animals may be able to skip some of their own trial and error and learn simply by watching the behavior of others. A good example is that of tits (chickadee-like birds) in England. Sometime in the early 1950s, one of these birds apparently learned to peck through the paper tops of milk bottles left on doorsteps and drink the cream on top. This was probably a case of instrumental conditioning with the bird learning that its general pecking, probing behavior was rewarded if directed at the bottles. But the behavior quickly spread through the population and was "handed down" to the succeeding generation that that learned the behavior by watching adults.

iv. Latent learning

Latent learning sometimes called exploratory learning, involves making associations without immediate reward. The reward is not obvious. An animal is apparently motivated, however, to learn about its surroundings. For examples, if a rat is placed in a maze that has no food or reward, it explores the maze, although rather slowly. If food or another reward is provided, the rat quickly runs the maze. Apparently previous learning of the maze had occurred but remained latent, or hidden, until an obvious reward was provided. Latent learning allows an animal to learn about its environment as it explores. Knowledge about an animal's home area may be important for its survival, perhaps enabling it to escape from a predator or capture pray.

v. Insight learning

Insight learning is the ability to perform a correct or appropriate behavior on the first attempt in a situation with which the animal have no previous experience (some prefer to call it reasoning, rather than learning). For example, if a chimpanzee is placed in an area with a

banana hung too high above its head to be reached and several boxes on the floor, the chimp can size up the situation and then stack the boxes to allow it reach the food. In general insight is best developed in primate and other mammals but even in these groups the level of insight often varies from one situation or species to another. The great majority of animals display little or no ability to use insight.

Very broadly the capacity to learn can be thought of as another adaptation that enhances survival and reproductive success and must have some genetic bases. However, the internal mechanisms of learning are very poorly known and it is only recently that progress has begun on linking some simple kinds of learning to internal biochemical or physiological changes. Although animals frequently appear to do complex things, most behaviors can be understood as relatively fixed patterns that are often modified in their frequency and orientation by simple kinds of learning. Put in another way, animals in general are not all that "smart" rather they have been fine-tuned by natural selection and their limited repertoire of abilities work very well in normal circumstances.
What is habituation?

What is Insight learning?

2.4 Communication in Animals

Communication is the transfer of information from one animal to another. It requires a sender and receiver that are mutually adapted to each other. The sender must send a clear signal to the receiver. Communication can occur within species (intraspecific) or between species (interspecific). Intraspecific communication in animal is very important for reproductive success. Examples of intraspecific communication include warning signals, such as the rattle of a rattle snake's tail and the skunk's presentation of its hindquarters and tail.

Animals use a variety of modalities for communication, including visual, auditory, tactile, and chemical signals. Natural selection has influenced the characteristics of a signal system. Animals have evolved combinations of signals that may be more effective than any single signal.

2.4.1 Types of Communication in Animals

i. Visual communication

Visual communication is important to many animals because a large amount of information can be conveyed in a short time. Most animals (e.g., cephalopod mollusk, arthropods and most vertebrates other than mammals) with well- developed eyes have color vision. Many fishes, reptiles and birds exhibit brilliant color patterns that usually have a signaling function. Most mammals have plain, darker colors and lack color vision because they are nocturnal, as were their probable ancestors- nocturnal insectivores. Primates are a notable exception in that they have both color vision and colorful displays.

A visual signal may be present at all times, as are the bright facial markings of a male mandrill. The signal may be hidden or located on a less exposed part of an animal's body and then suddenly presented. Some lizards, such as green anoles can actually change their color through activities of pigment cells in the skin.

Visual signals have some disadvantages in that various objects in the environment may block the line of sight and / or the signals may be difficult to see over a long distance. Also, the signals are usually not effective at night and may be detected by predators.

ii. Acoustic communication

Arthropods and vertebrates commonly use acoustic or sound communication. These animals must expend energy to produce sounds but sounds can be used during the night or day. Sound waves also have the advantage of traveling around objects and may be produced or received while an animal is in the open or concealed. Sounds can carry a large amount of information because of the many possible variations in frequency, duration, volume and tone.

Acoustic communication systems are closely adapted to the environmental conditions in which they are used and the function of the signal. For example, tropical forest birds produce low frequency calls that pass easily through dense vegetation. Many primates in tropical forests produce sounds that travel over long distances. Other examples include the calls of territorial birds that sit on a high perch to deliver the signal more effectively and the alarm calls of many small species of birds. Some of the more complex acoustic signals that have been studied are birdsong and human speech.

iii. Tactile Communication

Tactile communication refers to the communication between animals in physical contact with each other. The antennae of many invertebrates and the touch receptors in the skin of vertebrates function in tactile communication. Some examples of tactile communication are birds preening the feathers of other birds and primates grooming each other.

iv. Chemical communication

This is another common mode of communication. Unicellular organisms with chemoreceptor can recognize members of their own species. Chemical signals are well developed in insects, fishes, salamanders and mammals. Advantages of chemical signals are that they (1) usually provide a simple message that ca last for hours or days; (2) are effective night or day (3) can pass around objects; (4) may be transported over long distances; (5) take relatively little energy to produce. The disadvantages of chemical signals are that they cannot be changed quickly and are slow to act.

Chemicals that are synthesized by one organism and that affect the behavior of another member of the same species are called **pheromones**. Olfactory receptors in the receiving animal usually detect chemical signals. Many animals mark their territories by depositing odors that act as chemical signals to other animals of the same species. For examples, many male mammals mark specific points in their territories with pheromones that warn other males of their presence in the area. The same pheromones may also attract females that are in the breeding condition.

Differences in the chemical structure of pheromones may be directly related to their function. Pheromones used for making territories and attracting mates usually last longer because of their higher molecular weights. Airborne signals have lower molecular weight and disperse easily. For example, the sex attractant pheromones of female moths that are ready to mate are airborne and males several kilometers away can detect them.

The following are communication systems associated with the different animals:

1. Auditory - birds and humans, some insects (crickets)
2. Olfactory - most mammals, moths
3. Visual - bees and dancing, fireflies at night
4. Altruism - personal sacrifice for the good of the group
5. Alarm call of mammals - Belding's Ground Squirrels

6. Cooperative breeding - African bee-eaters, Scrub Jays Bees and other hymenopterous insects

What is Communication?

What is another name for Latent Communication?#

Self-Assessment Exercises 1

Attempt these exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. What is tactile communication?
2. Which group of animals uses acoustic communication?

2.5 Summary

Through learning an animal can adjust quickly to changes in its environment. Learning is adaptive for animals in an environment where changes are not predictable. The types of learning known to occur in animals include habituation, classical conditioning, instrumental conditioning, latent learning and insight learning. Communication is an essential aspect of animal behavior which enhances continuity in existence. The different types of communication showed how animals relate to one another. Communication in animals requires the use of clear signals by one animal and their reception by another. Visual, acoustic, tactile, and chemical signals are important channels in communication systems. Communication can occur within species (intraspecific) or between species (interspecific). Intraspecific communication in animal is very important for reproductive success.

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2.7 Possible Answers to SAEs

Answers to SAEs 1

1. Tactile communication refers to the communication between animals in physical contact with each other. The antennae of many invertebrates and the touch receptors in the skin of vertebrates function in tactile communication. Some examples of tactile communication are birds preening the feathers of other birds and primates grooming each other.

2. Arthropods and vertebrates commonly use acoustic or sound communication

Unit 3 Social Behaviour

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3.1 Introduction

Social behaviour typically refers to any interactions among members of the same species, but it also applies to animals of different species, excluding predator- prey interactions. A group of animals may form an aggregation for some simple purpose, such as feeding, drinking or mating. A true animal **society** is a stable group of individuals of the same species that maintains a cooperative social relationship. This association typically extends beyond the level of mating and taking care of young. Social behaviour has evolved independently in many species of animals; invertebrates have complex social organizations.

3.2 Intended Learning Outcomes (ILOs)

At the end of lecture the students should be able to;

- Understand the meaning of social behavior and
- Identify different types of social behavior among animals.

3.3 Social Behaviour

In the animal kingdom, social species group together with the goal of increasing the overall survival of the species. A solitary antelope is more likely to get picked off by a lion than if it had the protection of the group around it. Pack animals, like wolves and dolphins, work together to obtain food, raise young and protect the group. While they may have to share the food with others in the group, their overall survival is increased by the presence of the group.

Animal populations are often organized into groups. A group of animals may form an aggregation for some simple purpose, such as feeding,

drinking or mating. Several Drosophila flies on a piece of rotting fruit are an example of an aggregation. A true animal **society** is a stable group of individuals of the same species that maintains a cooperative social relationship. This association typically extends beyond the level of mating and taking care of young. Social behavior has evolved independently in many species of animals; invertebrates have complex social organizations.

One major benefit of belonging to a group may be that it offers protection against predators. There is safety in numbers and predator detection may be enhanced by having several group members on alert to warn against an intruder. Also, cooperative hunting and capture of prey increase the feeding efficiency of predators. Living in social groups is also advantageous in some instances due to the ability to gain protection from the elements (e.g. huddling together in cold weather) and during the processes of mate finding and rearing of young. In many species, most notably the social insects, living groups has resulted in the evolutionary division of labor, with specific individuals performing specialized tasks (defense, food procurement, feeding of young.

A disadvantage of group living may be competition for resources. Other disadvantages include the diseases and parasites that may spread more rapidly in group-living animals and interference between individuals with regard to reproduction and rearing of young. The value of group living depends on the species and behaviors involved. Below is an example of social behavior in animals:

i. Altruism and Kin Selection

Sometimes one animal in the group will do something to increase the survival of another at the potential cost to its own fitness or survival. This behavior is known as **altruism**. For example, if we are stranded on a deserted island and I find food and share it with you, I am performing an altruistic act.

Altruism is performed to better the survival potential of the group rather than the individual. Many animals, like prairie dogs, will risk the notice of a predator by sounding an audible alarm call. Others, like deer, use a visual alarm call to warn other members of the social group that a predator is near. But, in doing so, the individual sounding the alarm attracts the notice of the predator, potentially risking one's own life to save the group.

