Biyani's Think Tank

Concept based notes

Applied Zoology, Ethology & Biostatistics

B.Sc

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Published by :
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Edition : 2012

Leaser Type Setted by :
Biyani College Printing Department

Preface

I am glad to present this book, especially designed to serve the needs of the students. The book has been written keeping in mind the general weakness in understanding the fundamental concepts of the topics. The book is self-explanatory and adopts the "Teach Yourself" style. It is based on question-answer pattern. The language of book is quite easy and understandable based on scientific approach.

Any further improvement in the contents of the book by making corrections, omission and inclusion is keen to be achieved based on suggestions from the readers for which the author shall be obliged.

I acknowledge special thanks to Mr. Rajeev Biyani, *Chairman* & Dr. Sanjay Biyani, *Director* (*Acad.*) Biyani Group of Colleges, who are the backbones and main concept provider and also have been constant source of motivation throughout this endeavour. They played an active role in coordinating the various stages of this endeavour and spearheaded the publishing work.

I look forward to receiving valuable suggestions from professors of various educational institutions, other faculty members and students for improvement of the quality of the book. The reader may feel free to send in their comments and suggestions to the under mentioned address.

Author

Section–A

Applied Zoology

Principles and Practices of the following :

1. Vermiculture 2. Sericulture (Including Ericulture)
3. Lac culture 4. Apiculture
5. Prawn culture 6. Poultry keeping 7. Pisciculture

Economic Importance of the following :

1. Protozoa 2. Corals and coral reefs
3. Helminthes 4. Arthropods :
   i. Crustacean larvae. ii. Insects and their management.
5. Mollusca : Including an outline idea of Pearl culture.

Section–B

Ethology

1. Introduction and history of Ethology.
2. Concepts of Ethology : Fixed action pattern, sign stimulus, innate releasing mechanism, actron specific energy, motivation, imprinting and learning.
3. Methods of studying brain behaviour : Neuroanatomical, neurophysiological and neurochemical techniques.
4. Elementary idea of role of pheromones.
5. Societies : Characteristics and advantages with special reference to honey-bee, deer and monkey.

Section–C

Biostatistics

1. Introduction scope and application of Biostatistics.
2. Understanding the concepts of descriptive and inferential statistics.
3. Frequency distribution.
4. Graphical and tabular presentation of data.
5. Mean, mode, nedian and their significance.
6. Standard deviation, standard error and their significance.

PRACTICAL–ZOOLOGY

Min. Marks : 18 4 Hrs. duration Max. Marks : 50

I. Anatomy :

1. a. General viscera, afferent and efferent branchial blood

Applied Zoology

Chapter 1
Animal Culture

Q.1 Define vermiculture and Vermicompost.

Ans. Cultivation of annelid worms (as earthworms or bloodworms) especially for use as bait or in composting is called vermiculture. It is also known as vermicomposting. It is used in specially bred earthworms to aerate the soil and convert organic matter into compost. At large scale vermicomposting occurs in many countries and it may be used for farming, landscaping, making worm tea or for sale. At small scale it has become increasingly popular in the past few years as individuals become aware of the huge advantages of its environmental benefits. Vermicompost is the compost that's left after the worm has done his business. In human beings vermicompost is rich and is made up of decomposing materials and organic matter plus the worm's manure, known as worm castings.

Q.2 What do you mean by Sericulture?

Ans. Sericulture is also known as silk farming. Rearing of silkworms for the production of raw silk is called sericulture. There are several commercial species of silkworms, *Bombyx mori* is intensively studied and the most widely used. The discovery of silk production by *B. mori* dates to about 2700 BC, although archaeological records point to silk cultivation as early as the Yangshao period. Silkworm larvae fed mulberry leaves. After the fourth moult it climb a twig placed near them and spin their silken cocoons. This process is achieved by a dense fluid secreted from its gland structural glands, resulting in the fiber of the cocoon. In the head of each larva two salivary glands are present which secretes a continuous-filament fiber consisting of fibroin protein and a gum called sericin, which cements the two filaments together. When cocoons are placed in hot water sericin is removed, which frees the silk filaments and readies them for reeling. Single filaments are combined to form thread. Under tension through several guides this thread is drawn and wound onto reels. The threads may be plied together to form yarn. After drying, the raw silk is packed according to quality.

Q.3 Define Bee Pasturage.

Ans. Those plants that yield nectar and pollen are collectively known as "bee pasturage". The ornamental plants, fruit trees and forest trees comprise important bee pasturage. Sweet secretion of the flowers is called nectar.

Pollen provides the raw material for honey and it is necessary for the major food of the brood.

Q.4 Write Silk Producing States of India

Ans. Major Indian States producing mulberry silk are:

Karnataka

West Bengal

Jammu and Kashmir

Q.5 What is Non-mulberry "silks"?

Ans. We can defined non mulberry silk as follows-

1. **Tasar silk**- It is produced by certain species of another moth *Antherea royeli*. Their larvae are reared on Arjun trees, chiefly in Madhya Pradesh, Bihar and West Bengal.
2. **Muga silk**- It is obtained from *Antherea assama.* Its larvae are reared on " Som" trees in Brahmaputra Valley.
3. **Eri silk-** It is produced by the moth *Philosamia ricini.* Its larvae feed on castor leaves. It is produced in Assam.

Q.6 Write an easy on Apiculture (Bee-keeping).

Ans. Apiculture is also known as bee-keeping.

It is the art of caring and manipulating colonies of honeybee in large quantity. Thousands of years ago, in Rigveda, there are many references to bee and honey. Bee-keeping became a commercial proposition. During the 19th century, as a result of scientific research apiculture becomes a flourishing industry in many advanced countries like USA, Canada, Germany and Australia.

Importance of bee keeping

There are three main advantages of bee-keeping:

(i) It provides honey which is a valuable nutritional food.

(ii) It Provides bees wax which has many uses in industry.

(iii) For increasing agricultural yields honey bees are excellent pollinating agents.

Species of honey bee

There are four species of honey bee under a single genus *Apis* (apis = bee):

1. ***Apis dorsata* (The rock- bee)**

   This is the largest honeybee.

It builds single large open comb on high branches of trees and rocks.

It produces large quantity of honey, but this bee is difficult to domesticate.

Apis dorsata is ferocious, stings severely causing fever and sometimes even death.

2. ***Apis indica* (The Indian bee)**

Medium – sized bee, which hive is consists of several parallel combs in dark places such as cavities of tree, mud walls, earthen posts and trunks etc.

This bee can be domesticated easily and is not so ferocious.

3. ***Apis florea* (The little bee)**

   It is small – sized bee. It builds single small combs in bushes, hedges, etc.

   Its honey yield is poor.

4. ***Apis mellifera* (The European bee)**

   It is somewhat like the Indian bee (*Apis indica*).

   It has been introduced in many parts of the world including India.

   It can be easily domesticated.

   A honey bee colony has three castes-

   (i) Queen – only one.

   (ii) Workers – 20,000-30,000.

   (iii) Drones – a few only.

   Queen Bee

   Queen bee is the only perfectly developed female. This has well developed ovaries and other organs of female reproductive system. It is largest in size. Its wings are shriveled and smaller. Its mouth parts are for sucking food and shorter than that of workers. They have no wax glands.

   It lives for about 3 - 4 years.

   It may lay eggs at the rate of 800 - 1500 per day.

   This can lay two types of eggs:

   1. **Fertilized** – eggs, that produce females (either sterile workers or fertile females).
   2. **Unfertilized** – eggs, which produce drones.

   Worker bees

   Worker bees are imperfectly developed females. These bees are smaller than the queen. These have strong wings to fly. For sucking nectar they have a large and efficient proboscis (mouth parts packed together like a thin tube).

   A well-developed sting is present in this bee. Their hind legs have "pollen basket" for collecting pollen.

❖ Some scout bees set out in the morning for foraging. On locating good sources of nectar they return to their hive and perform movements known as bee dances, at the comb. These dances communicate to the other worker bees the direction and distance of the food source. Due to this more and more worker bees are deployed in food gathering. Against taking clue from

the position of sun as well as by certain amount of memory and finally the smell of their own particular hive workers visit flower to flower, collect nectar and pollen and return to their own nest

The bee dance

The middle course of the dance communicates to the other bees the angle from the hive with reference to the sun. By taking a hint from this angle they have to fly to reach the food source.

Drones

These are the male bees which developed from unfertilized eggs. Their production in the hive synchronizes with the production of the new queens. The drones perform mating flight chasing the new queen in the air at the age of 14-18 days. Drones lives up to about 60 days and killed after mating.

Usually in the third year, when the queen gets older her body gives out a chemical stimulus to the workers to construct a few rearing cells for queens. In each of such brood cells she places one fertilized egg. When larvae fed royal jelly which is saliva of workers they turn into pupae and then into queens. When first queen to emerge from the brood cells it kills the remaining ones.

Along with a mixture of workers of all ages leaves the old hive, the old queen takes to swarming to develop a colony at some new site.

In the old hive, the new queen takes to mating flight with the drones and returns the same hive.

Honey and wax are the products of bees, both are valuable and marketable commodities.

(1) Indigenous methods of bee keeping

Many villagers make-

(a) Movable types of hives in wooden boxes
(b) Wall or fixed types of hives in rectangular spaces in the walls with a small hole or from trees and bushes clustered swarms are catches by the traditional beekeepers and transfer them to the above-mentioned spaces. When the honey is ready, the bees are driven away from the comb usually by smoking the hive. After this the comb is cut away and the honey is squeezed out through a piece of large meshed cloth.

(2) Modern hives

The modern bee hive is made up of a series of square or oblong boxes without tops or bottoms, set one above the other. Inside these boxes, wooden frames are vertically hung parallel to each other. The wooden

frames are filled with sheets of wax foundation on which the combs are built by the bees. The only entrance to the hive is below the large bottom box (brood chamber). The queen is usually confined to the brood chamber. The boxes termed "supers" are used for storage of honey. The queen is prevented from going to the "supers" by the "queen excluder" that allows only the workers to move.

First of all swarms are collected with the help of a container to collect the bees. The containers are usually a straw basket. After this, collected swarm is transferred to the hive to buildup the colony and produce honey called hiving a Swarm. This can be operated in two ways:

(a) Traditional method

In this method the hive is set up with brood chamber filled with its full number of frames. Each frame has a crown board with roof and at the top a full sheet of foundation. Against the entrance of the hive, a sloping board with white sheet is set. On to the slope, bees are knocked out of basket. To move upwards onto the dark, drives them onto the hive through the entrance.

(b) Quick method

The crown board of the hive is taken off in this method the entrance is closed and frames are also taken off. The skip is intimately united with the hive and the bees are poured into the brood chamber from the top. In the hive the frames containing the wax foundation are placed. The crown board is put back in its position and the entrance is opened. It must be seen that the queen enters the hive. Now, sugar syrup must be fed to the swarm. This feeding will help the bees to settle down to work in their new home.

Products from a bee hive

A. Honey

For the bees and their larvae honey is a food material. Large quantities of honey are stored in the hive to meet the demands in scarcity. Chemically, it is a viscous water solution of sugar. Its approximate composition is as follows:

Water 13-20%

Fructose 40-50%

Glucose 2-3%

Minerals Traces

Vitamins (minute quantities)

(B1, B2, C)

The nectar is collected from which flower decides the composition of honey and its different flavors.

Extraction of honey from the combs is done by centrifugation.

Uses of Honey

Some uses of honey are as follows

1. Food: It is a nutritious food, rich in energy and vitamins.
2. Medicines: It is used as a carrier in unani and ayurvedic medicines. It prevents cold, cough and fever and acts as a laxative.

   – It is used in religious ceremonies.

   – It goes in the making of alcoholic drinks and beauty lotions.

   – Another important use is in scientific research.

   – It is also utilized for making poison baits for certain insect pests.

B. Beeswax

It is secreted by the wax glands located on the underside of the last four abdominal segments (4th to 7th) of the worker bee. This wax is used in constructing bee combs in which the colony of the bees develops.

Uses of beeswax

Some uses are as follows:

1. Water proofing and waxing of threads;
2. Making of candles;
3. Preparation of varnishes and paints;
4. Making pharmaceutical preparations;
5. Formation of comb foundation (wax foundation in apiaries).

Q.7 Describe Lac culture in detail.

Ans. Lac is a resinous substance secreted by a tiny insect called *Laccifer lacca* (popular name "lac insect")

Shellac is the purified lac usually prepared in the orange or yellow

Flakes Lac or shellac is used in many ways-

– Its commonest use is in polishing wooden furniture. The granules are dissolved in spirit and then they are applied in very thin layers on the wooden surfaces.

– In sealing parcels, packets and envelopes.

– As insulating material in electrical work.

- In making phonograph records.

– In shoe polishes.

– In toys and jewellery.

Lac insect

The lac insect lives on native trees in India, Burma (now called Myanmar) and

Malaysia. In India it is mainly grown on trees like " Kusum", " Palas", and "Ber".

– The minute young lac insect (also called crawler) finds a suitable branch.

– To obtain nourishment the insect inserts its beak into the plant tissue.

– When it grows in size and secretes a resinous material around itself.

– On exposure to air the resinous material becomes hardens.

– Thousands of crawlers settle side by side and the resinous secretion builds up around them and completely encases the twig.

– In the resinous mass most crawlers develop in about 3 months into female which occupy small cavities. The females can never come out of these masses.

Extraction of Lac

The encrusted twigs are known as **stick lac**. Such twigs are harvested.

– The stick lac is ground largely in crude mortars, and the resulting granular lac

is called **seed lac**.

– For making toys, bangles etc. the fine particles or the dust separated from the granular lac.

– The wood portion is used as fuel.

– The seed lacs are washed, melted, spread out in a thin layer and dried. This is the shellac of commerce.

Q. 8 Write a note on history of sericulture.

Ans. Sericulture or silk production from the moth, *Bombyx mori* has a long and colorful history unknown to most people. This insect is the only living species of family Bombycidae and has been domesticated for so long that it is possible that there are no survivors in the wild any longer.

According to the Chinese records, the discovery of silk production from *B. mori* occurred about 2700 BC. It is believed that empress Si-lung-Chi was asked by emperor Huang-ti to find the cause of damaged mulberry leaves on trees in their garden. The empress found white worms eating the leaves. She noticed that they were also shiny cocoons around themselves. A cocoon dropped in her cup of tea and silky threads separated from the cocoon. Silk industry began in China where the source of silk was kept a secret for more than 2000 years. After some time, China lost their monopoly in silk production, sericulture reached Japan through Korea and then to other countries.

Sericulture has been growing in India as an agro-based industry playing a vital role in the improvement of rural economy.

Q.9 Write an easy on sericulture.

Ans. The breeding and management of silk worms for the commercial production of silk is known as Sericulture or silk production. It is an important industry in Japan, China, India, Italy, France and Spain.

Source of silk – The silkworm

A source of silk is the silkworm which is the larva or the caterpillar of the moth *Bombyx mori* (popularly called the silk moth). The different stages of this moth are as follows:

(i) Adult

It is a creamy white moth that has a flat body and a wing expanse of about 5 cms. For fly it takes no food and seldom attempts to. It lives for only 2 to3 days. The female moth lays 300-500 eggs on leaves of the mulberry tree after mating.

(ii) Eggs (10 days)

These are round and yellowish-white and they become grey as hatching time approaches.

(iii) Larvae (4 stages-30 days)

The newly hatched larva somewhat black in colour and is about 3 mm long.

The larvae grow in size and shed their skin four times. This process is known as molting. Each growing stage of the caterpillar consumes lot of mulberry leaves.

The last stage full grown larva is about 7 cm long. It has a hump behind the head and a spine-like horn at the tail end.

When full grown, the mature larva stops feeding, climbs on a twig and spins a cocoon.

(iv) Pupa (cocoon-10days)

The full grown larva pupates inside the cocoon

- In about 10 days time it transforms into a winged adult. The adult moth makes an opening in the cocoon and escapes through it.

The cocoon

The cocoon is formed from a secretion from two large silk glands (actually the salivary glands), which extend along the inside of the body and open through a common duct on the lower lip of the mouthparts. The larva moves the head from side to side very rapidly (about 65 times per minute) throwing out the secretion of the silk glands in the form of a thread. The secretion is a clear viscous fluid, which on exposure to the air gets hardened into the fine silk fiber.

The filament forming a cocoon is continuous and ranges in length from 700-1100 meters.

The cocoons from which moths have emerged are called pierced cocoons. These are of low value because continuous thread cannot be obtained. Pieces are removed by instruments and spun into a thread.

Rearing of silkworms

Selected healthy silk moths are allowed to mate for 4 hours. Female moth is then kept in a dark plastic bed. She lays about 400 eggs in 24 hours; the female is taken out and is crushed and examined for any disease, only the certified disease- free eggs are reared for industrial purpose. The eggs are hatched in an incubator.

The hatched larvae are kept in trays inside a rearing house at a temperature of about 20°C-25°C. These are first fed on chopped mulberry leaves. After 4-5 days fresh leaves are provided. As the larvae grow, they are transferred to fresh leaves on clean trays, when fully grown they spin cocoons.

Reeling silk

The cocoons are cooked in hot water and the silk fiber is unwound from the cocoons.

This process is called reeling. The silk consists of two proteins; the inner core is fibroin and an outer cover of sericin.

For reeling silk the cocoons are gathered about 8 days after spinning had begun.

- To kill the insect inside the cocoons are first treated by steam or dry heat. This is necessary to prevent the destruction of the continuous fiber by the emergence of the moth.
- Next, the cocoons are soaked in hot water (95° -97°C) for 10-15 minutes to soften the gum that binds the silk threads together. This process is called cooking.
- The "cooked" cocoons are kept in hot water and the loose ends of the thread are caught by hand.
- Threads from several cocoons are wound together on wheels ("charkhas") to form the reels of raw silk.

Only about one-half of the silk of each cocoon is reel able, the remainder is used as a silk waste and formed into spun silk.

Raw silk thus obtained is processed through several treatments to give it the final shape.