When an altruistic act is performed for a member of one's own family it is called **kin selection**. This selection of related animals can affect the fitness of an individual. This increases the reproductive fitness (survival)

of future generations. A gene that a particular individual carries passes to the next generation through a related animal. Therefore, the fitness of an individual is based on the genes it passes on. It is -also based on those common genes that its relatives pass on. Therefore, altruism is a genetically based tendency. It is passed on by the individual carrying it or by a relative who also carries it. But the individuals of a group must identify its relatives for kin selection to work. It is done by small groups of primates and social insects. Lets consider few examples of altruism in some animals;

a. **Altruism in crows:** One individual of a group of crows gives an alarm call. It warns the other individuals of the group of a predator. This call may attract he predator to the sender of the signal.

b. **Altruism in Honey bee:** Altruism is also present in societies of hymenopteran insects like honeybees. The male drones are haploid. The female workers and queen are diploid. It develops genetic asymmetry. Diploid workers share three fourths of their genes with their full sisters. If they reproduced, they will share only half of their genes with hypothetical offspring. Thus, female honeybees have more genes common with their sisters than their offspring. The workers help their mother to produce more sisters. Thus the worker passes more genes to the next generation by their mother. Some of their sisters become reproductive queens.

ii. Dominance and Hierarchy

The organization of group of animals in such a way that some members of the group have greater access to resources like food or mates than others is called dominance hierarchies. Some animals are present near the top of the order. They have first choice of resources. The animals present near the bottom do not get sufficient resources.

Many primate, canine and other social groups are organized through a dominance hierarchy. The male or female in charge is the most dominant, the **alpha**, the leader of the group, like the president. While many groups are male dominant, some groups, like the spotted hyena and bonobo, are female dominant.

Example is the Pecking (fight with beaks) order is an example of a dominance hierarchy. Peck order is present in chickens in a pen. The chickens are placed together. They fight among themselves. Finally, a linear hierarchy of dominance is formed. Higher-ranked chickens are first to eat. They peck lower-ranked chickens. Peaceful coexistence is possible

after the setting of the hierarchy. Sometimes, a bird tries to move up in the order. Therefore, occasional fights o Cur.

Dominance hierarchies also exist in many vertebrate groups. The most common dominance hierarchy is present in the form of **linear relationships.** Sometime, triangular relationships may be formed. The strongest male is highest in the rank order in baboons. But sometimes, older males may form coalitions. They subdue a stronger male and lead the troop.

iii. Agnostic behaviour

The behavior in which one animal is aggressive or attacks another animal, the other responds by returning the aggression or submitting is called agnostic behavior. These behaviors are used to display one's fitness to a challenger in an attempt to intimidate him or her into backing down, like ritualistic fighting displays. A society of animals maintains social structure. Agnostic behavior is lethal in rare cases. Usually the animals are not killed or severely injured. Think of a dog growling and bearing its teeth, or an elephant stomping its feet and flapping its ears.

The males show their aggression in the form of threat displays. The aggression displays involve signals. It warns other males of an intention to defend an area or territory. Agnostic behaviour seems antisocial. But it maintains the social order. It is important in the maintenance of territories and dominance hierarchies.

iv. Territory

The site defend by territorial animal by agnostic behaviour is called territory of the animal. They excluded the competing individuals from this site. Many male birds and mammals occupy a breeding territory. A male actively defends his area against other males. He attracts a female in. his territory and courts (mating) her without interference. Some territories contain a food supply. Some territories provide shelter. It protects the animal from predators and unfavorable climate. What is Social behvaiour?
What is Altruism?

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. Write on agnostic behavior.
2. What is dominance hierarchies?

3.4 Summary

Social behaviors in animals have both advantages and disadvantages. Many animals' species live in groups that provide various benefits. Groups range from simple aggregations to more complex social organization or societies.

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3.6 Possible Answers to SAEs

Answers to SAEs 1

1. The behavior in which one animal is aggressive or attacks another animal, the other responds by returning the aggression or submitting is called agnostic behavior. These behaviors are used to display one's fitness to a challenger in an attempt to intimidate him or her into backing down, like ritualistic fighting displays. A society of animals maintains social structure. Agnostic behavior is lethal in rare cases. Usually the animals are not killed or severely injured. Think of a dog growling and bearing its teeth, or an elephant stomping its feet and flapping its ears.

2. The organization of group of animals in such a way that some members of the group have greater access to resources like food or mates than others is called dominance hierarchies.

Unit 4 Social Behaviour of Primates

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4.1 Introduction
4.2 Intended Learning Outcomes (ILOs)
4.3 Social structure compositions among primates
4.4 Summary
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4.1 Introduction

Most primates, including humans, spend their lives in large social groups. In the case of semi-terrestrial species, such as baboons, being in a large community helps provide protection against predatory cats, dogs, and hyenas. It also helps protect scarce food resources. This is especially true for non-human primates when the food is fruit. Leaf-eaters, such as colobus monkeys and langurs, tend to form smaller social groupings since there is little competition for their food. The very few nocturnal species of primates are mostly small, relatively solitary hunters.

As noted earlier, all primates (including us) form groups. Groups involve such cohesive (bonding) activities such as grooming and mother-infant bonding. It is a way to defend resources against intruders and to fend off predators, such as leopards that inhabit the forests. Group behavior among primates is the most complex among all gregarious animals (animals that form groups, which also include gazelles, cattle, bison, zebras, and others).

Most non-human primate communities are more or less closed to contact with members of other communities. Most often, they are tied to a particular locale and rarely migrate outside of their home range. This aloofness from other troops prevents high concentrations of individuals which could result in rapid depletion of local resources. Communities usually avoid each other and are aggressive towards outsiders. As a result, social interactions between members of different troops are usually very rare, especially for females. Chimpanzees are a notable exception. When chimpanzees from different troops come together, there is often an exciting, friendly encounter lasting several hours, following which, some of the adult females switch groups. Apparently, they are seeking new mates.

4.2 Intended Learning Outcomes (ILOs)

At the end of lecture the students should be able to;

- Understand the social structure among primate
- Identify different types of social behavior among primate

4.3 Social structure compositions among primates

Interactions within non-human primate communities are usually unlimited. Subgroups are rarely closed from group interaction. All members of a community have daily face to face, casual communication. The most common type of subgroup are as follow:

i. Single female and her offspring

The single female and her offspring group pattern is rare for primates but common for other mammals. It is found among the orangutans and some of the small nocturnal prosimians (e.g., mouse lemurs and galagos). The adult males lead their lives mostly alone. However, they come together with females occasionally for mating. The males of these species generally have large territories that overlap those of several females. Both male and female children usually leave their mother when they reach sexual maturity.

ii. Monogamous Family Group

Monogamous groups consist of an adult male and female with their children. When they are grown, the children leave to create their own nuclear families. While this group pattern is the most common one for humans, it is rare for non- human primates. It is found among the small Asian apes as well as some of the New World monkeys and prosimians. Specifically, monogamous family groups are the common pattern for gibbons, siamangs, titi monkeys, indris, tarsiers, and apparently some pottos.

iii. Polyandrous Family Group

The smallest New World monkeys, the marmosets and tamarins, form both monogamous and polyandrous family units. They generally start with a monogamous mating pair. Later, a second adult male may join the family and assist in child rearing. When this occurs, both

adult males will potentially mate with the adult female. This polyandrous mating pattern is extremely rare among non-human primates but does occur in some human societies in isolated rural regions of India, Sri Lanka, and especially Nepal, and Tibet.

iv. One-Male-Several Female group

One-male-several-female groups have **polygynous** mating patterns. That is to say, one male regularly mates with more than one female. Polygyny is generally not a promiscuous mating pattern. Rather, the male and his female mates form a distinct mating and child rearing group. This pattern is found among hamadryas baboons, geladas, langurs, howler monkeys, gorillas and many human societies.

It would be a mistake to automatically assume that non-human primate one-male- several-female groups are dominated by males. Among geladas, females largely control the social group. This is despite the fact that the males are larger, stronger, and more aggressive. Mothers, sisters, and aunts act as a team in chasing off other unrelated females. They also collectively select their mutual mate among a number of potential suitors roaming in and out of their territory. The male that is chosen usually is one that does not act abusively towards them and is willing to cooperate with them in defending their territory. The relationship with any particular male may be short-term. The stable core of the community is the group of related females. This is a long way from stereotypical male domination.

One-male-several female groups may take a different form when predator pressure is a problem. In open grasslands, hamadryas baboon communities are much larger, often consisting of a number of polygynous families. In such multiple one-male- several-female group societies, males are the dominant, controlling members. The adult males not only "herd" their own sexually mature females, but also maintain order and protect the community from predators.

In contrast, gorillas rarely have to be concerned about predator dangers. Subsequently, their communities usually consist of a single dominant adult male, his mates, and their children. When males reach maturity, they usually are driven off by the dominant silverback male. These exiled males ultimately form their own one-male-several-female groups. As females reach sexual maturity, they also leave their natal families and disperse. They later join with single males to form new families or they join the families of males who already have mates. When the silver back males have usually peaceful personalities, the gorilla community may have several of them.

v. Multimale- Multifemale Group

The most common social group pattern among semi-terrestrial primates is the multimale-multifemale group. With this pattern, there are no stable heterosexual bonds to both males and females have a number of different mates. This is characteristic of savanna baboons, macaques, as well as some colobus and New World monkey species.

Multimale-multifemale groups commonly have a **dominance hierarchy** among both males and females. Each individual is ranked relative to all other community members of the same gender. This tends to reduce serious violence within the community since everyone knows in advance who they must defer to and who must be submissive to them. Among rhesus macaques, one's position in the dominance hierarchy is determined by the rank of his or her mother. The top ranking individuals are referred to by primatologists as the **alpha male** and the **alpha female**. All other community members defer to them. A female's rank in the hierarchy stays with her throughout life. However, most young adult male rhesus macaques leave their natal community and ultimately join others to find mates. When they do so, they start at the bottom of the male dominance hierarchy again. Alpha males usually mate more often than others. This makes the social organization superficially look like one-male-several-female group. However, younger females often sneak off to mate with males lower down on the dominance hierarchy. The stable core of rhesus macaque communities is the group of female relatives. They stay within their natal community throughout life and work as a team to defend it against other females

vi. Fission-Fusion Society

A fission-fusion society is one in which the social group size and composition change throughout the year with different activities and situations. This is the social pattern typical of chimpanzees. Individuals enter and leave communities from time to time. Adult males occasionally wander off and forage alone or join a few other males in a hunting party. Females casually change membership from one group to the other. This occurs especially when females are in estrus and seeking mates. As a result, foraging and sleeping groups reform frequently. Male chimps are the relatively stable core of the community since they rarely join other troops.

What allows for the generally loose relationship between chimpanzee communities is that they apparently recognize a wider range of social bonds than do monkeys. They often have relatives and friends in several different neighboring troops. When chimpanzee communities come together, they usually exchange friendly greetings rather than show

aggression. However, it would be a mistake to assume from this that chimpanzee society is always peaceful. The adult males within each community are frequently engaged in complex political activities involving scheming and physical intimidation in order to move up the dominance hierarchy. They develop short-term alliances with other males by mutual support, sharing meat, and **allogrooming** (grooming others). It isn't always the largest and strongest males who make it to the top of the hierarchy. Often teamwork used to frighten and impress is more effective than any one individual's muscles in achieving chimpanzee goals. This is an indication of their intelligence.

Chimpanzees are not the only primates that change group membership from time to time. For instance, adult rhesus macaque males usually must permanently leave the community of their birth and try to join others in order to find mates. This is not easy since they are not warmly welcomed in their adoptive troop. Group composition of some langur and baboon species also change as a result of the availability of food and mates. Evidently, none of these monkey species change group composition with the ease and frequency of chimpanzees. As a result, their societies are not usually referred to as fission-fusion types.

What is Fission – Fussion Society?

Self-Assemeement Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. Write on Monogamous groups
2. What do you understand by Polyandrous family group?

4.4 Summary

Group behavior among primates is the most complex among all gregarious animals (animals that form groups, which also include gazelles, cattle, bison, zebras, and others). Primates live in social groups that provide various benefits like food, protection, mates, learning of skills, grooming and parental care.

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4.6 Possible Answers to SAEs

Answers to SAEs 1

1. Monogamous groups consist of an adult male and female with their children. When they are grown, the children leave to create their own nuclear families. While this group pattern is the most common one for humans, it is rare for non- human primates. It is found among the small Asian apes as well as some of the New World monkeys and prosimians. Specifically, monogamous family groups are the common pattern for gibbons, siamangs, titi monkeys, indris, tarsiers, and apparently some pottos.

2. The smallest New World monkeys, the marmosets and tamarins, form both monogamous and polyandrous family units. They generally start with a monogamous mating pair. Later, a second adult male may join the family and assist in child rearing. When this occurs, both adult males will potentially mate with the adult female. This polyandrous mating pattern is extremely rare among non-human primates but does occur in some human societies in isolated rural regions of India, Sri Lanka, and especially Nepal, and Tibet.

Unit 5 Herachical Organisation

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5.1 Introduction

A dominance hierarchy is the organization of individuals in a group according to their dominance. These hierarchies are often linear, each individual dominating all individuals below him and not those above him. The most dominant individual is often referred to as the **alpha male** (or female), followed by the beta male and so on. These social structures were first observed in chickens and are thus sometimes referred to as a "pecking order". The alpha male always eats first but also ensures that all members of the group get something, even the least dominant. He has a responsibility to 'look after' and make decisions for the group

The evolution of dominance hierarchies in a species is indicative that there is competition for resources. Members of a dominance hierarchy are aware of how they are positioned within that hierarchy and they behave appropriately. Of particular importance, the establishment of dominance hierarchies allows for the resolution of conflict between individuals without costly fighting that can result in serious injury or even death. In species where organized group living is essential to survival, it also serves to maintain order among pack members

5.2 Intended Learning Outcomes (ILOs)

At the end of lecture the students should be able to;

- Explain dominance hierarchy
- Identify different ty

5.3 Dominance Hierarchies

Dominance hierarchies characterize many species in which individuals live in close proximity to one another. The dominance hierarchy is a social structure within a group of animals in which certain individuals are dominant over others, and are therefore able to claim access to better resources in the form of food, mates, shelter, and other desirable commodities.

Those near the top of the order have first choice of recourses, whereas those near the bottom go last and may do without if resources are in short supply. An example of dominance hierarchy is the pecking order of chickens in pen. When chickens are placed together, they fight among themselves until a linear hierarchy of dominance is established. Higher-ranked chickens are among the first to eat and may peck lower–ranked chickens. Once the hierarchy is set, peaceful coexistence is possible. Occasional fights will occur if bird tries to move up in the order.

i. Establishment of Dominance Hierarchies

Dominance hierarchies are often established through ritualized displays or mild fighting, rather than all-out battle. The loser in a battle for dominance typically moves away from a choice habitat or a disputed mate. Among primates, dominance conflicts frequently involve no more than the display of enlarged canines, sometimes through yawning. Bears, also, will roar or wave their open mouths at social inferiors. Behaviors like these do not require fighting, but do result in the prominent exhibition of potentially formidable fighting weapons. In other cases, as in elephant seals, there actually can be prolonged, often bloody fighting. However, once the hierarchy is established, subsequent fighting is less frequent. In many cases, there is a strong correlation between dominance and large size.

Dominance hierarchies exist in many vertebrate groups, the most common being in the form of linear relationships, although triangular relationships may form. In baboons, the strongest male is usually highest in the rank order. But sometimes, older males may form coalitions to subdue a stronger male and lead the troop.

All primates have dominance hierarchies of some short. One chimp asserts its lordship over another individual. Chimps do shift in who is the top chimp. In Gombe, Freud was the alpha male, then his brother Frodo use bullying to displace Freud, who was getting ill. Then, having had enough bullying, the other chimps kicked out Frodo. Baboons have

more rigid hierarchies. Bonobos (below) have another system. The females form a hierarchy, and they pass it down to their sons. Yet, ironically, sisterhood is not possible. For one thing, there is no sisterhood. Females leave their troops to join another one, and the hierarchy is formed among total strangers.

Dominance hierarchies have to be reestablished when certain individuals feel prepared to move up within the hierarchy, or when new individuals are introduced into an area. During such time a series of challenges may occur. This can be a stressful period for all individuals involved.

ii. Dominance and Mate Competition

Mate competition is extremely common in the animal kingdom, and many dominance hierarchies relate to competition either for mates, or for those resources such as admirable territories that will attract them. In most cases males compete for females, although there are also a few instances of females fighting for males.

There are clearly advantages to dominance. Dominant males have been shown in many species to copulate more frequently or to produce more off-spring. In cowbirds, for example, only the dominant male is allowed to sing the songs that are most effective in attracting females. If subordinate males attempt to sing these highly charged songs, they are attacked, often brutally, by more dominant individuals.

Elephant seals are another group in which reproductive success is linked to dominance. Dominance battles in this species involve two males posturing chest to chest and attempting to bite each other, with the loser ultimately retreating. In a few species, such as wolves, the dominant members of a group are the only ones that reproduce.

One tell-tale sign of competition for mates is sexual size dimorphism, which describes a situation where one sex of a given species has much greater body size than the other. In the case of mate competition, it is the males that are larger than females. (There are other species where the females are larger, including, the large majority of frogs. However, in these species the large size of females appears to be associated with increased fertility rather than with the establishment of dominance.)

Sexual size dimorphism is often particularly pronounced in species where it is possible for a single male to monopolize many females, as in elephant seals. In fact, a study across various pinniped species (seals, sea lions, etc.) suggests that the degree of sexual size dimorphism is positively correlated with the size of the harem.

iii. Dominance and Submissive Displays

Even simpler behavioural displays are often use to maintain a dominance hierarchy. Agonistic displays are used to assert dominance. These often include a more upright, aggressive stance. For instance, this first pukeko's upright stance and raised wing is a dominance display. Subordinate individuals (lower in the hierarchy) will respond with submissive displays (appeasement gestures) such as making themselves look small, bowing the head and exposing vulnerable parts. The second pukeko's bowed head is a submissive display. When young dogs roll onto their back, this is also a submissive /appeasement gesture. The young dog is exposing its vulnerable areas to communicate that it is no threat to your dominance.

iv. Dominant hierarchical behaviour in spotted hyena

A particularly interesting example of the dominance hierarchy is that of the spotted hyena. It is the largest species of hyena and has also been called the laughing hyena because of the calls that individuals make when they are in danger. Spotted hyenas live in social groups that vary greatly in size, with the largest having as many as eighty members. Each group defends a territory and hunting occurs in packs.

What is unusual about social organization in this species is that females are dominant within the group and at the same time possess reproductive organs that very much resemble those of males. In fact, female genitalia resemble the scrotum and testes of males so closely that it is almost impossible to determine the sex of individuals in the field.

One early hypothesis to explain this male-mimicking anatomy was that females evolved it in order to participate in the hyena greeting ritual, in which members of the same social group sniff each other's' erect penises when they meet again after an absence. Because greeting behaviour is important to group solidarity, it was argued that females evolved male-like anatomy so they could participate as well.

However, the greeting ritual theory has since been abandoned in favour of an argument based on fighting for dominance within the hierarchy. There are numerous benefits to being the dominant female within a spotted hyena clan. Females who are high in the hierarchy have priority at kills, and obtain more food than subordinate females or males. Dominant females tend to be the largest hyenas of a pack. They also tend to produce dominant off-spring. The production of a dominant male is particularly advantageous because only the dominant male within a pack mates.