Main properties of silk

1. It is lustrous, soft and strong.
2. It is made of two proteins: the inner core is fibroin and an outer cover is sericin
3. It is hard wearing.
4. It can be dyed into several colours

Silk moth *Bombyx mori* is at present fully domesticated. It no longer exists in a

wild state and it cannot survive without the human care.

Q.10 Write short notes on-

(A) Fish farming

Ans. It is the principal form of aquaculture, while other methods may fall under mariculture. Fish farming involves raising fish commercially in tanks or enclosures, usually for food and other purposes.

There are two kinds of aquaculture: extensive aquaculture which is based on local photosynthetic production and intensive aquaculture, in which the fish are fed with external food supply. To contain and protect fish until they can be harvested fish cages are placed in bayous, lakes, ponds, rivers or oceans. When the cages are placed in the sea method is also called "off-shore cultivation". They can be constructed of a wide variety of components. They reach market size fish are stocked in cages, artificially fed, and harvested. many types of waters can be used (rivers, lakes, filled quarries, etc.), Many types of fish can be raised, and fish farming can co-exist with sport fishing and other water uses are few advantages of fish farming. Cage farming of fishes in open seas is also gaining popularity. Pond systems are easier to manage and simpler to start in concerns of disease, poaching, poor water quality, etc. The culture of non-native fish species in open-water cages generates due to past occurrences of cage-failures leading to escapes. The cage-industry has made numerous technological advances in cage construction in recent years; the concern for escapes remains valid.

(B) Poultry farming-

Ans. For the purpose of farming meat or eggs for food, **Poultry farming** is the raising of domesticated birds such as chickens, turkeys, ducks, and geese. Poultry are farmed in great numbers with chickens being the most numerous. For both their meat and their eggs more than 50 billion chickens are raised annually as a source of food. Chickens raised for meat are often called broilers and chickens raised for eggs are usually called laying hens. The UK alone consumes over 29 million eggs per day. In the US, the national organization overseeing poultry production is the Food and Drug Administration (FDA). In the UK, the national organization is the Department for Environment, Food and Rural Affairs (DEFRA).

Q.11 Different categories of earthworms.

Ans. An **earthworm** is a segmented animal. It is commonly found in soil. Its shaped like a tube (the gut) within a tube (the body). Its digestive system runs straight through its body, it conducts respiration through the cuticle covering its skin, and it has a closed blood circulatory system. Earthworms are hermaphrodites because each individual carries both male and female sex organs. As an invertebrate it lacks a skeleton, but an earthworm maintains its structure with fluid-filled chambers functioning like a hydro-skeleton.

"Earthworm" is the common name for the largest members of Oligochaeta in the phylum Annelids. In classical systems they were placed in the order *Opisthopora*, on the basis of the male pores opening posterior to the female pores, even though the internal male segments are anterior to the female. Folk names for the earthworm include "dew-worm", "Rainworm", "night crawler" and "angleworm" (due to its use as fishing bait).

Larger terrestrial earthworms are also called **megadriles** (big worms), as opposed to the microdriles (small worms) in the semi-aquatic families Tubificidae, Lumbriculidae, and Enchytraeidae, among others. The megadriles are characterized by having a distinct clitellum, which is more extensive than that of microdriles and a vascular system with true capillaries.

Q.12 Chicken breeds-

Ans. There are hundreds of chicken breeds domesticated for thousands of years, distinguishable breeds of chicken have been present since the combined factors of geographical isolation and selection for desired characteristics created regional types with distinct physical and behavioral traits passed on to their offspring. Physical traits used to distinguish chicken breeds are size, plumage color, comb type, skin color, number of toes, and amount of feathering, egg color, and place of origin. They are also divided by primary use, whether for eggs, meat, or ornamental purposes, and with some considered being dual-purpose chickens are frequently bred according to predetermined breed standards set down by governing organizations, in the 21st century. The first of such standards was the British Poultry Standard. Other standards include the Standard of Perfection, the Australian Poultry Standard, and the standard of the American Bantam Association, which deals exclusively with bantam fowl. Only some of the known breeds are

included in these publications, and only those breeds are eligible to be shown competitively. There are additionally a few hybrid strains which are common in the poultry world, especially in large poultry farms. These types are first generation crosses of true breeds. Hybrids do not reliably pass on their features to their offspring, but are highly valued for their producing abilities.

Chapter-2
Economic Importance

Q.1 Write a note on Barriers.

Ans. Row covers are useful for keeping insects out of one's plants, typically used for horticultural crops. They are made out of either plastic or polyester. They are made thin and light to allow plants to still absorb sunshine and water from the air.

Trap strips are crops that are grown on fields with the intention of using them to attract insects and not have insects infest the other crops that are being grown. The insects can then be dealt with much more easily than if they were to have been spread throughout an entire field. Trap strips are very useful for dealing with the wheat stem sawfly.

For farmers, fire has been a powerful technique used to destroy insect breeding grounds. It is used to burn the top of the soil in order to kill the insects that lie there. Unfortunately, this can present some drawbacks. Fire can make the soil much less effective or get rid of the insects that are beneficial to the plants. Also, there is no guarantee that it will actually solve the pest problems since there may be larvae below the surface of the soil.

Q.2 Give a brief account on types of Reefs.

Ans. The three principal reef types are:

1 **Fringing reef** – this type is directly attached to a shore, or borders it with an intervening shallow channel or lagoon.

2 **Barrier reef** – a reef separated from a mainland or island shore by a deep channel or lagoon

3 **Atoll reef** – this more or less circular or continuous barrier reef extends all the way around a lagoon without a central island.

A **fringing reef** is one of the three main types of coral reefs recognized by most coral reef scientists. It is distinguished from the other two main types (barrier reefs and atolls) in that it has either an entirely shallow back reef zone (lagoon) or none at all. If a fringing reef grows directly from the shoreline (see photo, right) the reef flat extends right to the beach and there is no back reef. In other cases (e.g., most of The Bahamas), fringing reefs

may grow hundreds of yards from shore and contain extensive back reef areas with numerous seagrass meadows and patch reefs.

This type of coral reef is the most common type of reef found in the Caribbean and Red Sea. Darwin believed that fringing reefs are the first kind of reefs to form around a landmass in a long-term reef growth process.

There are two main components that make up a fringing reef, the reef flat and the reef slope.

(a) Reef flat

The reef flat is the shoreward, flat, broadest area of the reef. The reef flat is found in fairly shallow water, and can be uncovered during low tide. This area of the reef is only slightly sloped towards the open ocean.

Since the reef flat is adjacent or nearly adjacent to land, it sustains the most damage from runoff and sediments. Typically, few of the flat's corals are alive. Sea grasses, seaweeds, and soft corals are often found there.

(b) Reef slope

This is found at the outer edge of the fringing reef, closest to the open ocean. This area of the reef is often quite steep and descends either to a relatively shallow sand bottom or to depths too great to allow coral growth.

Coral grows much more abundantly on this slope, both in numbers and in species diversity. This is mostly because runoff and sediments are less concentrated here. Greater wave action disperses pollutants and carries nutrients to this area.

The upper portion of this slope is called the reef crest. The crest has the best balance between sunlight and waves, so coral grows fastest here. The base of the slope receives the least sunlight and has the least growth out of the whole slope.

Barrier reef

Sometimes it is hard to tell the difference between fringing reefs and another type of reef called a **barrier reef**. One of the ways that these two types of reefs are separated is based on the depth of the lagoon in the back reef which is the area near to shore. Barrier reefs have at least some deep portions; fringing reefs do not. Another major difference is that barrier reefs tend to be much farther away from shore than fringing reefs.

Q.3 Describe in brief about any four protozoans diseases.

(A) Chagas disease

Ans. It is a tropical parasitic disease caused by the flagellate protozoan *Trypanosoma cruzi*. *T. cruzi* is commonly transmitted to humans and other mammals by an insect vector, the blood-sucking "kissing bugs" of the subfamily Triatominae, most commonly species belonging to the *Triatoma*, *Rhodnius*, and *Panstrongylus* genera.

The disease may also be spread through organ transplantation, blood transfusion, ingestion of food contaminated with parasites, and from a mother to her fetus.

The symptoms of Chagas disease vary over the course of an infection. In the early, acute stage, symptoms are mild and usually produce no more than local swelling at the site of infection. The initial acute phase is responsive to ant parasitic treatments, with 60–90% cure rates. After 4–8 weeks, individuals with active infections enter the chronic phase of Chagas disease that is asymptomatic for 60–80% of chronically infected individuals through their lifetime.

CHAGAS BUG

(B) Leishmaniasis

Ans. Leishmaniasis is a disease spread by the bite of the female sand fly.
Symptoms of cutaneous leishmaniasis may include:

- Breathing difficulty
- Skin sores, which may become a skin ulcer that heals very slowly
- Stuffy nose, runny nose, and nosebleeds
- Swallowing difficulty
- Ulcers and wearing away (erosion) in the mouth, tongue, gums, lips, nose, and inner nose

Systemic visceral infection in children usually begins suddenly with:

- Cough
- Diarrhea
- Fever
- Vomiting

Adults usually have a fever for 2 weeks to 2 months, along with symptoms such as fatigue, weakness, and appetite loss. Weakness increases as the disease gets worse.

Other symptoms of systemic visceral leishmaniasis may include:

- Abdominal discomfort
- Fever that lasts for weeks; may come and go in cycles
- Night sweats
- Scaly, gray, dark, ashen skin
- Thinning hair

The patient may have been bitten by sandflies, or was in an area known for leishmaniasis.

Tests that may be done to diagnose the condition include:

- Biopsy of the spleen and culture
- Bone marrow biopsy and culture

Preventing sand fly bites is the most immediate form of protection because prevention is better than cure. We can prevent a bite by:

- Putting fine mesh netting around the bed (in areas where the disease occurs)

- Screening windows
- Wearing insect repellent
- Wearing protective clothing

c) Amoebiasis

Ans. Amoebiasis is a common infection occurring in the gastrointestinal tract of humans. It is caused by a parasite known as *Entamoeba histolytica. Entamoeba histolytica* often burrows deep into the walls of the intestines, causing infections and abcesses. From the intestinal walls, it can travel to the spleen, liver, and all other essential parts of the body, thereby causing further infection.

Amoebiasis can lead to more serious complications if not given immediate treatment. Therefore, it is imperative to seek medical assistance if the presence of this disease is suspected in a person. A person who has this disease may feel a number of symptoms but in some cases, the condition can be asymptomatic, where no symptoms are felt at all.

Signs of Amoebiasis

The symptoms of amoebiasis may range from mild to severe. Not all people that have this disease may show signs of the infection but when symptoms do appear, they may take in a variety of forms, including the following:

- **Vomiting:** This may be an indication of severe infection in the gastrointestinal tract.
- **Diarrhea:** Persons with mild amoebiasis may pass stool at least three to eight times a day. The stool may be soft with specks of mucus and blood.
- **Bloody stools**: This is an indication of chronic or more severe amoebiasis. Usually, individuals may pass bloody, liquid stools of at least 10 to 20 times per day.
- **Abdominal pain**
- **Sudden weight loss**
- **Abdominal cramps**
- **Nausea**
- **Loss of appetite**
- **Fever**
- **Fatigue**: This can result due to the loss of a lot of liquid in the body.

- **Intestinal gas**
- **Rectal pain during movement of bowel**

Q. 4 Write a note on Entamoeba gingivalis.

Ans. *Entamoeba gingivalis* is a non pathogenic protozoa (reported by some to cause disease) and is known to be the first amoeba in humans to be described. It is found in the mouth between the gingival pockets and near the base of the teeth. *Entamoeba gingivalis* is found in 95% of people with gum disease and in 50% of people with healthy gums. The cyst formation is not present; therefore transmission is direct from one person to another by kissing, or by sharing eating utensils. Only the trophozoites are formed and the size is usually 10 micrometer to 20 micrometer in diameter. *Entamoeba gingivalis* have pseudopodia that allow them to move quickly. Their spheroid nucleus is 2 micrometer to 4 micrometer in diameter and contains a small central endosome. There are numerous food vacuoles and contain cellular debris, blood cells and bacteria.

Q.5 Write economic importance of mollusca.

Ans. Molluscs are indirectly harmful to man but most of them are beneficial. Molluscs are of great important in various ways. There are some benefits of molluscs:

1. The harmful molluscs ate slugs and shipworms. Slugs are injurious in gardens and cultivations. They not only eat leaves but also destroy plants by cutting up their roots and stems. Teredo, a shipworm damages wooden parts of ship.
2. Shell of fresh water mussels is used in button industry.
3. The shell of oyster is mixed with tar for making roads in America.
4. Shells in certain parts of world are also used for making ornaments.
5. Some oysters also make valuable pearls e.g. the pearl oyster.
6. Some pearls are used for making jewellery.
7. Some animals including in this phyla are use to eat in some countries.

Q.6 Short note-

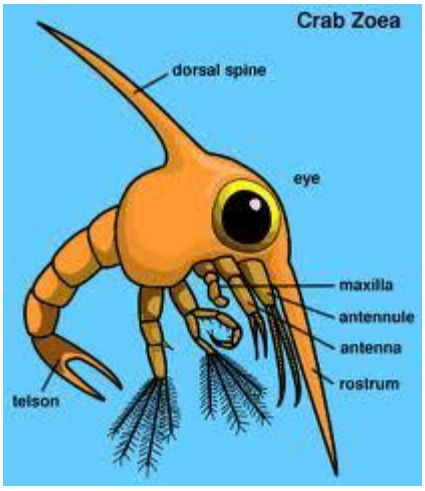
A. Nauplius larva-

Ans. In crustaceans the larva, called nauplius, does not differ substantially in mode of life or means of locomotion from the adult but has fewer appendages than the adult. A typical crustacean nauplius has three pairs of legs and an unpaired simple eye. Additional pairs of appendages and paired compound eyes appear in the course of a reproduction. The antennae are

used for swimming. As the **nauplius** feeds and grows, it gradually changes into the adult form—the body becomes segmented, or jointed, and additional limbs develop. The main features of a **nauplius** are a simple, unsegmented body, three pairs of appendages (antennules, antennae, and mandibles), and a single, simple, "naupliar" eye. Nauplius larvae are found in the life cycles of cirripedes, ostracods, branchiopods, copepods, euphausiids, and decapods.

B. Zoea larvae

Ans. Zoea larvae are most common during the summer and autumn. Most of them eat other organisms and other nutrients that hover around in the water. Many larvae are themselves eaten by suspension feeders. Zoea larvae are members of the crab group, a crustacean under the arthropods.

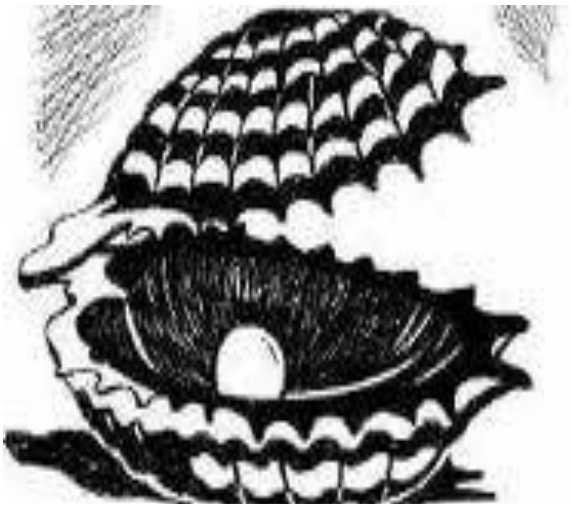


This stage follows the nauplius stage, which (in most decapods) is passed in the egg, and precedes the post-larval planktonic megalopa stage. Zoea larvae swim using thoracic appendages, (maxillipeds and pleopods), which distinguishes them from both earlier and later stages of development.

Q.7 Give a brief account on Pearl.

Ans. In nature, a pearl is formed when a foreign particle *viz*., piece of sand, insects, etc. by chance enters into the body of mussel and the mussel cannot reject that out and instead makes a shiny coating on the particle layer by layer. This simple phenomenon is being exploited in pearl culture practices.

The pearl is similar to the inner shining layer of shell called 'mother of pearl layer' or nacre It constituted by calcium carbonate, organic matrix and water. The pearls available which are available in the market could be artificial, natural or cultured. Artificial or imitation pearls are not pearls but pearl-like materials that simply contain a rigid, round core or base and an outer pearly coating. In natural pearls the core or nucleus is minute with thick pearl nacre. Generally, a natural pearl is small in size and irregular in shape. A cultured pearl is also a natural pearl, the only difference being the human intervention in surgical implantation of a live mantle graft and nucleus for hastening pearl formation to the desired size, shape, colour and lusture. In India, three species of commonly available freshwater mussel's *viz*., *Lamellidens marginalis*, *L. corrianus* and *Parreysia corrugata* found to produce good quality pearls.



formed.

Chapter 3
Insects and their Management

Q.1 Write short notes on-

(A) Beneficial insect

Ans Insects provide a wide range of benefits to humanity. Most of our crops are dependent on pollination by honey bees and other insects. Even the production of meat and milk depend on pollinated plants that are eaten by domestic animals.

Honey bees produce honey (more than 1 million tons produced every year) and beeswax. The larva of the silkworm moth secrets silk forms its salivary glands. The annual value of raw silk is estimated at about $ 1.4 billion. Insects perform a vast number of vital functions in our ecosystems. They provide foods for many birds, mammals, and fishes on which fishing and hunting depends. They also decompose dead materials, thereby reintroducing nutrient into the soil.

Insects can be effective as predators to control pests for agriculture. For example, the beetle (*Rodolia cardinalis*) is used to control the Cottony-Cushion Scale (*Icerya purchase*) from sucking the branches and bark of many fruit trees.

In many parts of the world, people use insects as a major source of food including protein. For example, in Mexico grasshoppers and other insects are sold in village markets and are fried before being eaten. By weight, termites, grasshoppers, caterpillars, weevils, and house flies are better sources of protein than beef, chicken, pork or lamb. Further, insects are low in cholesterol and fat.