Many scientists believe that because aggressive behaviour is advantageous in competitions for dominance, female hyenas have evolved high circulating levels of androgens (male sex hormones) such as

testosterone, which promote aggression. The curious male-mimicking genitalia are now believed to be a mere side effect of the unusually high testosterone levels. The testosterone circulating in the female's bloodstream while she is pregnant results in the masculinization of the anatomy of both her male and female offspring. It was indeed confirmed that female spotted hyenas do in fact have unusually high testosterone concentrations in their blood.

v. Dominant hierarchical behaviour in wolves

Most social mammals have some form of dominance hierarchies. Perhaps the most famous example of dominant hierarchical behavior is wolves. White wolves are displayed here, exhibiting the effects of their dominance hierarchy. One can see that a single wolf is lying down on the highest ground available. The alpha wolf and his chosen alpha female mate for life and are the only group members to procreate. All pack members are responsible for looking after the pups and providing them with food, water, and shelter. While many species, like lions, will kill the young offspring of dethroned alphas, wolves always adopt the pups as their own and raise them to maturity. This altruism often creates better pack unity and shows wolves' strong social bonds within these dominance hierarchies.

Domesticated chickens are another example of dominant behavior. Even in the absence of a rooster, hens will create a pecking order based on their physical and personality characteristics. The more dominant hens receive preference on roosting positions and access to food and water, which prevents hens from having constant disputes over resources.

In-Text Question(s)

What is dominance hierarchy?
Answer: A dominance hierarchy is the organization of individuals in a group according to their dominance. These hierarchies are often linear, each individual dominating all individuals below him and not those above him. The most dominant individual is often referred to as the **alpha male** (or female), followed by the beta male and so on.

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. How is Dominance Hierarchies **is established?**

5.4 Summary

Many animal species live in groups that provide various benefits. Groups range from simple aggregations to more complex social organizations or societies. Some animals organize themselves in hierarchies which rank members in order from the most dominant individual to the most subordinate individual. Once the hierarchy is established, agonistic behavior is reduced in the group.

5.5 References/Further Readings

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5.6 Possible Answers to SAEs

Answers to SAEs 1

1. Dominance hierarchies are often established through ritualized displays or mild fighting, rather than all-out battle. The loser in a battle for dominance typically moves away from a choice habitat or a disputed mate.

Glossary

°C = degrees Celsius
cm = centimeters
CNS = Central nervous system
CH4 = Methane
CO = Carbon
CH_4 = methane (CH_4)
DNA = Deoxyribonucleic acid
E. coli = Escherichia coli
FAP = Fixed Action Pattern
°F = degree Fahrenheit
Ft = feet
h = hour
in = inches
Kgs = kilograms.
km = kilometers
kph = kilometer per hour
m = meters
mm = millimeters
mph = meter per hour
NH2OH = Hdroxylamine
NH3 = Ammonia
O_2 = Oxygen
PNS = Peripheral Nervous System
PRC = Phase Response Curve
RNA = Ribonucleic acid
L = length
HIV = Human immunodeficiency virus
% = percentage
g = grams
spp = species
UV = Ultraviolet

End of the Module Questions

1. What is conflict behavior?
2. What is habituation?
3. List the different types of communication in animal?
4. What is pheromones?
5. What is a fission – fusion society?

Module 3 Habitat Selection, Homing and Navigation

Module Introduction

In Module three, unit one deals with the physiology of animal behavior, unit two deals with the different types of habitats, history and current understanding of Animal Ecology and how organisms and its environment relate and influence one another in their various ecosystems. You are taught about the fundamentals of ecology; interaction in animals and energy flow within the environment.

Unit 1 The Physiology of Bahviour
Unit 2 Habitat Selection
Unit 3 Homing and Navigation in Birds
Unit 4 Courtship bahviour and Parenthood
Unit 5 Biological Clocks

Glossary

Unit 1 The Physiology of Bahviour

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1.3 The Physiology of behaviour
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1.1 Introduction

Behavior is the varied activities that an animal perform during its lifetime. Internal physiological conditions, environmental stimuli and social situations influence specific behavioral responses. Animals are faced with two key problems finding food and a place to live. The evolution of various social systems, in which animals live in groups, affects many aspects of their behavior.

Animal behavior refers to the activities animals perform during their lifetime, including locomotion, feeding, breeding, capture of prey, avoidance of predators and social behavior. Animals send signals, respond to signals or stimuli, carry out maintenance behavior, make choices and interact with one another.

1.2 Intended Learning Outcomes (ILOs)

At the end of this course, students should be able to:

- Explain physiology of animal behaviour
- Expalin the four approaches to animal behaviour
- Defne anthropomorphism

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1.3 The Four Approaches to Animal Behavior

Naturalists and philosophers have observed animal behavior for centuries. Only in the last century, however has there been significant progress in understanding this behavior.

One approach to the study of animal behavior is comparative psychology. Comparative psychologists emphasize studies of the genetic, neural and hormonal bases of animal behavior. Psychologists conduct experimental studies in both laboratory and field settings, that relate to animal learning and to development behavior. They explore how animals receive information and the processes and nature of the behavior patterns constituting the animals' responses to the surroundings.

Ethology is the study of animal behavior that focuses on evolution and natural environment. The leaders of this approach have been Konrad Lorenz, Niko Tinbergen and Karl von Frisch, who were awarded the Noble price in physiology or Medicine in 1973. Ethologists observe the behavior of a variety of animals in their natural environment and study the behavior of closely related species to consider the evolution and origin of certain behavior patterns. Ethologists rarely deal with learning and are intereste instead in animal communication, mating behavior and social behavior.

Behavioral ecology emphasizes the ecological aspects of animal behavior. Predator-prey interaction, foraging strategies, reproductive strategies, habitat selection intraspecific and interspecific competition and social behavior are topics of interest to behavioral ecologists.

Sociobiology is the study of the evolution of social behavior. It combines many aspects of ethology and behavioral ecology. Sociobiologists emphasize the importance of natural selection on individuals living in group.

There are two major causes of behavior namely PROXIMATE AND ULTIMATE CAUSES

a. **Proximate causation** - immediate causes. This explains how behavior works and what stimulates behavior to occur. It could be studied by measuring or describing the stimuli that elicit behavior. It involves Internal - physiological events (hormones, nervous system) and External - environmental stimuli like changes in daylength.

b. **Ultimate causation** - historical explanations: this explains why a behavior evolved. It is studied by measuring influence on survival or reproduction Example; bird migration - birds that migrate have a selective advantage over birds that don't/didn't, selected for over time, could be due to long term climate changes, glaciation, disease, taking advantage of food sources, etc.

Behavioral scientists frequently ask, “Why do animals do what they do?” more immediate ecological and physiological causes of behavior, such as eating to satisfy hunger, are called proximate causes. Another level of causation in behavior occurs on the evolutionary time scale and that is of ultimate causes. For example, a display not only attracts a male, but also increases the likelihood of passing genetic information to the next generation.

i. Timing of behavior

Circaannual - behavior occurs on a seasonal/annual basis. Examples is the hibernation in bears, frogs, toads, salamanders bury themselves in mud during the winter, while Circadian - behavior occurs on a daily basis.

i. **Components of Behavior**

There are two Components of behavior and they are;

1) Innate behavior: instinct and genes determine behavior
2) Learned behavior: experience and learning influence behavior

The two components of behaviour are not mutually exclusive, but work together to influence behavior. Examples of Innate behavior are;

a. The Nest building in Lovebirds by Dilger such as;
- Fischer's Lovebird - uses long strips of nest materials, carries in beak, one at a time
- Peach-faced Lovebird - tucks several short strips in feathers
- Hybrids - intermediate lengths of nest materials, clumsy behavior trying to tuck strips into feathers, later will carry strips in bill but will still try and tuck into feathers

b. Egg ejection by cuckoos (brood parasites)
c. Freezing behavior of nestling birds when exposed to silhouettes (raptors versus waterfowl)
d. Parental feeding - brood parasites take advantage of parents
e. Freezing behavior of nestlings
f. Incubation behavior of some birds (Oystercatchers)
g. Drosophila - 2 alleles of the Dg2 gene sitter allele (sedentary behavior) rover allele (hyperactive, mobile)

Components of Innate behavior is the fixed action pattern, all or none response and

Sign stimulus which causes release of FAP. Examples are colors of stickleback males during mating, oyster catchers and eggs during incubation (super-normal releaser). The Nature of sign stimulus are usually an obvious aspect of the morphology such as red mark on beak of Herring Gulls, red belly of Sticklebacks, detection of ultrasounds from bats by prey species of moths.

2. **Learned Behavior**

a. Simple learning - habituation, species of prey and the presence of predators. Lehrman's study of gull chick feeding behavior - how an instinct is learned

b. Learning and development - imprinting and Lorenz's classic experiments with Greylag Goose (critical period for learning) - geese forms social attachments shortly after birth , salmon and home stream, birds and breeding range, nesting materials, etc.

c. Sexual imprinting - Direct sexual behavior at member of one's own species - cross-fostering studies, individuals raised by another species, recognizes foster species as its own when sexually mature, will attempt to mate with foster species.

d. Classical/Pavlovian conditioning;- Animals make associations such as Pavlov's dog associates bell with food, begins to salivate, can be extinguished and later followed by recovery (unconditioned stimulus - meat, unconditioned response - salivation, conditioned stimulus - bell, conditioned response – salivation).

e. Operant **conditioning-** Reward/punishment for behavioral response, rats bar press for food.

f. Observational learning - social imitation

g. Insight Learning **–** the ability to respond correctly to a situation that is experienced for the first time and that is different from experience encountered previously**.** Examples are Chickadees/tits and opening milk bottles, Egyptian Vulture - uses rocks, Cocos Finch - uses splinters of wood, North American Gulls, Northwestern Crow - smash clams on sandy beaches

1.4 Anthropomorphism

Anthropomorphism is the application of human characteristics to anything not human. In observing animals, assigning human feelings to animal behavior is not likely to be accurate, especially with invertebrate animals. Consider the example of placing an earthworm, on a fishhook. Does the fishhook hurt the earthworm, causing it to writhe in pain? Both of the descriptive words hurt and pain, are based on human experience and conscious awareness. A better explanation that reduces the anthropomorphic interpretation is that placing the earthworm on the hook stimulates certain receptors which generate nerve impulses that travel along reflex neural circuits. The impulses stimulate muscles that allow the worm to wriggle in an attempt to escape from the hook. This explanation more closely describes what has been observed and does not attempt to suggest what earthworm “feels.”
What is Behaviour? What is Circaannual?