(B) Biological pest control

Biological pest control strives to reestablish this balance in one of three ways:

1. **Importation**. Foreign exploration is conducted to identify and collect natural enemies in the country from which an exotic pest has been introduced. Following the discovery of a potential biocontrol agent, it undergoes extensive evaluation to insure that its ecology and host range are compatible with the community to which it will be introduced and that it will not become a pest once it is released. Suitable candidates are reared and released in the new habitat in hopes that they will become established and suppress the pest population.
2. **Conservation**. A variety of management activities can be used to optimize the survival and/or effectiveness of natural enemies. Conservation activities might include reducing or eliminating insecticide applications to avoid killing natural enemies, staggering harvest dates in adjacent fields or rows to insure a constant supply of hosts (prey), or providing shelter, over-wintering sites, or alternative food sources to improve survival of beneficial species.
3. **Augmentation**. Natural enemies that are unable to survive and/or persist in a new environment can sometimes be reared in large numbers and periodically released to suppress a pest population. In some cases, small numbers of a beneficial species are released in several critical locations to suppress local pest outbreaks (an inoculative release). In other cases, larger numbers are released in a single location to flood the pest population with natural enemies (an inoculative release).

(C). **Physical Pest Control**

It is a method of getting rid of insects and small rodents by removing, attacking, or setting up barriers that will prevent further destruction of one's plants. These methods are used primarily for crop growing, but some methods can be applied to homes as well. Physical control refers to mechanical or hand controls where the pest is actually attacked and destroyed. Physical controls are used mostly in weed control. Tillage, fire, removal by hand, grazing and mowing is all used to destroy weeds and prevent reproduction. Some insects may also be destroyed by tillage, which destroys their eggs or overwinter stages of growth. Weeds are not controlled through a single operation.

Q.2 Write few words on meal moth.

Ans. Meal Moth is often confused with the Webbing Clothes Moth, a fabric pest. Meal Moths affect food product and not fabric. Clothes Moths affect fabric only. This pest in introduced into a building by being brought in with a food product which is already infested. Although manufacturers attempt to deliver food that is virtually pest free, they do not always succeed.

Another way that this pest may enter food is from a store that has an infestation of this insect. The immature stages of this insect may crawl into other food packages the Meal Moths are most active at night, people often report finding them in rooms away from the source as they follow the lights

that may be turned on in those rooms. Meal Moths goes through complete metamorphosis including egg, larvae (crawling stage), pupae (cocoon) and adult (flying moth). Therefore, if the infested food product is discovered and removed, and no other food source exists, the life cycle of the moth may be interrupted.

If an infestation exists, sanitation i.e. removal of all infested food product, is key to managing this pest. Thus, the first step in managing an Indian Meal Moth problem is inspecting for and then removing infested food product.

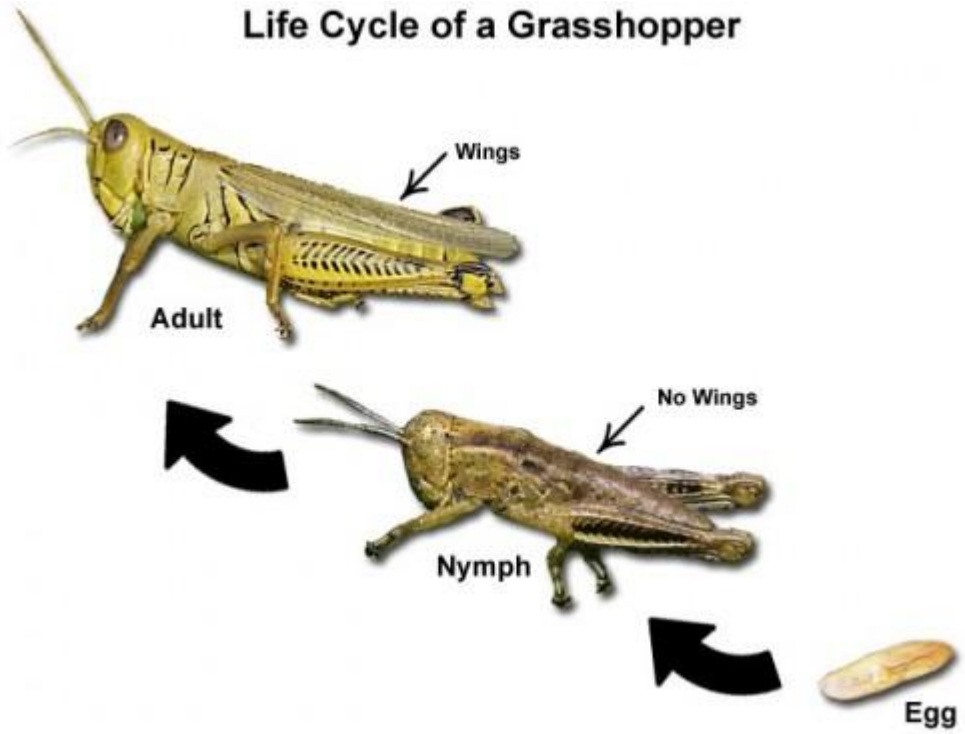
Q.3 Describe life cycle of grass hopper.

Ans. It is green or dry grass color, which lives in rice field. It is not actually jump. It can both leap and fly. Its life cycle complete in three stages-

A. Egg- By mid-summer female lays the fertilized eggs in the form of pods usually more than 10. Either it lay egg in the sand or on the leafs.

B. Nymph- Egg hatches after first rain and convert into nymph. At first these are dark but later they change into green.

C. Adult- After 25-30 days, wings developed and they convert into adult.



Key Terms

Antenna: A sensory apparatus found on the heads of insects and most arthropods. It is usually in pairs.

Arthropod: A group of invertebrate animals such as the insects, crustaceans, arachnids, centipedes, etc that is characterized by a exoskeleton and a segmented body with jointed appendages.

Embryo: An animal or plant that is in its first stage of development and is usually still contained within the seed, egg, or uterus.

Hatchling: A young one that has just been hatched from an egg.

Humus: Fine organic substance, composed of partial or full decomposed animal or plant matter, and found in soil.

Ichthyology: A branch of zoology dedicated to the systematic study of fishes.

Imago: Sexually mature adult stage in the life of certain insects.

Invertebrate: Pertaining to organisms without a backbone.

Juvenile: This term refers to a young bird in the stage when it has fledged, or young ones of the animals that have not yet reached its adult form, size and sexual maturity.

Larva: A premature form of animal or insect awaiting transformation to reach adulthood.

Life Cycle: Phases of life that animals go through starting from birth, to sexual maturity, till death.

Mandible: The lower jaw of a vertebrate animal, or the upper or lower part of the beak (bill) in birds.

Mantle: Single or paired set of feathers located on the mid-back of a bird, or an outgrowth that lines the inner surface of the valves of the shell.

Maxilla: A paired appendage usually located behind the mandibles of arthropods.

Metamorphosis: It is the process of marked change in the appearance and habits of some animals, as part of their normal development. Metamorphosis of a caterpillar into a butterfly is one such example.

Mouthparts: An appendage found close to the mouth of some animals, birds and insects, which they use for all eating functions.

Odontocetes: Used while referring to any whale of the suborder Odontoceti, such as killer whales, dolphins and sperm whales. They are characterized by a single blowhole, an asymmetrical skull and rows of teeth. They feed primarily on squid, fish and crustaceans.

Plankton: Microscopic organisms like algae and protozoa that drift on the oceans' currents.

Radula: A rough and raspy tongue normally seen in mollusks, used to grate food.
Rostrum: An anatomical structure, present in a species in the form of a snout, which projects out from the head of the animal.

Shell: A hard outer covering of an organism made up of carapace and plastron.

Ethology

Chapter 1

Introduction and History of Ethology

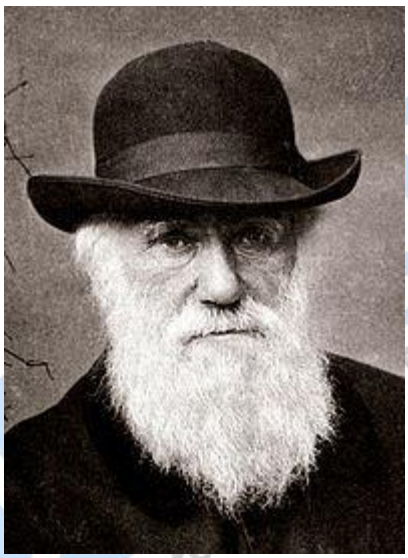
Q.1 Define Ethology.

Ans. Scientific and objective study of animal behavior is known as ethology. The word itself is derived from the Greek words ethos (meaning custom or character) and logos (meaning speech, word, controlling principal, fundamental reason). Ethology helps to explain the complicated interaction between the environment and naturally encoded "innate" behaviors. Ethology and comparative Psychology are both sciences which study animal behavior, typically non-human behavior, though both have often studied humans

Q.2 Give a brief account on history and significance of ethology.

Ans. Concerning animal behavior Aristotle had many interesting observations. Around the turn of the nineteenth century, the study of animal behavior was taken up more systematically mainly by German and British zoologists. **Jean-Baptiste Lamarck** (1744 - 1829) was the first biologist to describe a complex theory of evolution. His theory substantially comprised two statements: first, that animal organs and behavior can change according to the way they are used; and second, that those characteristics can transmit from one generation to the next (the example of the giraffe whose neck becomes longer while trying to reach the upper leaves of a tree is well-known). The second statement is that every living organism, humans included, tends to reach a greater level of perfection.

Because ethology is considered a topic of biology, ethologists have been concerned particularly with the evolution of behaviour and the understanding of behaviour in terms of the theory of natural selection. In one sense, 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, which did not gain scientific support.



The behavior of animals was also studied in the context of learning at the beginning of the twentieth century by the Russian physiologist Ivan P. Pavlov (1927) and the American psychologist Edward L. Thorndike (1911). In the study of evolution ethology has its roots, especially after evolution's increasing popularity after Darwin's detailed observations.

It became a distinct discipline in the 1930's with zoologists Konrad Lorenz and Niko Tinbergen. They elaborated on concepts that had not been well-understood, such as instinct and rejected theories that relied on stimuli and learning alone. They promoted the theory that evolution had placed within creatures innate abilities and responses to certain stimuli that advanced the thriving of the species. For their overarching career discoveries concerning organization is concerned with the evolutionary significance of an animal's behaviors in its natural environment.

Ethology is generally thought of as a sub-category of biology, though psychological theories have sprung up based on ethological ideas (e.g.sociobiology, evolutionary psychology, and attachment theory). Human ethology focuses on adaptive significance and the evolutionary of human behavior.

Chapter 2
Concepts of Ehology

Q.1 What do you mean by concepts of ethology?

Ans. Many ethologists such as Lorenz, Frisch and Tinbergen carried out specific research on animal behavior from which certain basic concepts have merged out, they are combidnely known as concepts of ethology.

Q.2 Differentiate between_

(A) Instinct and learned behavior.

Ans. An innate ability that an organism has at birth called instinct. It is a type of behavior that has essentially been programmed into an organism genome through evolution of the organism's population. A type of behavior that comes about through experience called Learned behavior. For instance, a bird can learn that Monarch butterflies taste bad after eating one. The bird remembers this bad taste and therefore avoids eating Monarchs. Learned behavior is associated with memory and experience, while instinct is a natural ability or reaction that an organism has innately (at birth).

(B) Ethology and psychology-

Ans. The study of human behavior is ethology which avoids attributing human characteristics to the animal. We should not be such egotists as to imagine that only humans have evolved certain behavioral characteristics. Play activity, curiosity, fear and aggression are common to many mammals as well as humans. To use ethology in managing and caring for zoo animals we need to know certain basic tenets.

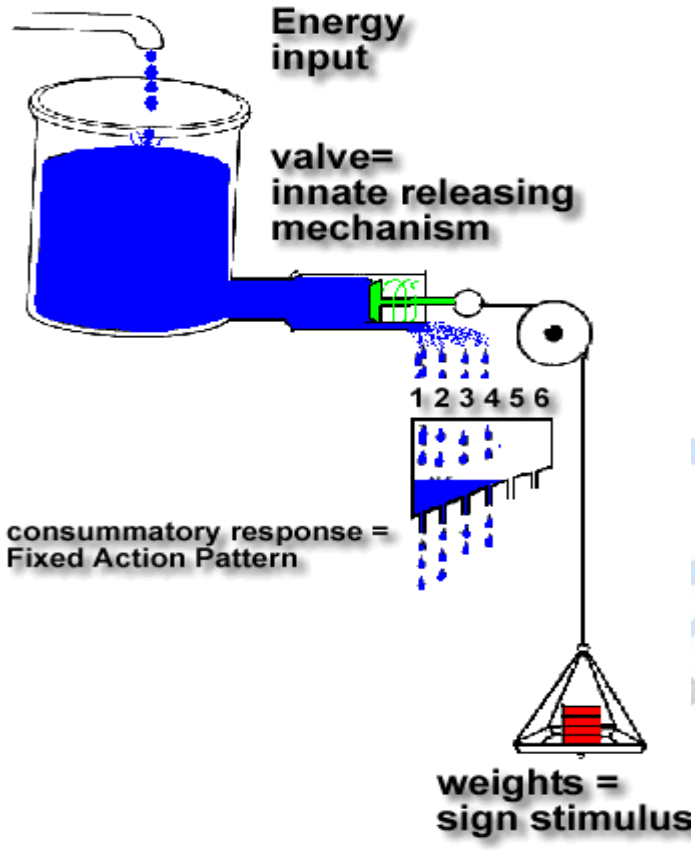
(c) Insight learning-

Ans. Kohler showed the power of insight learning by placing a banana above the reach of chimpanzees and watching how they attempted to reach the food. In the room there were several boxes, none of which was high enough to enable the chimpanzees to reach the banana. Kohler found that the chimpanzees spent most of their time unproductively rather than slowly working towards a solution. They would run around, jump, and be generally upset about their inability to snag the snack until, all of a sudden, they would pile the boxes on top of each other, climb up, and grab the bananas. Kohler

believed that the solution could not occur until the chimpanzees had a cognitive *insight* about how to solve the problem.

Q. 3 Describe Lorenz's Hydraulic Model.

Ans. Lorenz,s model describes the relationship between behavior (FAP's), motivation(ASE) and external stimuli. In this model motivation is specific for one type of behavior. This specific source of motivational energy is called action specific energy. It is represented by the accumulation of water in the reservoirs. The reservoir is filled by a tap. Lorenz postulated that the reservoir was being continuously filled with water in order to explain a phenomenon which he called vacuum activity. In hydraulic model, action specific energy can accumulate to such a high level that the pressure of water in the reservoir is capable of pushing open the restraining value. This causes water to flow into the trough and out through holes in the floor that represent FAP's.



Q.4 Write an easy on learning.

Ans. The usual technical definition of *learning* or *conditioning*, is any relatively permanent change in response that occurs as a result of experience. This refers to a response and not a cognitive outcome such as knowledge

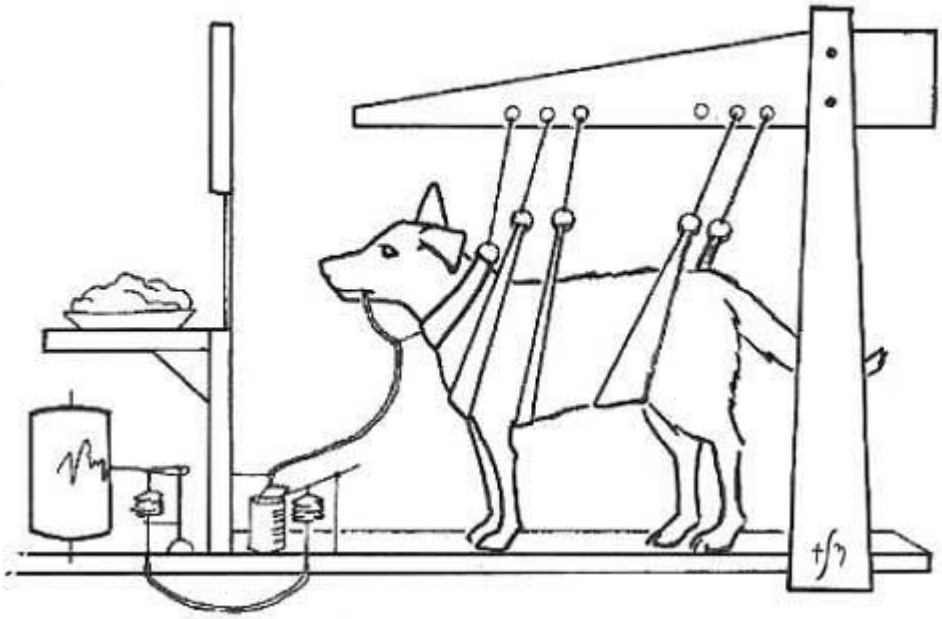
Learning can be dividing in two categories as follows:

1. **Flexible learning**- This is flexible to further changes and experiences. This can be divided into following sub categories-

(a) Classical Conditioning- It is the acquisition of a response to a new stimulus by association with an old stimulus. It involves coupling a stimulus with physiological response or an innate behaviour. Classical conditioning, laboratory based studies focus on physiological responses. The most famous, involved Pavlov and his dogs. Ivan Pavlov was a Russian physiologist who trained dogs to salivate at the sound of a bell ringing. Indeed he went on to win the Nobel prize in 1904 for research in which he measured the saliva production of dogs in response to a variety of stimuli and many workers in this field still refer to this sort of learning as Pavlovian conditioning.

Pavlov had trained his experimental dogs salivating when they heard his technician tinkling a bell as he approached the kennels to feed them. He decided to replace the sound of the bell with more easily varied sounds made by a buzzer and then a metronome to determine how accurately a dog could build such associations. He surgically implanted a tube to collect saliva and measure its rate of production using the apparatus. A second hole in the dog's cheek was used blast meat powder into its mouth.