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. What is Insight Learning?
2. What is Anthropomorphism?

1.4 Summary

Many behavior patterns require instinctive and learned components for efficient performance. In some instances, an animal may inherit a disposition to learn a specific behavior. Also, an animal may learn certain behavior patterns only during a specific sensitive period early in life.

1.5 References/Further Readings/Web Sources

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1.6 Possible Answers to SAEs

Answers to SAEs 1

1. Insight Learning **is** the ability to respond correctly to a situation that is experienced for the first time and that is different from experience encountered previously**.**

2. Anthropomorphism is the application of human characteristics to anything not human.

Unit 2 Habitat Selection

Contents

2.1 Introduction
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2.1 Introduction

Habitat selection is the choice by an organism of a particular habitat in preference to others. e.g may fly nymphs inhabit the underside of stones in fast-flowing streams and burrow in sediment in still water while habitat is a place where species get what they need to survive: food, water, cover, and a place to raise young. In other words, a habitat is a plant or animal's home. For people, habitat might stretch from their home (where they have water, cover and a place to raise young), to the supermarket (where they buy food). All the places people go to get what they need to survive can be considered part of their habitat.

2.2 Intended Learning Outcomes (ILOs)

At the end of this course, students should be able to:

- Define habitat and habitat selection
- Explain the different types of habitat.

2.3 Types of Habitat

The following are different types of habitats: Polar/arctic areas, Mountains, Oceans, Deserts, Savannah/grasslands/prairies, Tropical rainforest, Woodland/forest, Tundra, Taiga, Wetland areas/marshes, Pond Rivers/lakes, Coral reef, Deciduous forest, Tide pool Cave

i.) Forest habitat

Forests are fascinating ecosystems. The defining feature of a forest is its dense growth of trees. Generally speaking, two key variables dictate the geographical distribution of Earth's different habitat types: Humidity and temperature. Forests grow where there is enough water available to fulfill trees' needs. The extent of forest growth also depends on temperature ranges, soil nutrients, adequate growing season and altitude.

All of the forests in the continental United States are temperate forests (located between the boreal and sub-tropical zone). Eastern temperate forests tend to have cold winters and wet, hot summers. Deciduous trees (those that lose their leaves in the fall) like oak and maple thrive in these conditions. In fact, most eastern forests are defined by the mix of oak, maple, birch and other trees that grow there. These trees create a canopy that shades the forest floor and provides a variety of habitats.

For many creatures, such as gray squirrels, white-footed mice, white-tailed deer, blue jays. Deciduous trees are also found in continental Africa and Nigeria Southwest.
Generally speaking, deciduous trees dominate the forests of the Eastern United States, while coniferous trees (those that keep their leaves year-round) predominate in western forests. What kind of wildlife would you expect to live in the forests Western United States?

ii.) Grasslands habitat

Grasslands are characterized as areas where grasses are the predominant vegetation and the subsoil is dry with seasonal moisture in the upper soil layers. Their evolution was shaped by periodic fires and the presence of grazing animals. These conditions resulted in the establishment of vast areas of grassland on all of the continents except Antarctica. Today, a quarter of the earth's land surface remains covered by this rapidly vanishing ecosystem. Example in Nigeria is Osun State extending to part of kwara / kogi.

All grasslands share several common traits. In general, the term grassland refers to land which: is dominated by grasses; occurs on flat or rolling terrain; has similar soils (alkaline, lots of organic matter, very fertile, and fine- grained); has soil that is almost completely covered by vegetation, commonly has fires and high winds (which lead to high evaporation rates and the spread of fires); is characterized by periods of rain followed by periods of drought.

iii.) Desert habitat

As different from one another as deserts of the world are, they all share one characteristic: they are very dry. Scientists define deserts as areas that get less than 10 inches of rainfall a year and have a very high rate of evaporation. If the annual evaporation rate of an area is higher than the annual amount of rainfall, the area is considered a desert. Evaporation rates are high because deserts tend to have very little cloud cover and strong winds.

Another characteristic of deserts is sporadic rainfall. If the limited rainfall in deserts fell a little at a time throughout the year, many deserts probably would not look much like deserts. Instead, they'd have a lot more vegetation. Rain doesn't fall evenly throughout the year in a desert, though. It usually comes in big bursts. In some deserts, none at all may fall for more than a year. And then a huge thunderstorm may dump over 5 inches all at once!

Deserts have some of the most variable temperatures of any places on earth. Because the desert skies are nearly cloudless, the temperatures during the day may sizzle. But without cloud cover to hold in the heat, it radiates into the atmosphere very quickly once the sun goes down. In some deserts, the temperature may drop as much as 77 degrees Fahrenheit in 12 hours. For example Bauchi and Maiduguri.

iv.) Wetlands habitat

As the name implies, wetlands are areas where water is present at least part of the year, generally for at least a portion of the plant-growing season. In addition, wetland soils differ considerably from nearby or surrounding uplands. Hydric soils, found in wetlands, are wet, low in oxygen, and often black with muck. Finally, wetlands support plants — called hydrophytes — that are adapted to living in wet, oxygen-poor soils. Together, these water, soil and vegetation characteristics make up a broad definition for wetlands.

Though all wetlands contain water at least periodically, the volume of water and the amount of time a wetland is "wet" varies greatly. They also vary in size, from wading-pool sized vernal pools to thousands of acres along coastlines or rivers.

Wetlands are found all over North America, along coastlines, far inland, in rural areas, and even in the middle of well-populated urban areas.

There are generally five kinds of areas where we find wetlands:

a.) rivers;
b.) near coasts and inland lakes;
c.) in depressions where land is low compared to surrounding landscapes;
d.) areas where groundwater seeps out of the ground, and;
e.) in broad, flat areas that receive significant rainfall (such as the Everglades).

v.) Arctic Tundra habitat

The arctic tundra is circumpolar, meaning that it is an ecosystem surrounding the polar region, above roughly 60 degrees north latitude. The Arctic Circle occurs at 66 degrees north latitude.
In the tundra, short days for much of the year and a harsh cold climate result in a brief growing season of 50-60 days. By contrast, the growing season in temperate forests is about six months long and in tropical forests lasts the entire year.

Strong winter winds challenge the stability of any plants that grow more than an inch or two above ground surface. Below a thin layer of soil that thaws every summer is ground that remains frozen year-round, called permafrost. The permafrost may be very deep, reaching more than 1000 feet thick in some locations. Although the tundra receives less than ten inches of precipitation each year (which is why it is sometimes referred to as an arctic desert), there can be plenty of standing water when the upper layer of soil thaws each summer.

Due to its high latitude and the tilt of the earth, the arctic experiences light and temperature extremes throughout the calendar year. The plants and animals of the tundra must be adapted to face these challenges, including not only extremes of day length and temperatures, but also harsh winter winds, long periods of below- freezing temperatures, and permanently frozen ground.

2.3.1 Habitat selection by some animals

African Elephant are Found in forests, grasslands, marshes, scrub, and semi- desert areas. Elephants live in a highly organized social structure referred to as a matriarchal herd. The herd is typically composed of up to ten females and their young. All of the females in the herd are directly related to the matriarch who is typically the oldest and largest female. Males beyond the age of maturity are with the herd only during mating.

Penguin tend to inhabit islands and remote landmasses that are relatively free from land predators. Some species spend nearly 75% of their life at sea. All penguins live south of the equator, from the icy waters of Antarctica to the tropical Galapagos Islands off the coast of Ecuador, almost astride the equator. Penguins are specialized marine birds adapted to living at sea. Some species spend as much as 75% of their lives in the sea - only coming ashore for breeding and molting. Penguin wings are paddle-like flippers used for swimming, not flying.

Sea Stars are found from the bearing sea, usually resting on broken or solid rocks. They are usually found on gravel, rocks and sand in the low intertidal zone.

What is habitat selection? What is Grassland Habitat?

Self-Assessment Exercises 1

Attempt these exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. What is Desert?
2. List the five kinds of areas where wetland is found?

2.4 Summary

Habitat selection is the choice by an organism of a particular habitat in preference to others. e.g may fly nymphs inhabit the underside of stones in fast-flowing streams and burrow in sediment in still water while habitat is a place where species get what they need to survive: food, water, cover, and a place to raise young.

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2.6 Possible Answers to SAEs

Answers to SAEs 1

1. Scientists define deserts as areas that get less than 10 inches of rainfall a year and have a very high rate of evaporation.
2. There are generally five kinds of areas where we find wetlands:

a.) rivers;
b.) near coasts and inland lakes;
c.) in depressions where land is low compared to surrounding landscapes;
d.) areas where groundwater seeps out of the ground, and;
e.) in broad, flat areas that receive significant rainfall (such as the Everglades).

Unit 3 Homing and Navigation

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3.1 Introduction

Homing is the ability of certain animals to return to a given place when displaced from it, often over great distances. This may occur in any compass direction and at any season. Navigation clues used by homing animals are the sun angle, star patterns etc. very strong homing ability are found among birds seabirds and swallows eg. A Manx Shearwater (*Puffinus puffinus*) transported in a closed contain to a point about 5,500 km (3,400 miles) from its nest and returned to the nest in 12 ½ days.

Navigation means migration which is the movements of animals in large numbers from one place to another. In modern usage the term is usually restricted to regular, periodic movements of populations away from and back to their place of origin. A single round trip may take the entire lifetime of an individual, as with the Pacific salmon salmon, member of the Salmonidae, a family of marine fish that spawn in freshwater, including the salmons, the trouts, and the chars. Many authorities place the whitefish and the grayling among the Salmonidae, so similar are they in structure and habits. An individual may make the same trip repeatedly, as with many of the migratory birds and mammals. The animals may travel in groups along well-defined routes; or individuals may travel separately, congregating for breeding and then spreading out over a wide feeding area.

3.2 Intended Learning Outcomes (ILOs)

At the end of this course, students should be able to:

- Define homing and navigation.
- Explain navigation mechanism in animals.

3.3 Factors affecting initiation of Navigation/Migration

Various factors determine the initiation of migration. In some cases external pressures—temperature, drought, food shortage—alone may cause the animals to seek better conditions. For example, most of the mule deer of Yellowstone Park, Wyo., migrate between summer and winter pastures, but those living near hot springs, where grazing is available all year, do not. In many species migration is initiated by a combination of physiological and external stimuli. In birds the migratory instinct is related to the cycle of enlargement of the reproductive organs in spring and their reduction in fall. Experiments have shown that variation in day length is the chief external stimulus for this cycle: light received by the eye affects production of a hormone by the anterior pituitary gland, which stimulates growth of the reproductive organs.

3.3.1 Orientation and navigation

Much work has been done on orientation and navigation in migrating animals, although the subject is still not well understood. Studies of salmon indicate that they depend on the olfactory sense to locate and return to their stream of origin. Herbivorous mammals often follow well- established trails and probably also use their sense of smell. Bats, whales, and seals use echolocation to navigate in the dark or underwater; in addition, some whales appear to take visual bearings on objects on the shore in their migrations.

Migratory birds are believed to use the stars, sun, and geographic features as guides. The probability that stellar navigation is used has been strengthened by experiments in planetariums indicating that birds navigate at least in part by the stars. Night-migrating birds are sometimes disoriented in prolonged heavy fog. Day-flying birds navigate by the sun and also make some use of geographic features, particularly of shorelines. It has long been proposed that birds perceive the direction of the earth's magnetic field and use it for navigation, but experimental evidence for that hypothesis is inconclusive. Most

migratory birds travel within broad north-south air routes known as flyways. There are four major flyways in North America, called the Pacific, central, Mississippi, and Atlantic flyways. The space within the flyway used by a particular group of birds is called a corridor. Bird migration is not always in a north-south direction. Many European birds migrate in an east-west direction, wintering in the more temperate British Isles, and many mountain-dwelling birds descend to lower altitudes in winter. The breeding grounds of a bird species are regarded as its home territory. Some migratory birds winter only a few hundred miles from their breeding grounds, while others migrate between the cold or temperate zones of the two hemispheres. The longest journey is made by the arctic tern, common name for a sea bird of the Old and New Worlds, smaller than the related gull. Because of their graceful flight and their long pointed wings and forked tails, some terns are called sea swallows. They plunge headlong into the water to catch small fish. The monarch butterfly has a north-south migration pattern that resembles that of many birds. One monarch population that inhabits northeastern and midwestern North America averages c.12 mph (19 kph) as it heads for the winter to Mexico's Sierra Madre mountains. Monarchs start the return trip in the spring, but they breed along the way and then die; the new generation completes the journey.

There are various tools for studying migration. The movements of migrating animals are often studied by tagging individuals. Bird banding has been carried on extensively since the 1920s; more recently there has been tagging of fishes, butterflies, and marine mammals. Use is now made of radar, sonar, and radio for following migrations, particularly those of marine animals. Radio transmitters attached to whales or seals emit signals that can be picked up by weather satellites at regular intervals.

3.3.2 Navigation Methods in Animals

i.) The sun : starlings and ants navigate this way. Some birds can travel at night using the sun – theories suggested that they take a ‘reading’ from where the sun sets and use that to est their course.

ii.) Landmarks: fly towards those mountains head to the left a little when you see the ocean, nest in the first nice, looking tree you can find. E.g Whales traveling in the pacific ocean near the North American West.

iii.) Moon and stars: Planetarium experiments’ have proved that many birds rely on stars cues to figure out which way to migrate e.g indigo.

iv.) Scent: scent can pin point specific location. E.g Salmon find their exact spawning ground through scent.

v.) Weather: wind condition are often used as supplementary navigation aids by birds.AW

vi.) Magnetic field: the earth has a magnetic field that is usually undetectable to human who are not holding a compass. Bat and sea turtles use magnetic information to find their way. Bacteria even rely on the magnetic field to orient them.

What is Homing? What is Navigation?

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. What is the space within the flyway used bhy a particular group of birds called?
2. List the four major flyways in North America?

In animal behavior homing and navigation / migration are important issues that cannot be overemphasis. This topic had being dealt with but more information are still needed in the area of orientation and navigation. There are various tools for studying migration. The movements of migrating animals are often studied by tagging individuals. Bird banding has been carried on extensively since the 1920s; more recently there has been tagging of fishes, butterflies, and marine mammals.

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3.6 Possible Answers to SAEs

Answers to SAEs 1

1. The space within the flyway used by a particular group of birds is called a corridor.
2. There are four major flyways in North America, called the Pacific, central, Mississippi, and Atlantic flyways

Unit 4 Courtship Behaviour and Parenthood

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4.1 Introduction
4.2 Intended Learning Outcomes (ILOs)
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4.1 Introduction

Courtship is the period in a couple's relationship which precedes their engagement and marriages or establishment of an agreed relation of a more enduring kind. A courtship may be an informal and private matter between two people or may be a public affair or a formal arrangement with family approval. The average duration of courtship varies considerably throughout the world, this depends on individual.

Parenthood means parentage i.e. the state of being a parents. Parenthood is the intersection of two distinct relationships, that between parents and child, and that between the parents (or family) and the larges society or other collective. This is called relationship. Parenting is the processs of promoting and supporting the physical, emotional, social and intellectual development of a child from infancy to adulthood.

4.2 Intended Learning Outcomes (ILOs)

At the end of this course, students should be able to:

- Expalin courtship behavior in animals
- Identify the different forms of courtship behavior

4.3 Courtship

Many non-human animal species have mate-selection rituals also referred to as 'courtship' in an anthropomorphic (misleading) manner. Animal courtship may involve complicated dances, or touching, vocalization, displays of beauty or fighting prowess.

From the scientific point of view, courtship in the animal kingdom is the process in which the different species select their partners for reproduction purpose. Generally speaking, the male initiates the courtship and the female chooses to either mate or reject the male based on performance. for example, the Selfish Gene model was proposed by Richard Dawkins which state that an individual of a particular species will mate with individuals from the same species that display good genes.

In this case, courtship is a display of "genes" carried by a particular organism looking forward to mix with the genes of another organism in generation, thereby, ensuring the survival of the genes themselves. Examples of courtship behavior in animal kingdom are as followed;

i.) Insects: female uses odorous substances called pheromones to attract males from a distance eg. Gypsy moth (lymantria dispar).
ii.) Birds: boobies perform ritualized dances with many components, including whistling and an elaborate gesture known to Ornithologists as sky-pointing. The male peacock displays his glouries plumage the female.
iii.) Amphibians: Courtship of songs in frogs (Rana species).

a. Humans

Human sexuality, besides ensuring biological reproduction, has important social functions: it creates physical intimacy, bonds, and hierarchies among individuals; and in a hedonistic sense to the enjoyment of activity involving sexual gratification. Sexual desire, or libido, is experienced as a bodily urge, often accompanied by strong emotions such as love, ecstasy and jealousy. The extreme importance of sexuality in the human species can be seen in a number of physical features, among them hidden ovulation, the evolution of external scrotum and penis suggesting sperm competition, the absence of an os penis, permanent secondary sexual characteristics, the forming of pair bonds based on sexualattraction as a common social structure and sexual ability in females outside of ovulation. These adaptations indicate that the importance of sexuality in humans is on a par with that found in the Bonobo, and that the complex human sexual behaviour has a long evolutionary history.

Human choices in acting on sexuality are commonly influenced by cultural norms, which vary widely. Restrictions are often determined by religious beliefs or social customs. The pioneering researcher Sigmund Freud believed that humans are born polymorphously, perverse, which means that any number of objects could be a source of pleasure. According to Freud, humans then pass through five stages of

psychosexual development (and can fixate on any stage because of various traumas during the process). For Alfred Kinsey, another influential sex researcher, people can fall anywhere along a continuous scale of sexual orientation (with only small minorities fully heterosexual or homosexual). Recent studies of neurology and genetics suggest people may be born predisposed to various sexual tendencies.

b. Dog

In domestic dogs, sexual maturity begins to happen around age six to twelve months for both males and females, although this can be delayed until up to two years old for some large breeds. This is the time at which female dogs will have their first estrous cycle. They will experience subsequent estrous cycles biannually, during which the body prepares for pregnancy. At the peak of the cycle, females will come into estrus, being mentally and physically receptive to copulation. Because the ova survive and are capable of being fertilized for a week after ovulation, it is possible for a female to mate with more than one male.

Dogs bear their litters roughly 56 to 72 days after fertilization, with an average of 63 days, although the length of gestation can vary. An average litter consists of about six puppies, though this number may vary widely based on the breed of dog. Toy dogs generally produce from one to four puppies in each litter, while much larger breeds may average as many as twelve.

Some dog breeds have acquired traits through selective breeding that interfere with reproduction. Male French Bulldogs, for instance, are incapable of mounting the female. For many dogs of this breed, the female must be artificially inseminated in order to reproduce.

c. Raccoon

Raccoons usually mate in a period triggered by increasing daylight between late January and mid-March. However, there are large regional differences which are not completely explicable by solar conditions. For example, while raccoons in southern states typically mate later than average, the mating season in Manitoba also peaks later than usual in March and extends until June. During the mating season, males roam their home ranges in search of females in an attempt to court them during the three to four day period when conception is possible. These encounters will often occur at central meeting places. Copulation, including foreplay, can last over an hour and is repeated over several nights. The weaker members of a *male social group* also

are assumed to get the opportunity to mate, since the stronger ones cannot mate with all available females.

d. Chicken

To initiate courting, some roosters may dance in a circle around or near a hen ("a circle dance"), often lowering his wing which is closest to the hen. The dance triggers a response in the hen's brain, and when the hen responds to his "call", the rooster may mount the hen and proceed with the fertilization.

e. Desert Tortoise

Tortoises mate in the spring and in the fall. The female will lay a clutch of 3 - 5 hard-shelled-eggs (which are the size and shape of ping-pong balls), usually in June or July, and they hatch in August or September. Wild female tortoises can produce 2 or possibly 3 clutches a year.

f. Wood Turtles

The wood turtle takes a long time to reach sexual maturity, has a low fecundity (ability to reproduce), but has a high adult survival rate. However, the high survival rates are not true of juveniles or hatchlings. Although males establish hierarchies, they are not territorial. The wood turtle becomes sexually mature between 14 and 18 years of age. Mating activity among wood turtles peaks in the spring and again in the fall, although it is known to mate throughout the portion of the year they are active. However, it has been observed mating in December. In one rare instance, a female wood turtle hybridized with a male Blanding's turtle.