Pavlov coupled a novel external stimulus to a physiological stimulus and response. The dog learned to respond to a new stimulus, the buzzer, which had previously been irrelevant or neutral. Pavlov called the buzzer a *conditioned stimulus* because its effect was the product of learning.The salivation response to the *conditioned stimulus* is called the *conditioned response*. Before the learning experience, only meat powder, the *unconditioned stimulus*, produced salivation as an *unconditioned response*. Crucially, in classical conditioning, the sound of a buzzer was followed by the delivery of food to the mouth, regardless of what the dog might have done when it heard the buzzer. Classical conditioning enables the animal to associate events over which it has no control. This increases the predictability of an environment. In classical conditioning, behaviours are increased by positive reinforcement and repeated practice.



(b) Habituation

It is really the simplest form of learning. It is said to have occurred when repeated presentations of the stimulus by itself cause a decrease in the response. For example, a wild goose's flight response to humans decreases after it turns up from a remote winter feeding ground to spend the summer on a lake in a popular park. Compared to its behaviour when it first flew in, it soon tolerates people approaching it and eventually almost ignores them. It habituates to the stimuli. Consider a police horse, which is gradually exposed to more and more of the potentially frightening stimuli that he will later encounter when out on patrol. The people delivering these stimuli in training are familiar to him and start their disturbances at a considerable distance from him. Only when he is ignoring the rumpus at a certain noise level and a certain distance will these variables be made more threatening.

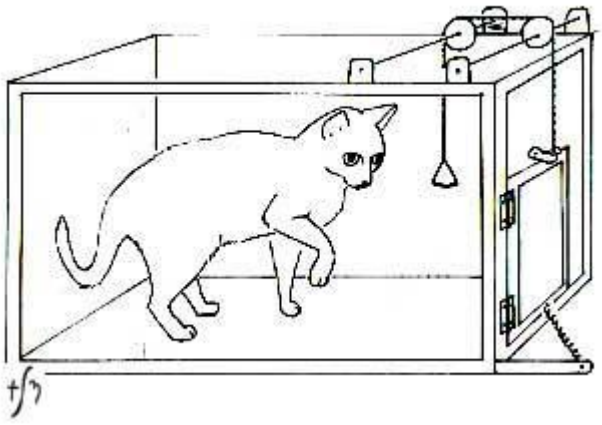
The likelihood of habituation and its rate are dependent on the nature of the stimulus, the rate of stimulus presentation, and the regularity with which it is presented. Habituated responses show spontaneous recovery when stimulation is withheld. This means that exposure to the relevant stimuli must continue at intervals to prevent the original response recurring.

(c)Associative learning-

The process by which an association between two stimuli or a behavior and a stimulus is learned called associative learning. The two forms of associative learning are classical and operant conditioning. To modify the occurrence and form of behavior, Operant conditioning consequencly used. *Operant conditioning* is distinguished from *Pavlovian conditioning* in that operant conditioning uses reinforcement/punishment to alter an action-outcome association. In contrast Pavlovian conditioning involves strengthening of the stimulus-outcome association.

An operant response is a voluntary activity that brings about a reward. In operant conditioning, the buzzer used by Pavlov might still be presented but the dog must make a particular response before food is consumed. In other words, there is a special link between a particular behavioural response and a food reward.

While Pavlov was concentrating on the physiological responses of dogs in harnesses, Thorndike (1911) was studying the behavioural responses of cats in puzzle boxes. Instead of delivering food independently of behaviour whenever a signal had been presented, Thorndike delivered it once his animals had responded. In a body of work intended to discredit the notion that animals are capable of reason, Thorndike described the behaviour of a native cat in a specially designed box.



Of course without any food or other home comforts, life was rather dull and unsustainable in the puzzle box but the cat could get out - but only by pulling a trigger. Motivated to access food outside the box, Thorndike's cats would eventually learn to escape by operating

the trigger that released the door latch. Once out of the box, the cat would get his food. Thorndike called this "trial and error learning". This label has largely been replaced by the terms *instrumental learning* and *operant conditioning*. The animal sees a cue (the trigger), performs a response (pulling) and gets a reward (liberty and food). The effect of the reward is to strengthen the correct response. This is known as *reinforcement***.** The term reinforcement refers to the process in which a *reinforcer* follows a particular behaviour so that the frequency (or probability) of that behaviour increases.

(d) Observational learning

Observational learning is also known as vicarious learning, social learning, or modeling, is a type of learning that happens as a result of observing the behavior of others. Although observational learning can take place at any stage in life, it is thought to be of great importance during childhood, particularly as authority becomes important. The idea that behavior is learned by observing others has influenced debates on the effect of television violence and parental role models. Observational learning appears to occur without the reinforcement of ongoing behavior that is called for in behavioral models of operant or instrumental conditioning. Bandura noted that "social imitation may hasten or short-cut the acquisition of new behaviors without the necessity of reinforcing successive approximations as suggested by Skinner (1953).

The learning process most characteristic of humans is imitation; one's personal repetition of an observed behavior, such as a dance. Humans can copy three types of information simultaneously: the demonstrator's goals, actions, and environmental outcomes (results, see Emulation (observational learning)). Through copying these types of information, (most) infants will tune into their surrounding culture.

- After imprinting there are two major categories of learning, *associative* and *non-associative*. In non-associative learning the animal is exposed to a single stimulus to which it can become habituated or sensitised, while in associative learning a relationship between at least two stimuli becomes established. There are two sub-divisions under the umbrella of associative learning. These are called *classical conditioning* and *operant conditioning*.

2. **Restricted learning**- This is resistant to future changes**.**

In psychobiology, Imprinting is a form of learning in which a very young animal fixes its attention on the first object with which it has visual, auditory, or tactile experience and thereafter follows that object. In nature the object is almost invariably a parent while in experiments, other animals and inanimate objects have been used. It has been intensively studied only in birds, especially chickens, ducks, and geese, but a comparable form of learning apparently occurs in the young of many mammals and some fishes and insects.

According to Konrad Lorenz, imprinting is said to occur when innate behaviours are released in response to a learnt stimulus. Most imprinting promotes survival of newborn animals and shapes their future breeding activities.

Characteristics of imprinting

1. **Critical sensitive period**

During early postnatal life Imprinting occurs at a particular time (termed the sensitive period). For example, in anserine birds such as ducks and geese, the time for imprinting is 24-48 hours after hatching when the 'following response' is learnt. At this time a gosling learns to follow his mother. In fact, of course, the visual stimulus that he imprints on does not necessarily have to be Mother Goose. In these species imprinting can occur on any object within a certain size range regardless of its colour or shape. Movement helps to attract attention but is by no means essential.

Imprinting seems more important in precocial species, in which the offspring are less dependent on their mothers for food and warmth, than in antiracial species which often confine their more vulnerable, and often hairless, young to nests. These apply when the animal's sensory, motor and thermoregulatory systems are fully functional and they learn to move away from their mother and to interact with others of the same and other species. The window of opportunity for learning varies according on the species. In dogs it is from 3-10 weeks and in cats 2-7 weeks, while in primates it is usually 6-12 months. Stimuli that the youngsters of each species are exposed to during these window periods will be accepted as being "normal". We do well to exploit this limited learning opportunity in our companion animals.

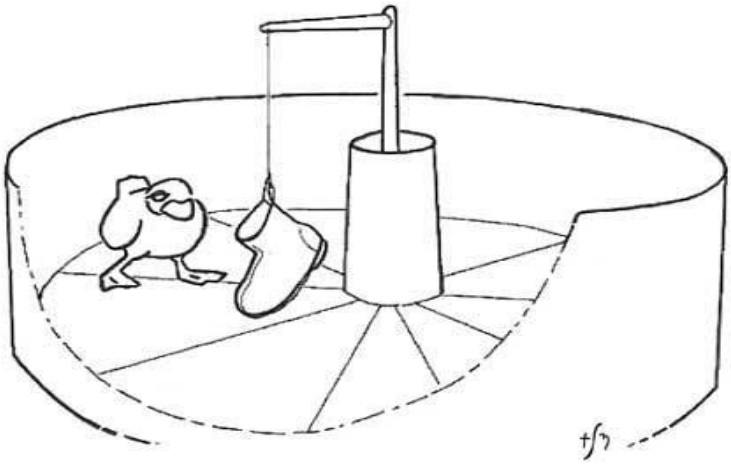
2. Of all forms of learning, imprinting is the least likely to be forgotten or unlearned so, imprinting is irreversible:

3. The imprinted knowledge is retained for life. 3. Imprinting establishes an individual animal's preference for a certain species

4. Not all behaviours but some behaviour are affected by imprinting more than others.

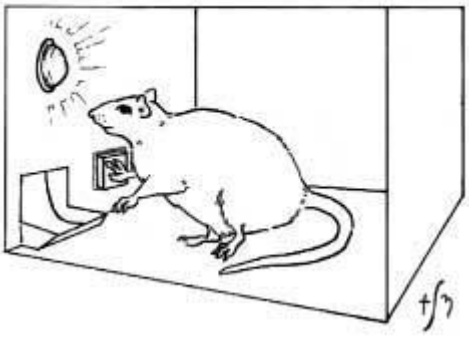
5. Stressful stimuli fortify imprinting

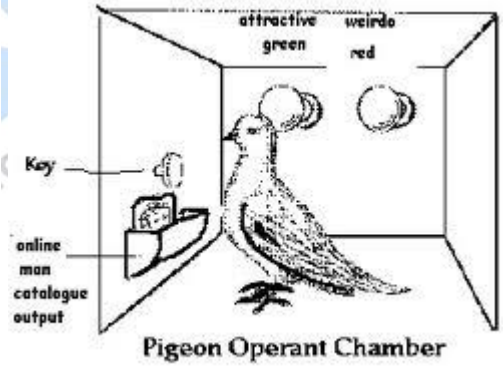
   If there is an increased level of stress at the time of the original imprinting, the learning is more robust that normal. So if, in the laboratory set up illustrated in the figure below, obstacles are placed in the runway between the duckling and the followed object then the following response the duckling subsequently exhibits is more determined and energetic. It may be that this enhances an individual duck family's level of imprinting at times of greatest need, for instance when the threat of predators or the distraction of other broods is a particular problem.



Q.5 Describe Reinforces and punishments.

Ans. B.F. Skinner who created the Skinner box, a device that is basically a problem box in which the subject learns by trial and error that pressing a bar yields a small reward. The bar-pressing behaviour is then reinforced. He argued that, with the selection of appropriate rewards could be used to teach anything.





Pigeon Operant Chamber

B. F. Skinner

Food is not the only reward that can be used. The other obvious one is water that can be given to subjects that have been kept thirsty. This is interesting because close observation of the heads of experimental pigeons in Skinner boxes shows that they adopt different approaches to the key (an operant device that must be pecked) depending on whether they are expecting to receive a food or water reward. If the reward is water then the bird will use the device with closed eyes, an open mouth and a peck of longer duration and less force than the peck for food.

Some argue that reinforcement is necessary for learning to take place. However, rats that receive a shock to their hind-paws while in transit, when being trained to run from A to B down an alleyway will reach A faster than those given only food as an incentive. A reinforcer is anything that increases the frequency of the particular behaviour that it follows. Operant conditioning allows us to use reinforcers and punishers that positively and negatively influence the likelihood of a behaviour being repeated or not. A response will increase in strength when followed by a reward. In his free operant experiments, Skinner measured the strength of a response by recording the response rate, i.e. number of responses per unit of time. Skinner used this outcome to develop the principle of reinforcement.

The merit of reinforcement can only be measured in terms of the degree to which it makes the behaviour more likely in future. If a trainer's saying "good dog" in response to a dog's heel-work has no effect on the dog's future behaviour then, according to this definition, reinforcement has not

occurred. The trainer's words have had a neutral or even confusing effect. The definition does not describe how or why some events act as reinforcers. Whether some event is called a reinforcer is purely a matter of the effect it had. This is why, instead of encouraging owners to give their dogs praise, which can so often be understated and, as a result, ineffective, many of the more enlightened dog schools tell their humans to 'make those tails wag'.

Animals can be trained to do quite remarkable things if they are reinforced at the right time. For example, in one study, Skinner delivered food to eight pigeons every 15 seconds regardless of what they were doing at the time. After a number of rewards, six of them were performing behaviours (such as circling in a single direction) repeatedly throughout the interval between reinforcers. Even though there was no causal relationship between the behaviour and the reinforcer, the birds happened to be doing something at the time of reinforcement. By waiting for an incidental movement of the eyelids, scientists were able to teach pigeons to blink to receive a food reward. Cats that learn to rub their owner's legs just prior to the delivery of food have learned in the same way. The activity generally does little to get the food to them quicker, i.e. is not causal, but because of its contiguity to reinforcement it is slavishly included in pre-prandial rituals. Those of us who repeatedly press the on-button at a pedestrian crossing are probably subject to the same phenomenon. Because we perceive a link between serial button pressing and the appearance of the signal to cross, we think it is the best way of getting the desired outcome quicker. Strangely, this was called superstitious learning for some time. This was surely a misnomer since the pigeon was behaving predictably and rationally rather than misguidedly.

Reinforcers can be either primary or secondary. Primary reinforcers are any resources that animals have evolved to seek. If the animal's motivation is correctly predicted food, water, sex, play, liberty, sanctuary and companionship can all be used as primary reinforcers. *Secondary reinforcers* are stimuli that are not intrinsically rewarding but that have become associated with the kind of primary resources listed above. For example, a fox can learn to make associations between the smell of hens and the meal they represent. If the smell did nothing to help the fox feed then it would hold no value and remain neutral. Instead, it encourages the fox to persist in its foraging activities.

Q.6 Define Concepts of ethology? Write an easy on concepts of ethology with suitable examples.

Ans. Ethologists such as Lorenz, Frisch and Tinbergen carried out specific research on animal behavior from which certain basic concepts have

emerged out, they combidnely known as concept of ethology**.** These concepts are very essential to understand the animal behavior. These concepts are as follows:

A. Appetitive and consummatory behavior-The appttitive behavior applied to characterize in term of an inferred or anticipated consummatory act.

B. Fixed action patterns (FAPs)

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

Many mating dances which are 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. Niko Tinbergen carried out many experiments 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.

Other well known cases 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. 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).

C. Sign stimulus or **releaser**-

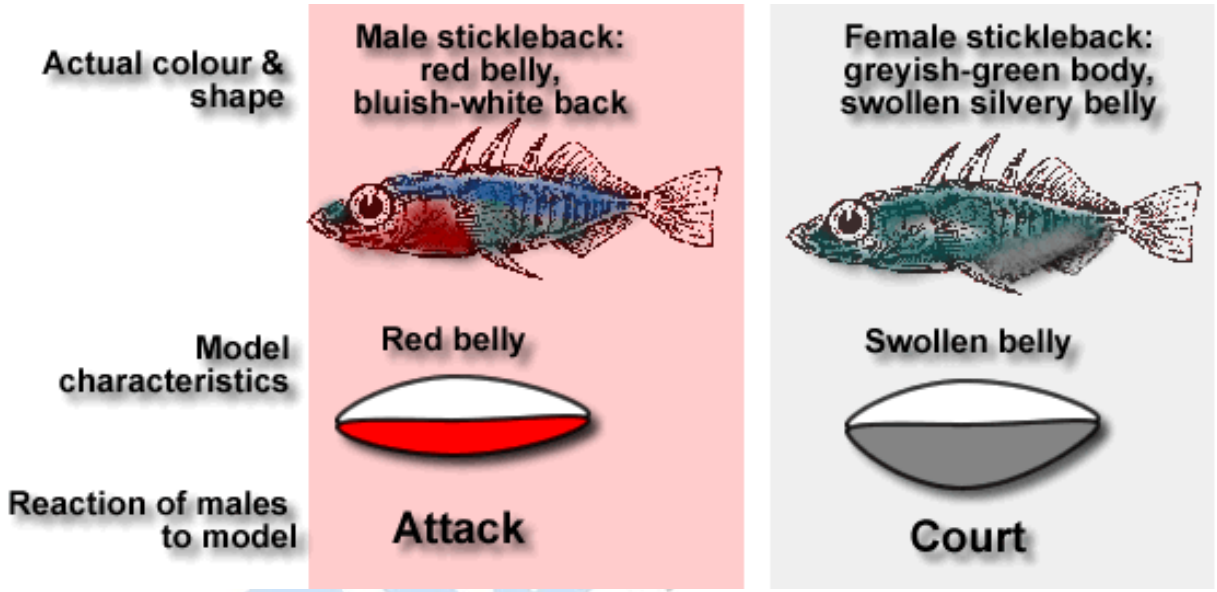
The term sign stimulus or releaser was used to describe simple features (e.g. red belly) of a complex stimulus (e.g. male stickleback) that bring about a particular fixed action pattern (e.g. head down attack behaviour in male sticklebacks).

In spring male sticklebacks change colour, establish a territory and build a nest. They attack male sticklebacks that enter their territory, but court females and entice them to enter the nest to lay eggs.

Tinbergen (1951) used crude models of sticklebacks to investigate which features of male and female sticklebacks elicited attack and courtship behaviour from male sticklebacks.

Following diagram shows Tinbergen's main findings:

- a model with a red belly was attacked
- a model with a swollen belly was courted by male sticklebacks.



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The terms sign stimulus and releaser are sometimes used interchangeably. However

- Strictly speaking the term releaser is used for stimuli that have evolved to facilitate communication between animals of the same species
- Sign stimuli are features of an animal's environment to which it reacts in a particular way. For example, the fly orchid is a plant that looks like an insect which helps it attack pollinators.