The courtship ritual consists of several hours of 'dancing,' which usually occurs on the edge of a small stream. Males often initiate this behavior: starting by nudging the females shell, head, tail, and legs. Because of this behavior, the female may flee from the area, in which case the male will follow. After the chase (if it occurs), the male and female approach and back away from each other as they continually raise and extend their heads. After some time, they lower their heads and swing them from left to right. Once it is certain that the two individuals will mate, the male will gently bite the female's head and mount her. Intercourse lasts between 22 and 33 minutes. Actual copulation takes place in the water, between depths between 0.1 and 1.2 meters (0 and 4 ft). Although unusual, copulation does occur on land. During the two prominent times of mating (spring and fall), females are mounted anywhere from one to eight times, with several of these causing impregnation. For this reason,

a number of wood turtle clutches have been found to have hatchlings from more than one male.

Nesting occurs from May until July. Nesting areas receive ample sunlight, contain soft soil, are free from flooding, and are devoid of rocks and disruptively large vegetation. These sites however, can be limited among wood turtle colonies, forcing females to travel long distances in search of a suitable site, sometimes a 250 meters (820 ft) trip. Before laying her eggs, the female may prepare several false nests. After a proper area is found, she will dig out a small cavity, lay about seven eggs (but anywhere from three to 20 is common), and fill in the area with earth. Oval and white, the eggs average 3.7 centimeters (1.5 in) in length and 2.36 centimeters (0.93 in) in width, and weigh about 12.7 grams (0.45 oz). The nests themselves are 5 to 10 centimeters (2.0 to 3.9 in) deep, and digging and filling it may take a total of four hours. Hatchlings emerge from the nest between August and October with overwintering being rare although entirely possible. An average length of 3.65 centimeters (1.44 in), the hatchlings lack the vibrant coloration of the adults. Female wood turtles in general lay one clutch per year and tend to congregate around optimum nesting areas.

The wood turtle, throughout the first years of its life, is a rapid grower. Five years after hatching, it already measures 11.5 centimeters (4.5 in), at age 16, it is a full 16.5 to 17 centimeters (6.5 to 6.7 in), depending on gender. The wood turtle can be expected to live for 40 years in the wild, with captives living up to 58 years.

In-Text Question(s)

What is Courtship?

Answer: Courtship is the period in a couple's relationship which precedes their engagement and marriages or establishment of an agreed relation of a more enduring kind.
At what age do sexual maturity begins with domestic dogs?
What period do Raccoon usually mate?

Self-Assemeement Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. Write briefly on desert tortoise courtship.
2. Exlain courtship behavior in chicken.

4.4 Summary

In summary, courtship in the animal kingdom is the process in which the different species select their partners for reproduction purpose. Generally speaking, the male initiates the courtship and the female chooses to either mate or reject the male based on performance.

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4.6 Possible Answers to SAEs

Answers to SAEs 1

1. Tortoises mate in the spring and in the fall. The female will lay a clutch of 3 - 5 hard-shelled-eggs (which are the size and shape of ping-pong balls), usually in June or July, and they hatch in August or September. Wild female tortoises can produce 2 or possibly 3 clutches a year.

2. To initiate courting, some roosters may dance in a circle around or near a hen ("a circle dance"), often lowering his wing which is closest to the hen. The dance triggers a response in the hen's brain, and when the hen responds to his "call", the rooster may mount the hen and proceed with the fertilization.

Unit 5 Biological Clocks

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5.1 Introduction

Biological clocks are mechanisms internal to the animal, that has rhythmic influence upon its physiology and behavior, synchronizing them to cyclic changes in the environment. Biological clocks are internal timing mechanisms which can have a period of several hours, a day, or a year.

The circadian clock runs with a period of *about* 24 hours. Circadian clocks have two functional characteristics:

i.) they will persist (=free-run) with a period of about a 24 hours in the absence of environmental cues; and
ii.) they will synchronize (=entrain) to a 24 hour environmental cue, such as the light-dark cycle.

Entrainment is important because it permits animals to synchronize to a changes in the seasonal photocycle. How they synchronize to the cue is determined by the phase response curve (PRC).

Biological clocks are groups into the following;

i.) Exogenous: this is a direct response to various changes in external (exogenous) geophysical stimuli
ii.) Endogenous: this is an internal (endogenous) rhythm that programs the animals' behavior in synchrony with the exogenous temporal period, particularly a 24- hours or 365-days period.

An animal may use many features of the external environment to gain information about the passage of time. The most important of these is the apparent movement of celestial bodies e.g sun, moon and stars, such

influences have been much studies in birds and in bees (Apidae). In addition, it is possible that animals can obtain time cues from changes in environmental temperature, barometric pressure and magnetic phenomena.

Endogenous daily rhythms are termed "circadian" and usually fall short of a 24- hour periodicity. Endogenous annual rhythms are termed "circannual" and usually less than 365 days.
Our biological clocks measure the day length and change our behavior according to the seasons circadian rhythms and circannual rhythms are internal calendars built into an animals' nervous system, especially in the brain.

5.2 Intended Learning Outcomes (ILOs)

At the end of this course, students should be able to:

- Explain biologica clock
- Identify the different types of biological clocks
- Differentiate between circadian and circannual rhythm

5.3 Circadian Clocks

Circadian clocks are important in photoperiod time measurement. There are two models for how clocks might be important in measurement of photoperiod:

i.) External coincidence model (external light occurs at a critical phase in the circadian oscillation) and
ii.) Internal coincidence model (internal phase of multiple circadian oscillators is set by dusk and dawn).

Circadian clocks are also important in animal orientation. Many species of bird and fish use the sun for orientation. To be successful, however, adjustment to the sun's daily movement is necessary. A circadian clock makes this adjustment.

The concept of time has always perplexed and fascinated people. Although the ancient Greek philosophers believed that time was infinite, they perceived it as following endless cycles where the universe is born and dies, with an exact recurrence of everything in each cycle. The Newtonian view held that time is an immutable entity flowing on an

infinite linear scale operating independent of nature's forces. Einstein's theory of relativity radically changed this conventional wisdom by revealing that time is actually embedded in the very fabric of the physical universe giving rise to a reality that is more accurately expressed as a four-dimensional space-time continuum. It follows from the big bang theory that time and our physical universe were jointly created at a singular event that, according to current estimates, occurred ~12–15 billion years ago, at least from our frame of reference. Interestingly, Kabbalists had intimate knowledge of old oral traditions that discussed the deep relationship between time, corporeal entities, and their creation. For example, almost 800 years ago a famous rabbi known as Nachmanidies, in his commentary to *Genesis*, wrote, "with this primeval creation, which was like a very small point having no substance, everything in the heavens and the earth was formed, and when the heavens and the earth came forth from nothing into existence, time came into being and from the moment some substance came into existence time was already part of it"

Despite our changing understanding of the nature of time, one thing has remained constant, the human obsession with harnessing this elusive entity. From sundials to calendars to cesium clocks, the quest to capture the essence of time and measure its passage has significantly influenced human history.

But on what basis do we rationalize the units we use to measure time? Essentially, this is a tale of spheres and cycles. The passage of time has been recorded (at least historically) by observing the rhythms of "heavenly bodies", most notably the daily rotation of the Earth on its axis, the monthly cycle of the moon around the Earth, and the yearly journey of our planet around the Sun. Considering the average human lifespan and spatial distribution on our tilted planet, the broad frequencies encompassed by these reliable celestial rhythms (day, month, and year) provide quite relevant and useful units for recording time. These predictably recurring physical events inspired humans to design timing devices that could measure the passage of a known amount of time (e.g., sand-filled hourglasses), identify a specific phase in a cycle (e.g., sundials, Stonehenge?), or both (e.g., modern clocks).

The most influential physical oscillation that reminds us of our inescapable rhythmic relationship with time is the day-night cycle. Although we intuitively know that time proceeds in a unidirectional flight into the future, our lives are largely organized into a 24-h schedule dominated by periods of wakefulness and sleep. Thus we perceive time as being spiral in its geometry; there is ever forward progression into the future (e.g., counting years) coupled with time

coordinates that are revisited in a cyclical manner (e.g., measuring time of day).

In 1729, a French astronomer named Jean Jacques d'Ortous de Marian took plants that displayed daily leaf movements and put them in the dark for several days. He noted that the leaves of the plants continued to open during the day and close at night despite the absence of sunlight. Based on this seminal experiment, he concluded that the observed rhythm was not passively driven by a cyclic environment but was an innate property of the plant. From these humble beginnings, the formal study of circadian (endogenously driven biological rhythms with periods of ≈24h) biology can be traced. It is now quite clear that living organisms have been tracking the passage of daily time long before we ever invented clocks.

However, the contention that life forms have internal time keeping devices was only widely accepted about 60 years ago. For some it seemed too incredulous that organic material had properties similar to clocks fashioned by human hands. After all, it was claimed that although daily pacemakers keep on ticking with a reasonably constant period in the absence of environmental cues (zeitgebers), in natural conditions they are accurately synchronized to local time. Adding to the dismay was a peculiar attribute of circadian rhythms; the length of the period is invariant over a wide range of temperatures. This still mysterious property, known as temperature compensation, was viewed largely enigmatic from a chemical or biochemical perspective because most chemical reactions speed up about two- to threefold for every 10°C increase in temperature (or Q_{10}). Moreover, the prevailing thought at the turn of the previous century was that physiology is governed by the principles of homeostasis, effectively dismissing any observed oscillatory behavior as nothing more than random fluctuations of little or no significance.

With the eventual realization that endogenously driven daily rhythms are "real" and widespread, occurring in virtually all organisms, much interest was placed on elucidating the nature of the underlying pacemaker or clock.

Then, almost overnight, there are now a bunch of clock genes identified in humans, rodents, fish, frogs, insects, plants, and even cyanobateria. This gold mine led to important paradigm shifts in how the organization of the circadian timing system is viewed. From a molecular perspective, the basic message from these recent studies is that circadian clocks use the same design principles; namely, the period, amplitude, and phase of a circadian clock are determined by a specialized set of interconnected proteins, many of which undergo daily rhythms in one or more

character traits, most notably abundance. From a theoretical point of view, this framework for understanding the molecular underpinnings governing circadian rhythms is very satisfying, because regular change is the basis for timekeeping devices. However, although the RNA and protein products from many genes display cyclical behavior, those that define the clock operate within molecular.

5.3.1 Circadian Timing System

Circadian rhythms are operationally defined as biorhythms that exihibit the following three properties:

i.) Persist (or free run) with a period of ≈24 h in the absence of external time cues (or zeitgebers)
ii.) Reset by changes in environmental conditions, most notably the daily light –dark and temperature cycyles, and
iii.) Have an invariant period length over a wide range of physiological relevant tempareture (temperature compensation, see above).

It is not clear why circadian clocks are designed with the capacity to keep on ticking for long periods of time in the absence of a cyclical environment (first property), a situation not normally faced in nature. A free-running oscillator might enable animals to maintain synchrony even during days when adverse weather conditions or other unfavorable settings force them to seek shelter in places that receive little or no light. Alternatively, this self-sustaining property might reflect some peculiarity of the design principles required to build these oscillators and not an adaptation with a particular advantage. The ability to reset a circadian clock (second property) allows it to maintain temporal alignment with local time. The last property (i.e., temperature compensation) makes biological sense, because regardless of whether it is a cold day or a warm day, it still lasts 24 h. A mechanism that can offset the effects of temperature on the periodicity of an oscillator is likely to be absolutely necessary in non-homeotherms, if they are to maintain accurate timekeeping. Indeed, early versions of man-made clocks were not very accurate, because increases in temperature lengthened the pendulum causing the clock to slow down. The circadian timing system is usually depicted as being composed of three interconnected parts:

i.) input pathways that can receive and transmit environmental cues, such as light and temperature, to a
ii.) clock or pacemaker, connected to
iii.) downstream effector pathways that manifest overt rhythms.

Although the input to clock to output paradigm is usually depicted as moving from left to right, there are examples where the flow of information occurs in the opposite direction. These findings support a recent model whereby photic input and circadian clock are viewed in a more fluid relationship being composed of overlapping molecular loops.

Whatever the early driving force(s), from our present vantage point it appears that the most critical property of circadian clocks under natural conditions is that they can be reset by external time cues. This property was not merely selected so that we could avoid perpetual jet lag following transmeridian flight. Rather, the ability to anticipate environmental changes enables organisms to organize their physiology and behavior such that they occur at biologically advantageous times during the day. In addition, a second function that is widely regarded as important is that these endogenous timekeeping devices also serve to impose internal alignments between different biochemical and physiological oscillations.

With this in mind we can appreciate why circadian rhythms are observed at all levels of cellular organization. There are daily oscillations in the levels of enzymes and hormones that affect the timing of cell function, division, and growth. Physiological parameters such as body temperature, immune responses, digestion, susceptibility to anesthesia, and dental pain threshold. all undergo cyclic changes peaking at fixed times during the day. Our visual and mental acuity fluctuate during the day, affecting complex behaviors.

In addition to circadian rhythms that are manifested by and within individuals, there are also group or population rhythms. Some of these rhythms occur multiple times during the lifetime of the organism. For example, in many Diptera, males and females have the same peak time for activity during a daily cycle, increasing the chances of productive encounters between the sexes. In this regard it is interesting to note that because related species of insects have varying daily distributions of activity , the circadian clock might have contributed to insect speciation by establishing temporal barriers limiting the mating opportunities of individuals sharing the same spatial constraints. Other population rhythms involve events that occur once in a lifetime. A well-studied example is the eclosion (emergence from pupal cases) rhythm in *Drosophila*, which is only apparent in a group of individuals comprising mixed developmental stages. The circadian clock gates the timing of eclosion such that it happens in the early morning when the relative humidity in the air is high. This is important because upon emerging from its pupal case the fruit fly is susceptible to desiccation, and its wings do not readily expand at low humidities. An interesting example of a

population rhythm that is composed of many synchronized once-in-a-lifetime events is the daily oscillation in luminescence displayed by the cyanobacterium *Synechocystis sp*. It is interesting to note that this rhythm is somehow transmitted from mother to daughter in mid- stride without missing a beat, as the replication cycle is shorter than 24 h. Stable population rhythms are not restricted to individuals of the same species. The classic tango between bees and plants is a case in point. Different flowering plants have characteristic times during the day when they open and close their petals, making nectar available only at restricted times. The presence of an endogenous and synchronizable clock maximizes the feeding success of bees by enabling them to return to the same plants at times in the day when their nectar is available.

These rhythms also highlight the fact that the "adaptive value" of a circadian rhythm might only be understood within the framework of the dynamic interactions occurring in particular habitats. On a more global perspective, it is important to consider that organisms do not adapt to a static environment but one that undergoes daily changes. Oscillations in physical parameters (e.g., intensity of visible light, water and air temperature, relative humidity) will pervade natural habitats and their occupants, adding a strong daily component to the intricate relationships that govern ecosystems. Whether physical or biotic factors play primary or secondary roles in influencing the daily activity patterns of animals is likely to be largely dependent on the species in question. It has been suggested that the high rate of water loss in dry air might be the main driving force for the nocturnal activities of some small animals. On the other hand, biotic factors such as predation are relatively more significant in determining the daily activity patterns of larger animals. In any case, it is almost certain that many behaviors involved in mating, reproduction, seeking shelter, hunting for food, and avoiding predators evolved to take advantage of temporal niches. A recent study showed that the ability of *Drosophila* to smell odors is under circadian regulation (90), suggesting that many cyclical behaviors are ultimately "hardwired" into clocks that regulate physiological changes in the ability to sense, interpret, and respond to various cues in the environment.

Circadian clocks are not limited to timing daily events, but also play a role in adapting to seasonal changes in day length (photoperiod). By distinguishing between the long days (or short nights) of summer/spring and the short days (or long nights) of autumn/winter, organisms that live in temperate latitudes can anticipate and respond to seasonal changes in external conditions by controlling appropriate developmental, physiological, and behavioural switches. For example, certain species of insects enter diapause, a period of growth arrestment that is induced by short photoperiods or cold temperatures.

The Siberian hamster typically breeds only in the spring and summer months, a seasonal adaptation that is partly regulated by regression of the gonads induced by the expanded nocturnal release of melatonin. Photoperiodism has been extensively studied in plants, where floral initiation can be experimentally controlled by altering day length. Recent genetic evidence in the flowering plant *Arabidopsis* clearly indicates that common elements participate in circadian clock function and in eliciting photoperiodic responses.

In addition to day length, circadian rhythms are modulated by seasonal changes in average daily temperatures. Diurnal animals typically respond to colder temperatures by displaying a greater proportion of their activity during daytime hours, whereas nighttime activity predominates at warmer temperatures. This directional response has a clear adaptive value, ensuring that the activity of an organism is maximal at a time of day when the temperature would be expected to be optimal for activity. Direct evidence for circadian clock function in temperature-induced alterations in the timing of the daily distribution of activity has been shown in *Drosophila melanogaster*, where a thermosensitive splicing event in *per* RNA contributes to preferential daytime activity on cold days.

A less classic example in which circadian clocks are used is during long distance navigation of birds, insects, and other animals to predetermined target areas using the azimuth of the sun as a compass. By artificially resetting the circadian clock, the animal misrepresents the position of the sun leading to a predictable change in the direction of navigation. What is Biological clocks? What is Exogenous?

Self-Assessment Exercises 1

Attempt this exercises to measure what you have learnt so far. This should not take you more than 5 minutes.

1. What is Circadian Timing System?

5.4 Summary

Biological clocks are internal timing mechanisms which can have a period of several hours, a day, or a year. The circadian clock runs with a period of *about* 24 hours. Circadian clocks have two functional characteristics where they will persist (=free-run) with a period of about

a 24 hours in the absence of environmental cues; and will synchronize (=entrain) to a 24 hour environmental cue, such as the light-dark cycle.

5.5 References/Further Readings/Web sources

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5.6 Possible Answers to SAEs

Answers to SAEs 1

1. Circadian rhythms are operationally defined as biorhythms that exihibit the
following three properties:

i. Persist (or free run) with a period of ≈24 h in the absence of external time cues (or zeitgebers)
ii. Reset by changes in environmental conditions, most notably the daily light –dark and temperature cycyles, and
iii. Have an invariant period length over a wide range of physiological relevant tempareture (temperature compensation, see above).

Glossary

°C = degrees Celsius
cm = centimeters
CNS = Central nervous system
CH4 = Methane
CO = Carbon
CH_4 = methane (CH_4)
DNA = Deoxyribonucleic acid
E. coli = Escherichia coli
FAP = Fixed Action Pattern
°F = degree Fahrenheit
Ft = feet
h = hour
in = inches
Kgs = kilograms.
km = kilometers
kph = kilometer per hour
m = meters
mm = millimeters
mph = meter per hour
NH2OH = Hdroxylamine
NH3 = Ammonia
O_2 = Oxygen
PNS = Peripheral Nervous System
PRC = Phase Response Curve

RNA = Ribonucleic acid
L = length
HIV = Human immunodeficiency virus
% = percentage
g = grams
spp = species
UV = Ultraviolet

End of the Module Questions

1. What is proximate causation?
2. List examples of innate behaviour?
3. What is Anthropomorphism?
4. What is habitat selection?
5. What is Parenthood?