Chapter 3

Methods of Studying Animal Behavior

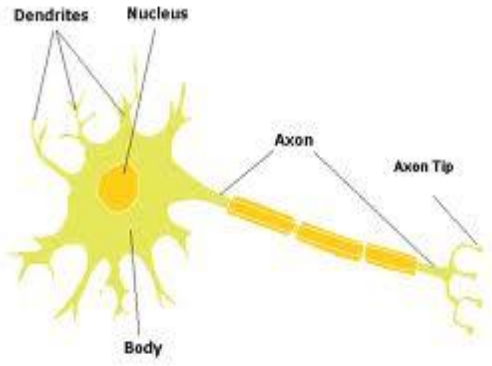
Q.1 Write short notes on-

(A). Neuron

Ans. A nerve cell that is the basic building block of the nervous system called neuron. Neurons are similar to other cells in the human body in a number of ways, but there is one key difference between neurons and other cells. The basic building blocks of the nervous system are neurons. These specialized cells are the information-processing units of the brain responsible for receiving and transmitting information. Each part of the neuron plays a role in the communication of information throughout the body. Follow the links below to learn more about the functions of each part of a neuron. Neurons are specialized to transmit information throughout the body. These highly specialized nerve cells are responsible for communicating information in both chemical and electrical forms. In the human body there are also several different types of neurons responsible for different tasks. Sensory neurons carry information from the sensory receptor cells throughout the body to the brain. Motor neurons transmit information from the brain to the muscles of the body. For communicating information between different neurons in the body interneuron are responsible.

The Structure of a Neuron

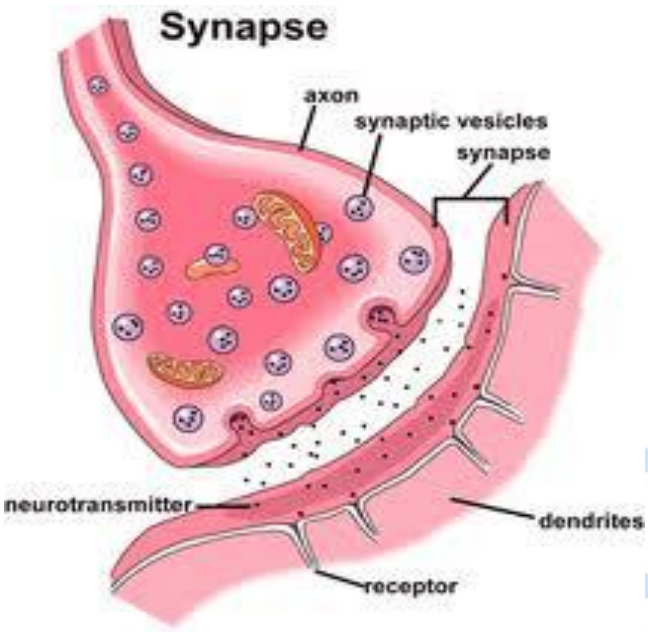
There are three basic parts of a neuron: the dendrites, the cell body and the axon. Depending on the function and role of the neuron all neurons vary somewhat in size, shape, and characteristics. Some neurons have few dendrite branches, while others are highly branched in order to receive a great deal of information. Some have short axons, while others can be quite long. The longest axon in the human body extends from the bottom of the spine to the big toe and averages a length of approximately three feet!



(B). Synapse- A synapse is a structure that permits a neuron to pass an electrical or chemical signal to another cell (neural or otherwise). The word "synapse" comes from "synaptein" from the Greek "syn-" ("together") and "haptein" ("to clasp").

These are essential to neuronal function: neurons are cells that are specialized to pass signals to individual target cells, and synapses are the means by which they do so. There are two fundamentally different types of synapses:

- First is, chemical synapse, a chemical called a neurotransmitter is a chemical releases from the presynaptic neuron binds to receptors located in the postsynaptic cell, usually embedded in the plasma membrane. The neurotransmitter may initiate an electrical response or a secondary messenger pathway that may either excite or inhibit the postsynaptic neuron.
- Second is, electrical synapse, the presynaptic and postsynaptic cell membranes are connected by special channels called gap junctions. These gap junctions are capable of passing electric current, causing voltage changes in the presynaptic cell to induce voltage changes in the postsynaptic cell. The main advantage of an electrical synapse is the rapid transfer of signals from one cell to the next.



Neurochemicals

Neurochemicals are chemicals which involved in the functioning of an organism's nervous system. They have purposes such as regulating thoughts and emotions, transmitting signals from neurons, and promoting the growth and repair of the nervous system's cells. A person's neurochemistry can have profound effects on his or her abilities, health, and behavior. Psychoactive drugs affect the user by altering his neurochemistry, and many health problems and disorders are the result of the sufferer's inability to produce or absorb neurochemicals in proper amounts.

Neurotransmitters are one major type of neurochemicals which cross the synapses between neurons to transmit signals. The most common neurotransmitter in humans is glutamate, which is important in learning and memory. Dopamine is a neurotransmitter which is produced by the brains of many organisms, including humans. Like many neurotransmitters, dopamine has several different functions. It plays a critical role in the function of the central nervous system, and it is also linked with the brain's complex system of motivation and reward. Altered levels of dopamine in the brain can cause a range of symptoms and problems, ranging from Parkinson's disease to Attention Deficit Disorder (ADD).

(D) Stimulation

Stimulation is the action of various agents on nerves, muscles, or a sensory end organ, by which activity is evoked; especially, the nervous impulse produced by various agents on nerves, or a sensory end organ, by which the

part connected with the nerve is thrown into a state of activity. The word is also often used metaphorically. For example, an interesting or fun activity can be described as "stimulating", regardless of its physical effects on nerves. Stimulation in general refers to how organisms perceive incoming stimuli. Simple organisms broadly react in three ways to stimulation: too little stimulation causes them to stagnate, too much to die from stress or inability to adapt, and a medium amount causes them to adapt and grow as they overcome it. Similar categories or effects are noted with psychological stress with people. Thus, stimulation may be described as how external events provoke a response by an individual in the attempt to cope.

Chapter 4
Pheromones

Q. 1 Define Pheromones.

Ans. Pheromones like hormones are secretions that act as chemical signals. While hormones change the behavior of target cells elsewhere in the body, pheromones are odors that 'carry stimulation' (from the Greek *phero* and *horma*) and change the behavior of other creatures of the same species that pick up the scent. In the animal world, Pheromones are widespread from the single-celled amoeba to human beings. A classic example is the pheromone emitted by female gypsy moths, which can be detected by sensory receptors on the antennae of a male moth 1 Km or more away, enabling it to home in on the female. To elicit attacks on or flight from predators, to mark trails and so on ants have a 'lexicon' of different pheromones. Territorial mammals often mark their territory with pheromones in their urine, or rubbed on to 'scenting posts' from glands in their skin.

Q.2 Differentiate-

(a) Pheromones and hormones

Ans. Hormones are secreted internally and trigger various biochemical pathways that cause certain effects. Pheromones are secreted externally and have an effect on another creature in similar ways. Usually they have to do with attracting sexual partners or changing a sex partners behaviour or body in some way.

Pheromones are well known in the animal kingdom....it is less clear what role they may play in human behaviour.

(c) **Allomones**

Ans. These are information-bearing compoundsor mixtures emitted by individuals of one species that affect the behaviour of individuals of adifferent species for the benefit of the emitter, e.g.hydrocarbon secretion by ticks to deter ant predators.Kairomones are information-bearing compoundsor mixtures released by individuals of one species,detected by individuals of another species that benefit the recipient, e.g. host odours that enablea blood feeding ectoparasite to locate, recognize and feed on a suitable host. Often, kairomonal

compoundsare most effective when combined with visualcues, body heat and even sounds made by the vertebrate.

Q.3 Write short notes on-

(a) Different types of Pheromones

Ans Pheromone refers to a type of secretion that triggers reactions to members of the same species. They normally impact the behavior of another individual. There are different types of pheromones. Some of these are alarm, food trail and sex pheromones.

Alarm pheromones are produced by certain insect that will act when attacked. Insects such as ants, termites and bees will produce a certain smell when they are attacked by a predator. Some plants also produce them. This will cause other plants inedible to herbivorous.

There are also aggregation pheromones. These act by overcoming host by mass attack, predators and mate selection. The word aggregation here will mean in large numbers. Most sex pheromones will be produced by females. The males too can produce them, as they are sex attractant. The pea and bean evil are the most common.

In insects, there are epideictic pheromones that are used to mark territories. Insects will lay their eggs on certain fruits to signal to other insects that they should find other places to clutch.

Territorial pheromones are quite similar to the epideictic ones. It is a term that is used to refer to pheromones produced to mark boundaries by animals like dogs and cats. These animals may use urine as a pheromone sign.

Another type of pheromones is the releaser pheromones. These are the most commonly produced. They are secreted in order to influence the behavior of the same species. Some insects will produce molecules in order to attract males that may be at a distance. This distance may vary from one to two miles, and the smell does not usually last for long.

Primer pheromones are quite different from other pheromones that trigger the behavior of a species. They trigger change in developmental undertakings.

Other common pheromones are sex pheromones that are used to indicate the readiness for mating. They are produced in order to attract the opposite sex.

(b) Sex attractant

Ans. A **sex-attractant pheromone** would be disadvantageous if it also attracted individuals of other species. Specificity is dependent to some extent on the degree to which a particular molecular structure can be modified.

Many insects produce a **sex-attractant pheromone**, by which one sex attracts the other from a distance. Among moths, it is common for the female to produce a **sex-attractant pheromone**. For example, female gypsy moths, which are flightless despite having fully developed wings, and female bagworms, which do not have wings, depend wholly on the power of their sexual odour to attract a mate. Hundreds of pheromones are known with which one sex (usually the female) of an insect species attracts its mates. Many of these sex attractants — or their close chemical relatives — are available commercially. They have proved useful weapons against insect pests in two ways:

- **Male Confusion**

Distributing a sex attractant throughout an area masks the insect's own attractant and thus may prevent the sexes getting together. This "communication disruption" has been used successfully against a wide variety of important pests. For example, the sex attractant of the cotton boll weevil has reduced the need for conventional chemical insecticides by more than half in some cotton-growing areas.

- **Insect Monitoring** Insect sex attractants are also valuable in monitoring pest populations. By baiting traps with the appropriate pheromone, a build-up of the pest population can be spotted early. Even if a conventional insecticide is the weapon chosen, its early use reduces
  - the amount needed
  - damage to the crop
  - cost to the grower
  - possible damage to the environment.

Early detection of pest build-up is a key ingredient in the system known as integrated pest management (IPM)

(c) Trail Pheromone

Ans. Trail pheromones are often incorporated with secretions of more than one exocrine gland to produce a higher degree of specificity. These often serve as a multi purpose chemical secretion in which, it leads members of its own species towards a food source, while representing a territorial mark in the form of an allomone to organisms outside of their species. Considered one

of the primary chemical signaling methods in which many social insects depend on, trail pheromone deposition can be considered one of the main facets to explain the success of social insect communication today. Certain ants, as they return to the nest with food, lay down a trail pheromone. This trail attracts and guides other ants to the food. It is continually renewed as long as the food holds out. When the supply begins to dwindle, trail making ceases. The trail pheromone evaporates quickly so other ants stop coming to the site and are not confused by old trails when food is found elsewhere. And at least in one species of ant, trails that no longer lead to food are also marked with a repellant pheromone.

A stick treated with the trail pheromone of an ant (left) can be used to make an artificial trail which is followed closely by other ants emerging from their nest (right). The trail will not be maintained by other ants unless food is placed at its end.

(c) Lee–Boot effect

Ans. It is a phenomenon concerning the suppression or prolongation of oestrous cycles of mature mice and other rodents when females are housed in groups and isolated from males. It is caused by the effects of an oestrogen-dependent pheromone, released via the urine, that acts on the vomeronasal organ of recipients. This pheromone lowers the concentration of luteinizing hormone and elevates prolactin levels, synchronising or stopping the recipient's cycle. This effect goes some way to explain why spontaneous pseudopregnancy can occur in mice. The same response is invoked from isolated females when brought into contact with urine-soaked bedding from other females' cages. Removing the vomeronasal organ of recipients causes an ineffective response – indicating that the cues are purely chemosensory in nature.

(d) Whitten effect

Ans. The Whitten effect occurs when male pheromones stimulate synchronous estrus in a female population.

Social signals or social stimuli, have an effect on reproduction in all mammals. For certain female mice, the pheromones contained in the urine of male mice can act as a social stimulus, and induce synchronous estrus.

Estrus is a stage of the female reproductive cycle, and if a female is in estrus, it means that she is both fertile and sexually receptive. Synchronous estrus occurs when multiple females are in estrus at the same time.

When the pheromones contained in the urine of male mice stimulate synchronous estrus in a population of female mice, it is known as the Whitten effect. This is a phenomenon observed by Wesley K. Whitten (1956, 1966, 1968), whereby male mouse pheromone-laden urine synchronizes the estrus cycle "among unisexually grouped females," and is an example of male-to-female pheromonal effects in mice, similar to the Bruce effect.

When a group of female mice are exposed to the urine produced by a male mouse the Whitten effect occurs. The hormonal processes of the females that control their reproductive status affect by the male's urine contains certain volatile, airborne, pheromones. A sexually mature and viable male must produce the urine, as the pheromones that produce the Whitten effect are dependent on male sex hormones such as testosterone.

(e) Bruce effect

Ans. The Bruce effect (pregnancy block) refers to the tendency for female rodents to terminate their pregnancies following exposure to the scent of an unfamiliar male. This Effect was first noted in 1959 by Hilda M. Bruce. The effect has primarily been studied in laboratory mice (*Mus musculus*) but is also observed in deer-mice, meadow voles, and collared lemmings. In mice, pregnancy can only be terminated prior to embryo implantation, but other species will interrupt even a late-term pregnancy. This Effect has also been observed in geladas and it has also been proposed but not confirmed in other non-rodent species such as the lion.

(f) Vandenbergh effect

Ans. This effect is caused by pheromones and found in a male's urine. The male does not have to be present for this effect to take place, the urine alone is sufficient. These pheromones are detected by the vomeronasal organ which is present in the septum of the female's nose. This occurs because the female body will only take the step to begin puberty. She will not waste energy on puberty if there is no possibility of finding a mate.

Q.4 Give a detailed account on honey bee pheromones.

Ans. Honey bees (*Apis mellifera)* have one of the most complex pheromonal communication systems found in nature, possessing 15 known glands that produce an array of compounds. These chemical messengers secreted by a queen, drone, worker bee or laying worker bee to elicit a response in other bees. The chemical messages are received by the bee's antenna and other body parts. They are produced as a volatile or non-volatile liquid and transmitted by direct contact as a liquid or vapor. Pheromones may either be single chemicals or a complex mixture of numerous chemicals in different percentages

Types of Honeybee Pheromones

1. Alarm pheromone

In honeybee workers two main alarm pheromones have been identified. One is released by the Koschevnikov gland, near the sting shaft and consists of more than 40 chemical compounds, including isopentyl acetate (IPA), butyl acetate, 1-hexanol, *n*-butanol, 1-octanol, hexyl acetate, octyl acetate, n-pentyl acetate and 2-nonanol. These chemical compounds have low molecular weights are highly volatile and appear to be the least specific of all pheromones. When a bee stings another animal and attract other bees to the location and causes the other bees to behave defensively i.e. sting or charge alarm pheromones are released. It has been suggested that when a bee stings another animal smells like bananas the alarm pheromone emitted. Smoke can mask the bees' alarm pheromone. The other alarm pheromone is released by the mandibular glands and consists of 2-heptanone, which is also a highly volatile substance. This compound has a repellent effect and it was proposed that it is used to deter potential enemies and robber bees. Interestingly, the amounts of 2-heptanone increase with the age of bees and becomes higher in the case of foragers. It was therefore suggested that 2-heptanone is used by foragers to scent-mark recently visited and depleted foragers, which indeed are avoided by foraging bees.

2. Brood recognition pheromone

Another pheromone is responsible for preventing worker bees from bearing offspring in a colony that still has developing young. Both larvae and pupae emit a "brood recognition" pheromone. This inhibits ovarian development in worker bees and helps nurse bees distinguish worker larvae from drone larvae and pupae. This pheromone is a ten-component blend of fatty-acid esters, which also modulates adult caste ratios and foraging ontogeny dependent on its concentration. The components of brood pheromone have

been shown to vary with the age of the developing bee. An artificial brood pheromone was invented by Yves Le Conte, Leam Sreng, Jérome Trouiller, and Serge Henri Poitou and patented in 1996.

3. Drone pheromone

Drones produce a pheromone that attracts other flying drones to promote drone aggregations at sites suitable for mating with virgin queens.

4. Dufour's gland pheromone

The Dufour's gland opens into the dorsal vaginal wall. This gland and its secretion have been somewhat of a mystery. The gland secretes its alkaline products in to the vaginal cavity and it has been assumed to be deposited on the eggs as they are laid. Indeed, Dufour's secretions allow worker bees to distinguish between eggs laid by the queen, which are attractive, and those laid by workers. In the latter, the workers' Dufour secretions are similar to those of a healthy queen.

5. Egg marking pheromone

This pheromone helps nurse bees distinguish between eggs laid by the queen bee and eggs laid by a laying worker.

6. Footprint pheromone

This pheromone is left by bees when they walk and is useful in enhancing. In the queen, it is an oily secretion of the queen's tarsal glands that is deposited on the comb as she walks across it. This inhibits queen cell construction and its production diminishes as the queen ages.

7. **Nasonov pheromone**

This pheromone is emitted by the worker bees and used for orientation.

- **Other pheromones**

Other pheromones produced by most honeybees include tarsal pheromone, rectal gland pheromone, comb pheromone, wax gland and tergite gland pheromone.

Types of Queen Honeybee Pheromones

Queen mandibular pheromone (QMP)

In the bee hive QMP, emitted by the queen, is one of the most important sets of pheromones. It affects swarming, mating behaviour, social behaviour, maintenance of the hive, and inhibition of ovary development in bees. The effects can be short and/or long term. Carboxylic acids and aromatic

compounds are some of the chemicals found in QMP. The following compounds have been shown to be important in retinue attraction of workers to their queen.

- (E)-9-oxodec-2-enoic acid (9-ODA) – It inhibits queen rearing as well as ovarian development in worker bees; strong sexual attractant for drones when on a nuptial flight; critical to worker recognition of the presence of a queen in the hive.
- (R,E)-(-)-9-hydroxy-2-enoic acid (9-HDA)promotes stability of a swarm, or a "calming" influence.
- (S,E)-(+)-9-HDA
- Methyl-p-hydroxybenzoate (HOB)
- 4-hydroxy-3-methoxy phenylethanol (HVA)

Queen retinue pheromone (QRP)

In the mandibular glands the following compounds have also been identified of which only coniferyl alcohol is found. The combination of the 5 QMP compounds and the 4 compounds below is called the Queen Retinue Pheromone (QRP). These nine compounds are important for the retinue attraction of worker bees around their queen.

- methyl (Z)-octadec-9-enoate (methyl oleate)
- (E)-3-(4-hydroxy-3-methoxyphenyl)-prop-2-en-1-ol (coniferyl alcohol)
- hexadecan-1-ol
- (Z9,Z12,Z15)-octadeca-9,12,15-trienoic acid (linolenic acid)

Chapter 5

Societies and Social organization

Q. 1 What is sociobiology?

Ans. Sociobiology is a field of scientific study which is based on the assumption that social behavior has resulted from evolution and attempts to explain and examine social behavior within that context. Often considered a branch of biology and sociology, it also draws from ethology, anthropology, evolution, zoology, archaeology, population genetics, and other disciplines. Within the study of human societies, sociobiology is very closely allied to the fields of Darwinian anthropology, human behavioral ecology and evolutionary psychology.

Sociobiology investigates social behaviors, such as mating patterns, territorial fights, pack hunting, and the hive society of social insects. It argues that just as selection pressure led to animals evolving useful ways of interacting with the natural environment, it led to the genetic evolution of advantageous social behavior.

Q.2 What do you mean by dominance hierarchy?

Ans. Dominance hierarchy is a form of animal social structure in which a linear or nearly linear ranking exists, with each animal dominant over those below it and submissive to those above it in the hierarchy. Dominance hierarchies are best known in social mammals such as baboons and wolves and in birds notably chickens.

Dominance hierarchy is relatively stable from day to day. Direct conflict is rare; an animal usually steps aside when confronted by one of higher rank. Temporary shifts occur, for instance, a female baboon mated to a high-ranking male assumes a high rank for the duration of the pair bond.

Q. 3 Write short notes on-

(A) Altruism

Ans. Altruism involves the unselfish concern for other people. It involves doing things simply out of a desire to help, not because we feel obligated to out of duty, loyalty or religious reasons.

From the guy at the grocery store who kindly holds the door open as you rush in from the parking lot to the woman who gives twenty dollars to a homeless man everyday life is filled with small acts of altruism. One aspect of altruism is what social psychologists refer to as prosocial behavior.

Prosocial behavior refers to any action that benefits other people, no matter what the motive or how the giver benefits from the action. Altruism involves true selflessness. While all altruisms acts are prosocial not all prosocial behaviors are altruistic. For example, we might help others for a variety of reasons such as guilt, obligation, and duty or even for rewards.
Psychologists have suggested a number of different explanations for why altruism exists, including biological reasons like Kin selection - We may be more altruistic towards those we are related to because it increases the odds that our blood relations will survives and transmit their genes to future generations.

(B) Kin selection

Kin selection is an evolutionary theory. It proposes that people are more likely to help those who are blood relatives because it will increase the odds of gene transmission to future generations. The theory suggests that altruism towards close relatives occurs in order to ensure the continuation of shared genes. The more closely the individuals are related, the more likely people are to help. The basic idea of kin selection is simple. Imagine a gene which causes its bearer to behave altruistically towards other organisms e.g. by sharing food with them. Organisms without the gene are selfish — they keep all their food for themselves and sometimes get handouts from the altruists.

(C) Agonistic behavior

Agonistic behavior results in a contest which involves both threatening and submissive behavior between contestants who are competing for access to the same resource such as food or a mate. Sometimes it involves tests of strength or the contestants engage in threatening displays that make them look large or fierce, often with exaggerated posturing and vocalizations such as a dog bearing teeth, growling or when defeated, tucking in their tail and looking away.
The behavior sometimes involves a ritual use of symbolic activity with no harm done to either participant. The degree of the ritual depends on the scarcity of the resource competed for.

(**D) Territoriality-**

It is only shown by a minority of species. An individual or a group of animals will have an area that it habitually uses but does not necessarily defend this is called its home range. The home ranges of different groups often overlap and in the overlap areas the groups will tend to avoid each other rather than seeking to expel each other. Within the home range there may be a *core area* that no other individual group uses but again this is as a

result of avoidance rather than defense. The term territory refers to any sociographical area that an animal of a particular species consistently defends against conspecifics. Animals that defend territories in this way are referred to as territorial.

(E) Agonistic behaviour

Agonistic behaviour is any social behaviour related to fighting. Thus it is broader than aggressive behaviour because it includes not only actual aggression but also displays, threats, retreats, placating aggressors and conciliation. This term was coined by Scott and Fredericson in 1951. Agonistic behaviour is seen in many animal species because resources including food, shelter and mates are often limited.

Some forms of agonistic behavior are between contestants who are competing for access to the same resources such as food or mates. Other times it involves tests of strength or threat display that make animals look large and more physically fit. A display that may allow it to gain the resource before an actual battle takes place. Agonistic behaviour varies among species; agonistic interaction consists of three kinds of behaviours: aggression, threat and submission. These three behaviours are functionally and physiologically interrelated with aggressive behaviour yet fall outside the narrow definition of aggressive behaviour. While any one of these divisions of behaviours may be seen alone in an interaction between two animals, they normally occur in sequence from start to end. Depending on the availability and importance of a resource, behaviours can range from a fight to the death or a much safer ritualistic behaviour, though ritualistic or display behaviours are the most common form of agonistic behaviours.

Q.4 Write an easy on social structure of monkeys.

Ans. Social structure of monkeys is very interesting to observe. They are very intelligent animals and need socialization for them to be able to thrive in their natural environment. Based on the species of monkey the overall structure can vary. There social feelings can also change based on stress from their environment just like it can for humans. They enjoy having fun too and bring amazing games and spontaneous events to their lives.

For the monkey, vocalization is the most common method of socialization. They have a variety of sounds that they use. This can be low chatter, clicking, and even high pitch yelling that can be heard for long distances. To take care of their young and to warn other groups of monkeys to stay away these sounds allow them to be able to create strong bonds. They will warn each other of potential risks and predators when they can too.

They also use non verbal communication to show emotion. Snuggling a baby is a way for the mom to protect it. At the same time it helps the young to feel loved and cared for. Adults may sit close to each other and even touch each other's faces as a means of socialization. They can use facial expressions too in order to show love, fear, anger, or sadness to each other.

There are confrontations that can occur in the social groups. They are mainly going to involve males but not always. The males get aggressive over mating issues and that is why they are the ones usually involved. However, many of the Monkey species have a female in control. She may fight with other females as well. In the end she will get to decide who stays and who has to go.

The moods of the members of a group of monkeys can vary. If monkeys are stressed due to lack of food or shelter then they can be on edge. It will be harder for them to keep conflicts from occurring. When there is plenty of food though and they don't feel threatened they are more likely to live in harmony with each other.

Grooming is a part of the social behavior for the Monkeys too. They take bugs and debris out of the fur of each other. They do this process for hours and hours in a very loving and careful manner. They will be offering social elements to the relationship as they do so through the power of touch.

The hierarchy of the social structure is very detailed. It doesn't matter if there are only a few members or hundreds of them. There can be many smaller groups within a larger one too. They all have their role within that group. In many instances the young will maintain the same social status as their mother. They may decide to leave the group and create their own if they aren't content with that status.

Males often challenge the leaders of a group of monkeys too so that they can be the one that leads it. This will give them better opportunities for breeding and for eating. They will also have shelter and protection. This is why there is often a great deal of turnover in the leadership roles of many monkeys.

Most experts are in awe over the social attributes of Monkey groups. The primates are very in tune to each other and what is going on around them. They often help each other with finding food, caring for the young, and staying protected. It is very interesting to witness their interactions with each other.

Vocal communication forms an important part of their social behavior. They each have an enlarged basihyal or hyoid bone which helps them make their loud vocalizations. Group males generally call at dawn and dusk, as well as interspersed times throughout the day. The main vocals consist of loud, deep guttural growls or "howls". Howler monkeys are widely considered to be the loudest land animal. According to Guinness Book of World Records, their vocalizations can be heard clearly for 20 mi (32 km). The function of

howling is thought to relate to intergroup spacing and territory protection, as well as possibly to mate-guarding.

Q.5 Describe honey bee society.

Ans. Honeybees belong to the order Hymenoptera, which includes other wasps, bees and ants. Most Hymenoptera have two pairs of clear wings. All have chewing mouthparts. Some, including the honeybee, can suck up liquids. These insects undergo complete metamorphosis so they change in form, during their development. The four life stages are: egg, larva, pupa, and adult.

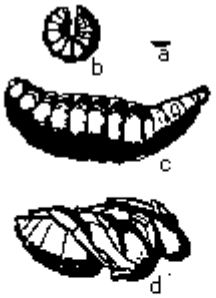


Fig. 1 The honeybee:
a) egg
b) young larva
c) old larva
d) pupa
Three times natural size.

Bees are perfectly equipped to collect nectar and pollen. They are covered with finely branched hairs that trap pollen as they visit flowers. While visiting flowers, the bees gather pollen from their hairs and store them in pollen baskets on their hind legs. A tongue-like portion of the mouthpart sucks up nectar.

Although man has managed bees for hundreds of years and carried them around the world, honeybees have not been "tamed." Bees in the most modern apiary follow the same instincts as wild bees that live in hollow trees. Successful beekeepers anticipate and work with or around the bees.
Honeybees are social insects. They live together in highly organized colonies. Each member has a specific job to do. A single honeybee cannot grow or survive by itself. The three distinct kinds of honeybees in a colony are queen, worker, and drone.

The Queen
The queen is the longest bee in the hive but has the shortest wings. She is the mother of all the other bees. Her most important job is to lay eggs. Her productivity depends on the amount of food, the workers bring in and the amount of brood space in the colony. She can lay more than 1,500 eggs a day. A good queen does not waste any space. She lays a solid pattern of brood, meaning one egg in every cell. Few eggs scattered among many empty cells or several eggs per cell are signs of problems. The queen might be missing or old or parasites or disease might have weakened the colony. It can take some detective work to solve the problem. Your county extension agent can determine what samples to take from the hive to diagnose the problem.
Worker bees usually rear new queens for one of three reasons:
1) The former queen left with a swarm
2) The queen is laying increasingly fewer eggs
3) The colony is overcrowded and has no place to expand. A colony that loses its queen suddenly is very upset but soon starts to rear a new one. Worker eggs or larvae less than three days old are raised in quickly built queen cells which hang vertically and are about the size and shape of a peanut shell. A fertilized egg hatches in about three days. The larva eats a special food called royal jelly. After growing rapidly for about six days, the larva pupates in the cell. The queen emerges about eight days later.
A newly emerged queen stings the remaining queen cells in the colony and fights any other queens she finds. The former queen is killed if she is still in the hive. Usually she has already left with other bees in the colony. Six to eight days after emergence, the queen takes nuptial flights and mates high in the air with the male (drone). Then she settles down and lays eggs. She will leave the hive only with a swarm. (Swarming is the natural way by which colonies are established at new locations.)
Queens live about five years with some living as long as nine, but egg-laying drops off significantly after two years. Many beekeepers keep a queen longer than that; others replace the queen every year to keep the colony strong. Colonies with older queens are more likely to swarm.

Swarming usually occurs just before the main nectar flow. Hives that swarm have drastically reduced honey production.

The Worker

Workers are smaller than the queen and drones but there are lots of them. There might be only a few hundred during winter and early spring but there are usually many thousands during summer when pollen and nectar are plentiful. A strong colony at full strength can have close to 1,00,000 workers. These bees keep the colony going. Life begins as a fertilized egg. Laid singly in cells, each egg is attached to the bottom of the cell and stands upright. Eggs hatch in about three days. Each larva is fed royal jelly for three days then pollen and honey for three more. Pollen and honey are not as rich as royal jelly, so the larva becomes a worker instead of a queen. The white grub-like larva molts (sheds its outer covering) five times during the six days. Just before maturity, house bees cap the cell. The larva then spins a cocoon and becomes a pupa. The adult emerges 12 days later. It takes about three weeks to mature from the egg to an adult bee ready to go to work.

Workers' jobs change with their ages. Young bees, called house bees, do the hive chores. They produce wax and shape it into combs (structures of cells containing honey and brood) and use propolis (a gummy substance gathered from plants) to seal cracks or cover rough edges in the hive. House bees also fan their wings to ventilate the hive in summer, controlling temperature and humidity, and they provide heat in winter. Some guard the hive to keep out raiders. Many produce honey and royal jelly. A lot of time is spent feeding brood and cleaning and repairing cells. House bees also feed the queen, the drones, and each other.

Older workers, or field bees, gather nectar, pollen, and water.

The average adult worker lives less than a month during the busy season; overwintering bees live several months.

The Drone

Drones are larger than workers but not as long as queens. A drone has large eyes that touch each other at the top of the head. Drones do not have stingers, pollen baskets on their legs, or glands for producing wax, and their mouthparts are too short to gather nectar. Moreover, they do not even do jobs they could like ventilating the hive. Their only function is to fertilize the queen, and they die in the process. Drones are banished from the hive before winter begins.

While queens and workers develop from fertilized eggs, drones develop from unfertilized eggs. Drone cells are slightly larger than worker cells. This stimulates the queen to lay only unfertilized eggs in them. Drone eggs are also laid in worker cells that have become enlarged because of stretched or

sagging combs. Small drones develop in worker cells if a queen gets old and loses her ability to fertilize eggs. Total time from egg to adult is 24 days.

mThe Colony

In many respects a honeybee colony is like a single animal. Individual bees and castes are like the cells and tissues. When one part is threatened, the whole colony reacts. If an essential segment of a colony becomes diseased or destroyed, the colony often can heal itself. It may divide and become two or more separate colonies.

The colony also changes to survive different seasons. Let's follow the life of a colony through a year.

In mid to late summer, only small amounts of nectar and pollen are brought into the colony. Often no brood is being reared, so the colony does not grow. A fall nectar flow usually allows a small crop of young bees to carry through the winter. The colony needs honey for energy and pollen for protein, minerals, and vitamins to survive the winter and raise brood in early spring. Survival depends on a large cluster of young bees and a good food supply. If the cluster is too small, it cannot generate enough heat to survive the winter. Bees die if their body temperature gets much below 57°F. The colony must be able to make and save heat to survive in winter.

Bees produce heat by digesting honey. They save the heat by bunching together in a tight cluster. The outer layer of bees is an insulating shell that traps the heat in the center of the cluster. The bees on the outer layers periodically change places with inside bees so that none of them become too cold. The cluster tightens or loosens depending on the temperature in the hive.

Below 57°F, bees do not work in the hive. They do not even move to get honey that is not next to the cluster. If it stays cold for too many days straight, bees can starve even if honey is just a few inches away. The colony soon runs out of heat and freezes. Even if honey is within reach, they can freeze if there are not enough bees to produce some heat and save it.

A large colony with plenty of food can keep the temperature at the center of the cluster around 90°F. This is warm enough to rear brood. They start doing this in late winter. As spring arrives, increasingly more brood is raised. As pollen and nectar are brought in, empty cells in the hive soon fill with brood and food.

Bees do not like to be crowded. If there is not enough room to add comb, some leave in a swarm. Colonies with plenty of space are less likely to swarm and will continue to grow. Beekeepers can keep healthy, productive bees by managing food and space wisely during the year.

Fig. 2 Three kinds of bees in a hive:
a) worker;
b) queen; and
c) drone.

Key Terms

- **Altruism -** The actions of one individual towards another in which the altruist reduces its own apparent fitness while increasing that of the recipient.

- **Associative Learning**-The association of events such as stimuli and responses with positive or negative consequences which leads to a change in behavior. Involves behavioral and its underlying neural plasticity. *Associative learning* is distinguished from non-associative learning such as change in behavior as a result of habituation or sensitization.

- **Behavior**-All coordinated actions and responses of an individual

- **Bruce effect**-A possible form of Postcopulatory competition .In some taxa, a strange male (or his odor) can cause a female to abort (previous male's fetus) and make the female receptive. (e.g., Bruce 1966 in mice; Hrdy 1977 with langur monkeys; Packer 1986 with lions)

- **Classical Conditioning**-A type of associative learning in which a stimulus comes to affect a pre-existing stimulus-response relationship as a result of frequent exposure to it; an organism comes to associate a new (often arbitrary) stimulus (such as a bell) with a well-learned, reflexive, or automatic response (such as salivating when food is presented); e.g., a person who has had painful experiences at the dentist's office may become fearful at just the sight of the dentist's office building. Also called *Pavlovian conditioning* -- compare with Operant Conditioning.

- **Communication**-"an action on the part of one organism (or cell) that alters the probability pattern of behavior in another organism (or cell) in a fashion adaptive to either one or both of the participants" (Wilson 1975); "the transmission of a **signal** from one animal to another such that the sender benefits, on average, from the response of the recipient" (Slater 1983).

- **Fixed Action Pattern (FAP)**-Coordinated responses (often motor patterns) that have a fixed form and need not be learned. Within a species, different individuals will produce almost identical behavioral responses to a specific

sign stimulus; once initiated FAPs continue until completed (=*Erbkoordination*).

- **Motivation**-Processes that account for the direction, intensity, and persistence of effort expended to meet needs or attain a goal. Along with affect and cognition constitute a useful "triad" of psychological functions. Associated with the hypothalamus in the brains of vertebrates. [see "drive" and "instinct" ... "The Standard Edition of Freud's works in English confuses two terms that are different in German, Instinkt ("instinct") and Trieb ("drive"), often translating both as instinct. 'This incorrect equating of instinct and Trieb has created serious misunderstandings'.

- **Neurotransmitter**-Compound that is released at a synapse and diffuses across the synaptic cleft to act on a receptor located on the membrane of a postsynaptic cell, which may be another neurone, a muscle cell or a specialized gland cell. It is released from nerve endings by nerve impulse activity at morphologically distinguishable synaptic junctions producing suitable changes in the excitability of the postsynaptic membrane, also see Neuromodulator, Neurohormone

- **Non-associative Learning**-A change in behavior as a result of exposure to stimuli that are not associated with positive or negative consequences -- examples are habituation and sensitization.

- **Releasing mechanism (RM)**-A functionally organized, neural circuit that recognizes a specific sign stimulus and produces the appropriate response. previously the RM was called the "Innate releasing mechanism".

- **Releaser-** A sign stimulus emanating from a conspecific Examples: (a) Red spot on gull's bill (b) Lizard dewlap display.

- **Supernormal stimulus (in animal behavior)-** A stimulus that produces a more vigorous response than the normal stimulus eliciting that particular response. For example, a female herring gull will brood a giant egg in preference to its own eggs, which are smaller. A supernormal stimulus is an exaggerated sign stimulus.
  A stimulus that is more intense than a normal stimulus and is capable of inducing a response in a nerve fibre during the relative refractory period.

- **Stimulus**-Any form of energy that can be detected by the body, requires Sensory Transduction

- **Sign stimulus.** Any stimulus that activates an innate releasing mechanism (IRM) responsible for evoking a fixed action pattern (FAP) or species-typical behavioral pattern.

- **Sociobiology**-"The systematic study of the biological basis of social behavior." (EO Wilson 1975). Sociobiology emphasizes an ecological and evolutionary perspective, including population biology. The emphasis on genetic influences on behavior invited vigorous controversy about determinism.

- **Signal**-Physical coding of a message for transmission through environment. Signals can be discrete or graded (digital (easily distinguished units) or analog (an apparent continuum). They can also be combined to create a new meaning (composite signals are "combinations" of units) or have their meaning altered by varying syntax (changing the order of presentation of units)

- **Sleep**-A state of inactivity during which animals are not responsive to external stimuli.

- **Skinner box**-An animal placed inside the box is rewarded with a small bit of food each time it makes the desired response, such as pressing a lever or pecking a key. A device outside the box records the animal's responses, see Operant conditioning

- **Social dominance**-An individual's exercise of **priority of access** to a resource

- **Social hierarchy**-A form of social organization which manifests the relative social rank of individuals. They can be linear "peck-order" or arborizing (branching as when one individual influences multiple individuals of lower rank)
- **Territory**-Any defended area; an area of more or less fixed boundaries from which rival conspecifics are excluded.
- **Trait**-A manifest morphological or behavioral attribute of an organism; most traits are **polygenic**; traits that are demonstrably adaptive are often termed adaptations.

- **Trial-and-error learning**-Behavioral plasticity

Multiple Choice Questions

1. Questions concerned with proximate causation of a behavior would focus on -
a. Its evolutionary origin using comparative methodology
b. Its genetic origin using recombinant DNA techniques
c. Its immediate cause and effect using experimentation
d. Its ancestry using a clado gram
e. None of the choices are correct (c)

2. Ethologists
a. Attempt to study the behavior of an animal in its natural habitat
b. Have demonstrated that behavioral traits can be isolated and measured
c. Have demonstrated that behavioral traits have evolutionary histories
d. Attempt to study the behavior of an animal in a laboratory environment where all variables can be controlled
e. All of the choices are correct (a)

3. The effort to experiment with animals to determine general laws of behavior that might also apply to humans is
a. Sociology
b. Behavioral ecology
c. Comparative psychology
d. Sociobiology
e. Ethology (c)

4. Sociobiology, the ethological study of social behavior, was originated by
a. Konrad Lorenz
b. Edward O. Wilson
c. Niko Tinbergen
d. Charles Darwin
e. Karl von Frisch (b)

5. A stimulus that triggers a fixed action pattern is called
   a. A goal or accomplishment
   b. A releaser or sign stimulus
   C. Imprinting
   d. A drive or instinct
   e. A reflex arc (c)

6. Tinbergen's male stickleback fish would attack models of other males if the models had
   a. A wide gaping mouth
   b. A red underside
   c. A fat pregnant profile
   d. Three spines
   e. The exact full shape of a normal stickleback fish (b)

7. If a behavior is most closely associated with an organism's genetic makeup, identical to behavior in other members of the species, the behavior is referred to as
   a. Innate
   b. Conditioned
   c. Trial-and-error
   d. Learned
   e. None of the choices are correct (a)

8. At first puppies crouch in fear when a leaf flutters overhead. Later they learn to disregard it. This mode of learning is termed
   a. Imprinting
   b. Habituation
   c. Operant conditioning
   d. Classical conditioning
   e. Reasoning or insight learning (b)

9. Experiments with *Aplysia* revealed that
a. Sensitization was innate but habituation was genetically determined
b. Sensitization was innate but habituation was learned
C. Repeated stimulation reduced the amount of the neurotransmitter being released and induced the habituation
d. Repeated stimulation exhausted the neurotransmitter being released and caused the sensitization
e. Shocking the interneurons caused habituation (c)

10. Imprinting -
a. Illustrates another form of learned behavior
b. Is confined to a brief sensitive period in the individual's early life
c. Is permanent once it is established
D. All of the choices are correct
e. None of the choices are correct (d)

11. Salmon fish managers add a harmless chemical morpholine to a stream when they release young fish. When the fish mature, they swim back to the home stream by using this perfume still added by the wildlife managers. In nature, the fish smell the unique odors of soil and trees along the home stream. In effect, the biologist is using -
a. The fish's genetic-grounded ability to relocate its own stream via chemotropism
b. A fish's ability at higher order reasoning
c. The fishes' ability to learn by trial-and-error
D. Sensitization
e. Habituation (d)

12. If a male white-crowned sparrow is hatched and reared in isolation but allowed during a critical period of imprinting (10 to 50 days after hatching) to hear the song of a male from another species, the bird most likely will-
A. Only learn the appropriate song of its own species
b. Sing the appropriate song of the other species
c. Try to modify the crude song it was "born with" with the other-species song and produce a unique song
d. Not sing at all
e. None of the choices are correct
(a)

13. A benefit of social organization may be-
a. Protection from predators
b. Cooperation in hunting for food
c. To facilitate contact between males and females
D. All of the choices are benefits
e. None of the choices are correct (d)

14. On a beach area off Japan, a tribe of monkeys was given wheat and sweet potatoes at a feeding station. The wheat sometimes became mixed with sand grains. A female named Imo often washed the potatoes and observed that a handful of the sand-wheat mixture, accidentally dropped in the water, separated with the sand sinking and the wheat floating. She repeated this efficient sifting procedure and in a few years, this was imitated by her peers and subordinates, but not by the dominant males. This is a case of -
a. Ritualization
b. Insight, or highlevel reasoning
C. Cultural transfer by genetic selection
d. Cultural transfer by learning
e. None of the choices are correct (c)

15. An example of social organization is-
a. Barnacles attached to a boat bottom
B. A beehive in full activity
c. A cloud of moths attracted to a light
d. A swarm of mosquitoes hovering around a sweaty person
e. All of the choices are social gatherings (b)

16. Aggressive behavior between sexual rivals-
a. Is rare in mammals
b. Is characteristically nonviolent and ritualized
C. Usually results in death or injury of one opponent
d. Occurs equally among females as among males
e. None of the choices are correct (c)

17. The researcher who first proposed that hens established a "pecking order" was-
a. Niko Tinbergen
b. Ivan Pavlov
c. Konrad Lorenz
D. Thorleif Scheldrup-Ebbe
e. Herbert Spencer (d)

18. The function of territoriality may be-
a. To reduce intraspecific fighting
b. To ensure food supply
c. For mating and rearing of young
D. All of the choices are correct
e. None of the choices are correct (d)

19. A territory -
A. Is a defended area from which animals of the same species are excluded
b. Is a defended area from which animals of all species are excluded
c. Is the same as an animal's home range
d. Is much more common among mammals than birds
e. None of the choices are correct (a)

20. When many female seals gather on a small island so the few dominant males can gain access and defend their groupings of females, this represents -
a. A lek
B. Female defense polygyny
c. Male defense polyandry
d. Male dominance polygyny
e. Resource defense polygyny (b)

21. If the leader of a troop of baboons defends his family, or honeybees defend their hive "to the death", this apparent behavior of risking one's life for others is called-
A. Altruism
b. Sexual selection
c. Ritualization
d. Soft competition
e. Agonistic behavior (a)

22. Altruistic behaviors between closely related animals-
a. Force individuals to cooperate with one another and thereby increase population growth
B. Increase the frequency of the altruistic genes in the next generation
c. Reduce cooperation between species
d. Ensure the survival of the altruistic individual but not his close relatives
e. All of the choices are correct (b)

23. Many sterile worker bees give their lives to save a bee hive from an attack by bears, etc. From William Hamilton's work, we now know-
a. These female worker bees are more related to hive offspring than they would be if they were themselves fertile and mated — it is "calculated selfishness."
b. This is really a case of bees consciously understanding the need to preserve the nest for their individual benefit and they might survive if all work together
c. Each female worker is waiting to get her chance to reproduce
d. This is a case of sexual selection
E. The system is not yet understood (e)

24. Pheromones are -
a. Internal secretions that influence behavior
b. External secretions that influence genes directly
C. Common in insects
d. Disruptive to normal behavior
e. None of the choices are correct (c)

25. A modification of a normal behavior into a display through evolution to improve communication is -
a. Altruism
B. Ritualization
c. Imprinting
d. Sensitization
e. Habituation (b)

26. The waggle dance helps bees-
a. Communicate when they are hungry
b. Perfect the avoidance response
C. Communicate the location of food
d. Sound the alarm to protect the hive when it is invaded
e. Find mates (c)

27. If food is close to the hive-
a. No dance is necessary to communicate a source that is within eyesight
b. The bees dance in a very small figure-8
C. The bees perform a round dance
d. The bees dance in a straight "bee line."
e. None of the choices are correct (c)

28. Parrots have provided researchers with experiments that can test animal cognition because parrots have ability to-
a. Fly
b. Sign
c. Manipulate tools well
d. Write
E. Vocalize (e)

BIOSTATISTICS

Chapter 1
Introduction, Scope and Application of Biostatistics

Q.1 What do you mean by biostatistics? Write its application also.

Ans. Biostatistics also known as a portmanteau of biology and statistics, sometimes referred to as biometry or biometrics, is the application of statistics to a wide range of topics in biology. The science of biostatistics encompasses the design of biological experiments, especially in medicine and agriculture; the collection, summarization, and analysis of data from those experiments; and the interpretation of, and inference from, the results.

Applications of biostatistics

- Public health including epidemiology, health services research, nutrition, environmental health and healthcare policy & management.
- Design and analysis of clinical trials in medicine
- Population genetics, statistical genetics in order to link variation in genotype with a variation in phenotype. This has been used in agriculture to improve crops and farm animals (animal breeding). This work can assist in finding candidates for gene alleles that can cause or influence predisposition to disease in human genetics
- Analysis of genomics data, for example from microarray or proteomics experiments. Often concerning diseases or disease stages.
- Ecology, ecological forecasting.
- Biological sequence analysis.
- Systems biology for gene network inference or pathways analysis.

Statistical methods are beginning to be integrated into medical informatics, public health informatics, bioinformatics and computational biology.

Chap 2

Q. 1 Define descriptive statistics and inferential statistics.

Ans Statistics is a branch of mathematics used to summarize, analyze, and interpret a group of numbers or observations.

Two general types of statistics are:

- Descriptive statistics: statistics that summarize observations.
- Inferential statistics: statistics used to interpret the meaning of descriptive statistics.

Descriptive statistics are procedures used to summarize, organize, and make sense of a set of scores or observations.

Descriptive statistics are typically presented graphically, in tabular form (in tables), or as summary statistics (single values). **Inferential statistics** are procedures used that allow researchers to infer or generalize observations made with samples to the larger population from which they were selected.

Q.2 Write short notes on-

(A) Variable

Ans. A variable is any characteristic, number, or quantity that can be measured or counted. A variable may also be called a data item. Age, sex, business income and expenses, country of birth, capital expenditure, class grades, eye colour and vehicle type are examples of variables. It is called a variable because the value may vary between data units in a population, and may change in value over time.

Types of variables-

- Numeric variables have values that describe a measurable quantity as a number, like 'how many' or 'how much'. Therefore numeric variables are quantitative variables. Numeric variables may be further described as either continuous or discrete:

2.Continuous variables can take a value based on a measurement at any point along a continuum. The value given to an observation for a continuous variable can include values as small as the instrument of measurement allows. Examples of continuous variables include height, time, age, and temperature.

3. Discrete variables can take a value based on a count from a set of distinct whole values. A discrete variable cannot take the value of a fraction between one value and the next closest value. Examples of discrete variables include the number of registered cars, number of business locations, and number of children in a family, all of which measured as whole units (i.e. 1, 2, 3 cars).

(B) Data

Ans. Information obtained from experiments or collected from an experiment called data.

Classification of Data

The process of arranging the data in groups or classes according to their common characteristics is technically known as classification. Classification is the grouping of related facts into classes. It is the first step in tabulation. Classification is the process of arranging data into sequences and groups according to their common characteristics or separating them into different but related parts.

(c) Population and sample.

Ans. In statistics the term "population" is used to represent all possible measurements or outcomes that are of interest to us in a particular study. The term sample refers to a portion of the population that is representative of the population from which it was selected**.** The term population takes on a slightly different meaning. In statistics the population includes all members of a defined group that we are studying or collecting information on for data driven decisions.

A part of the population is called a sample. It is a proportion of the population. A sample is a scientifically drawn group that actually possesses the same characteristics as the population – if it is drawn randomly.

❖ **Which of the following statements are true?**

I. The mean of a population is denoted by x.
II. Sample size is never bigger than population size.
III. The population mean is a statistic.

(A) I only.
(B) II only.
(C) III only.
(D) All of the above.
(E) None of the above.

Solution

The correct answer is (E), none of the above.

(C) Tabulation

Ans.The process of placing classified data into tabular form is known as tabulation. Tabulation refers to the systematic arrangement of the information in rows and columns. Rows are the horizontal arrangement. In simple words, tabulation is a layout of figures in rectangular form with appropriate headings to explain different rows and columns. The main purpose of the table is to simplify the presentation and to facilitate comparisons. Tabulation refers to the systematic arrangement of data in rows and columns. The arrangement of data obtained after this process is called a table. Tables contain only numerical data. They do not contain details.

Q.3 Define exclusive and inclusive series.

Ans. Class intervals are of two types; exclusive and inclusive. The class interval that does not include upper class limit is called an exclusive type of class interval. The class interval that includes the upper class limit is called an inclusive type of class interval.

Example: Inclusive series is the one which doesn't consider the upper limit are-
00-10
10-20
20-30
30-40
40-50
The first one (00-10), we will consider numbers from 00 to 9.99 only. And 10 will be considered in 10-20. So this is known as inclusive series.

Exclusive series is the one which has both the limits included, for example,
00-09
10-19
20-29
30-39
40-49
Here, both 00 and 09 will come under the first one (00-09). And 10 will come under the next one.

Chap 3
Frequency Distribution

Q. 1 Explain frequency distribution with example.

Ans. A frequency distribution is an arrangement of the values that one or more variables take in a sample. Each entry in the table contains the frequency or count of the occurrences of values within a particular group or interval, and in this way, the table summarizes the distribution of values in the sample. This shows us a summarized grouping of data divided into mutually exclusive classes and the number of occurrences in a class. It is a way of showing unorganized data e.g. to show results of an election, income of people for a certain region, sales of a product within a certain period, student loan amounts of graduates, etc. Some of the graphs that can be used with frequency distributions are histograms, line graphs, bar charts and pie charts. Frequency distributions are used for both qualitative and quantitative data. A frequency distribution is a summary of how often different scores occur within a sample of scores.

For example, let's suppose that you are collecting data on how many hours of sleep college students get each night. After conducting a survey of 30 of your classmates, you are left with the following set of scores:

7, 5, 8, 9, 4, 10, 7, 9, 9, 6, 5, 11, 6, 5, 9, 10, 8, 6, 9, 7, 9, 8, 4, 7, 8, 7, 6, 10, 4, 8

In order to make sense of this information, you need to find a way to organize the data. A frequency distribution is commonly used to categorize information so that it can be interpreted quickly in a visual way. In our example above, the number of hours each week serves as the categories and the occurrences of each number are then tallied.

Using the information from a frequency distribution, researchers can then calculate the mean, median, mode, range and standard deviation. Frequency distributions are often displayed in a table format (as you can see in the example found below), but they can also be presented graphically using a histogram.

Chap 4
Graphical Presentation Of Data

Q.1 Define bar graphs.

Ans. A bar graph is a chart that uses either horizontal or vertical bars to show comparisons among categories. One axis of the chart shows the specific categories being compared while other axis represents a discrete value. Some bar graphs present bars clustered in groups of more than one (grouped bar graphs) and others show the bars divided into subparts to show cumulate effect (stacked bar graphs).

How to use Bar graph:

1. Determine the discrete range.

Examine our data to find the bar with the largest value. This will help us to determine the range of the vertical axis and the size of each increment. Then label the vertical axis.

2. Determine the number of bars.

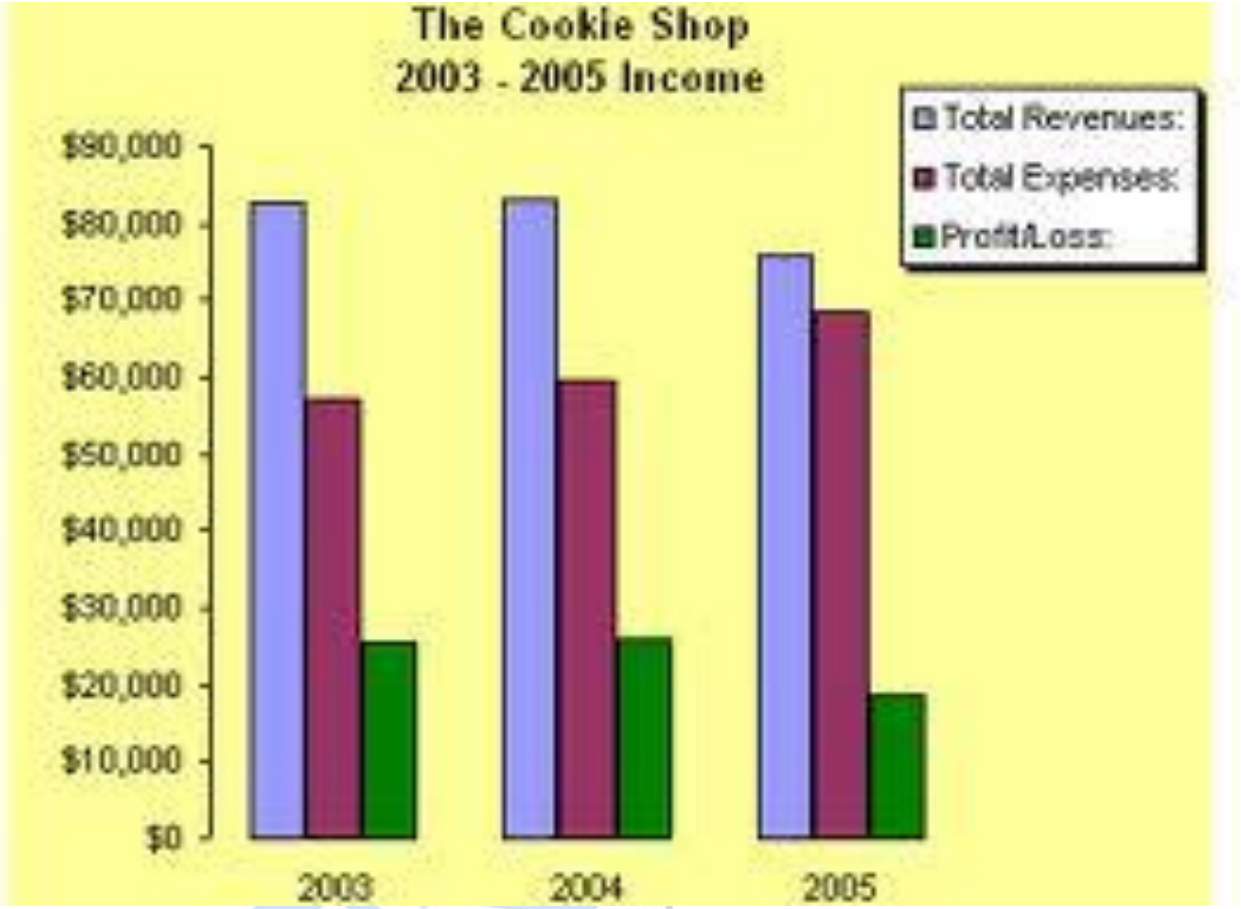
Examine our data to find how many bars your chart will contain. These may be single, grouped or stacked bars. We can use this number to draw and label the horizontal axis.

3. Determine the order of the bars.

Bars may be arranged in any order. (A bar chart arranged from highest to lowest incidence is called a Pareto chart.) Normally, bars showing frequency will be arranged in chronological (time) sequence.

4. Draw the bars.

If we preparing a grouped bar graph, remember to present the information in the same order in each grouping. If you are preparing a stacked bar graph, present the information in the same sequence on each bar. A sample of bar graph is as follows-



Q. 2 Explain Pie chart with the help of suitable example.

Ans To compare different parts of whole amount pie charts are useful. It is a circular chart in which the circle is divided into sectors. Each sector visually represents an item in a data set to match the amount of the item as a percentage or fraction of the total data set. For example- A company's expenditure can be shown to be the sum of its parts including different expense categories such as salaries, borrowing interest, taxation and general running costs (i.e. rent, electricity, heating etc).

Example

Draw a pie chart of a family's weekly expenditure on its house mortgage, food and fuel given as follows:

Expense	$
Mortgage	300
Food	225
Fuel	75

The total weekly expenditure = $300 + $225 + $75
= $600

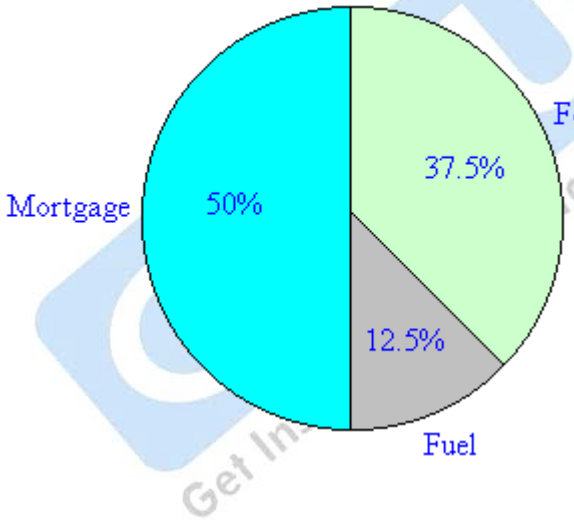
Total weekly percentage expenditure can be calculated as follows:

$$\text{Mortgage} = \frac{300}{600} \times 100\% = 50\%$$

$$\text{Food} = \frac{225}{600} \times 100\% = 37.5\%$$

$$\text{Fuel} = \frac{75}{600} \times 100\% = 12.5\%$$

To draw a pie chart, divide the circle into 100 percentage parts. Then allocate the number of percentage parts required for each item.



Q.3 Give a brief account on measures of central tendency

Ans. The term "measures of central tendency" refers to finding the mean, median and mode.

Mean:	Average. The sum of a set of data divided by the number of data.

	(Do not round your answer unless directed to do so.)
Median:	The middle value or the mean of the middle two values.
Mode:	The value that appears the most. It is possible to have more than one mode, and it is possible to have no mode. If there is no mode-write "no mode", do not write zero (0).

Q4. Find the mean, median and mode for the following data:

5, 15, 10, 15, 5, 10, 10, 20, 25, 15.

Ans: First you will need to organize the data.

5, 5, 10, 10, 10, 15, 15, 15, 20, 25

Mean: $\frac{sum\ of\ data}{number\ of\ data} = \frac{130}{10} = 13$

Median: 5, 5, 10, 10, 10,15, 15, 15, 20, 25

Listing the data in order is the easiest way to find the median.
The numbers 10 and 15 both fall in the middle.
Average these two numbers to get the median is $\frac{10 + 15}{2} = 12.5$

Mode: Two numbers appear most often: 10 and 15.
There are three 10's and three 15's.
In this example there are two answers for the mode.

Q. 5 Find the mode of:
9, 3, 3, 44, 17 , 17, 44, 15, 15, 15, 27, 40, 8,

Ans. Put the numbers is order for ease:
3, 3, 8, 9, 15, 15, 15, 17, 17, 27, 40, 44, 44,
The Mode is 15 (15 occurs the most at 3 times)

Q.6 The following frequency distribution showing the marks obtained by 50 students in statistics at a certain college. Find the arithmetic mean using (1) Direct Method (2) Short-Cut Method (3) Step-Deviation.

Marks	20 – 29	30 – 39	40 – 49	50 – 59	60 – 69	70 – 79	80 – 89
Frequency	1	5	12	15	9	6	2

Ans

			Direct Method	Short-Cut Method		Step-Deviation Method	
Marks	f	x	fx	$D = x - A$	fD	$u = \frac{x-A}{h}$	fu
20 – 29	1	24.5	24.5	–30	–30	–3	–3
30 – 39	5	34.5	172.5	–20	–100	–2	–10
40 – 49	12	44.5	534.5	–10	–120	–1	–12
50 – 59	15	54.5	817.5	0	0	0	0
60 – 69	9	64.5	580.5	10	90	1	9
70 – 79	6	74.5	447.5	20	120	2	12
80 – 89	2	84.5	169.5	30	60	3	6
Total	50		2745		20		2

(1) Direct Method:

$$\overline{X} = \frac{\Sigma fx}{\Sigma f} = \frac{2745}{50} = 54.9$$ or 55 Marks

(2) Short-Cut Method:

$$\overline{X} = A + \frac{\Sigma fD}{\Sigma f}$$ Where $A = 54.5$

$$= 54.5 + \frac{20}{50} = 54.5 + 0.4 = 54.9$$ Marks

(3) Step-Deviation Method:

$$\overline{X} = A + \frac{\Sigma fu}{\Sigma f} \times h$$ Where $A = 54.5 \quad h = 10$

$$= 54.5 + \frac{2}{50} \times 10$$

$$= 54.5 + 0.4 = 54.9$$ Marks

Q. 7Explain Mean by a suitable example.

Ans. Mean- The **mean** (or average) of a set of data values is the sum of all of the data values divided by the number of data values. That is:

$$\text{Mean} = \frac{\text{Sum of all data values}}{\text{Number of data values}}$$

Symbolically,

$$\bar{x} = \frac{\sum x}{n}$$

where $\bar{x}$ (read as 'x bar') is the mean of the set of x values,
$\sum x$ is the sum of all the x values, and
n is the number of x values.

Example

- The marks of seven students in a mathematics test with a maximum possible mark of 20 are given below:
  15 13 18 16 14 17 1

Find the mean of this set of data values.

Solution:

$$\text{Mean} = \frac{\text{Sum of all data values}}{\text{Number of data values}}$$
$$= \frac{15+13+18+16+14+17+12}{7}$$
$$= \frac{105}{7}$$
$$= 15$$

So, the mean mark is 15. By formula we can set out the solution as follows:

$$\bar{x} = \frac{\sum x}{n}$$
$$= \frac{15+13+18+16+14+17+12}{7}$$
$$= \frac{105}{7}$$
$$= 15$$

So, the mean mark is 15.

Median

The median of a set of data values is the middle value of the data set when it has

Q.8 Define Standard Deviation:

Ans. **Standard Deviation is a measure of variation (or variability) that indicates the typical distance between the scores of a distribution and the mean.**

The Standard Deviation is a measure of how spreads out numbers are.

Its symbol is **σ** (the greek letter sigma)

The formula is easy: it is the square root of the Variance.

Key Terms

- **Bell curve -**A frequency distribution statistics. Normal distribution is shaped like a bell.
- **Frequency** -This is a key question in the coding process. The researcher must decide if he/she is going to count a concept only once, for existence, no matter how many times it appears, or if he/she will count it each time it occurs. For example, "damn" could be counted once, even though it appears 50 times, or it could be counted all 50 times. The latter measurement may be interested in how many times it occurs and what that indicates, whereas the former may simply looking for existence, period.
- **Mean** -The average score within a distribution
- **Median-** The center score in a distribution.
- **Mode** -The most frequent score in a distribution.
- **Normal distribution -**A normal frequency distribution representing the probability that a majority of randomly selected members of a population will fall within the middle of the distribution. Represented by the bell curve.
- **Population** -The target group under investigation, as in all students enrolled in first-year composition courses taught in traditional classrooms. The population is the entire set under consideration. Samples are drawn from populations.
- **Random sampling** -Process used in research to draw a sample of a population strictly by chance, yielding no discernible pattern beyond chance. Random sampling can be accomplished by first numbering the population, then selecting the sample according to a table of random numbers or using a random-number computer generator. The sample is said to be random because there is no regular or discernible pattern or order. Random sample selection is used under the assumption that sufficiently large samples assigned randomly will exhibit a distribution comparable to that of the population from which the sample is drawn.
- **Sample** -The population researched in a particular study. Usually, attempts are made to select a "sample population" that is considered representative of groups of people to whom results will be generalized or transferred. In studies that use inferential statistics to analyze results or which are designed to be generalizable, sample size is critical--generally the larger the number in the sample, the higher the likelihood of a representative distribution of the population.

- **Standard Deviation** -A term used in statistical analysis. A measure of variation that indicates the typical distance between the scores of a distribution and the mean; it is determined by taking the square root of the average of the squared deviations in a given distribution. It can be used to indicate the proportion of data within certain ranges of scale values when the distribution conforms closely to the normal curve.
- **Standard Error (S.E.) of the Mean -**A term used in statistical analysis. A computed value based on the size of the sample and the standard deviation of the distribution, indicating the range within which the mean of the population is likely to be from the mean of the sample at a given level of probability (Alreck, 456).
- **Variable-** Observable characteristics that vary among individuals. See also ordinal variable, nominal variable, interval variable, continuous variable, discrete variable, dependent variable, independent variable.
- **Variance-** A measure of variation within a distribution, determined by averaging the squared deviations from the mean of a distribution.
- **Variation** -The dispersion of data points around the mean of a distribution.

Multiple choice questions

1. What is the mean of the data set given below?
   10.2,10.5 , 10.9 , 10.2 , 10.6 , 10.0
   A)10.1
   B)10.2
   C)10.3
   D)10.4
   E) 10.5

2. Which of the statements, related to the mean, mode and median of the data set given below is true?
   12 , 15 , 10 , 19 , 5 , 5
   A) the mean is equal to the median
   B) the mode is larger than the mean
   C) the median is smaller than the mode
   D) the above data set has two modes
   E) The median of the above data is equal to 14.5

3. What is(are) the mode(s) of the data set given below?
   20.1, 30.5, 10.1 , 20.1 , 10.6 , 30.5 , 10.1 , 10.5
   A) one mode: 10.1
   B) one mode: 30.1
   C) two modes: 20.1 and 30.1
   D) three modes: 10.1 , 20.1 and 30.5
   E) this data set has no modes

4. What is the median of the data set given below?

0 , 12 , 5 , 45 , 12 , 8 , 2

A) 45
B) 8
C) 25
D) 18.5
E) 12

5. What is the mean of the fractions 2/3, 5/6 and 1/2?
   A) 2
   B) 8/33
   C) 1/3
   D) 25/11
   E) 2/3

6. What is the median of the data set given below?
   0.3, 0.33 , 0.003 , 0.31 , 0.0003
   A) 0.003
   B) 0.33
   C) 0.31
   D) 0.0003
   E) 0.3

7. Which of these data sets has no mode(s)?
   A) 57 , 24 , 57 , 21 , 49
   B) 23 , 24 , 56 , 21 , 43
   C) 20 , 20 , 20 , 20 , 20
   D) 2000 , 3000 , 4000 , 2000 , 20000
   E) 5 , 6 , 7 , 8 , 9 , 5

8. What is the mean, median and mode of the following data set?
   101 , 99 , 102 , 105 , 100 , 98 , 102
   A) mean = 101 , median = 101 , mode = 102
   B) mean = 101 , median = 102 , mode = 101
   C) mean = 100 , median = 105 , mode = 102
   D) mean = 100 , median = 105 , mode = 101
   E) mean = 100 , median = 100 , mode = 100

9. Which of these data sets has a mean less than 100?
   A) 101 , 99 , 102 , 99 , 100
   B) 90 , 110 , 101 , 100 , 100
   C) 100 , 100 , 100 , 100 , 99
   D) 50 , 155 , 101 , 100 , 98
   E) 0 , 101 , 100 , 201 , 100

10.Which of the following data sets has the largest mean?

A) 2001 , 2002 , 2008 , 2010
B) 2000 , 2010 , 2005 , 2002
C) 2999 , 1000 , 2001 , 2002
D) 2000 , 2000 , 2000 , 2000
E) 2010 , 2004 , 2012 , 2020

11. Which of the following provides a measure of central location for the data?

A. standard deviation
B. mean
C. variance
D. range

12. The difference between the largest and the smallest data values is the-

A. variance
B. interquartile range
C. range
D. coefficient of variation

13. Which of the following is not a measure of central location?

A. mean
B. median
C. variance
D. mode

Answer: c

14. The most frequently occurring value of a data set is called the-

A. range
B. mode
C. mean
D. median

15. If the variance of a data set is correctly computed with the formula using n - 1 in the denominator, which of the following is true?

A. the data set is a sample

B. the data set is a population

C. the data set could be either a sample or a population

D. the data set is from a census

16. The most important statistical descriptive measure of the location of a data set is the-

A. mean

B. median

C. mode

D. variance

17. The numerical value of the standard deviation can never be-

A. larger than the variance

B. zero

C. negative

D. smaller than the variance

18. The sample variance-

A. is always smaller than the true value of the population variance

B. is always larger than the true value of the population variance

C. could be smaller, equal to, or larger than the true value of the population variance

D. can never be zero

19. If two groups of numbers have the same mean, then-

A. their standard deviations must also be equal

B. their medians must also be equal

C. their modes must also be equal

D. None of these alternatives is correct

20. Which of the following symbols represents the standard deviation of the population?

A. σ^2

B. σ

C. μ

D. $\bar{x}$

21. Which of the following symbols represents the mean of the population?

A. σ^2

B. σ

C. μ

D. $\bar{x}$

22. Which of the following symbols represents the variance of the population?

A. σ^2

B. σ

C. μ

D. $\bar{x}$

23. Which of the following symbols represents the size of the population?

A. σ^2

B. σ

C. μ

D. N

24. Which of the following symbols represents the mean of the sample?

A. σ^2

B. σ

C. μ

D. $\bar{x}$

25. Which of the following symbols represents the size of the sample?

A. σ^2

B. σ

C. N

D. n

B.Sc. (Part III) EXAMINATION, 2012
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[Also Common with Subsidiary Paper
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(Three-Year Scheme of 10 + 2 + 3 Pattern)
(For Regular)

ZOOLOGY
Second paper
(Applied Zoology, Ethology and Bio- Statistics)
Time Allowed: Three Hours
Maximum Marks-34

(1) No supplementary answer-book will be given to any candidate. Hence the candidates should write the answer precisely in the Main answer-book only.
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Part I is compulsory to attempt
Attempt FOUR questions in Part II, selecting at
Least ONE question from each Section

PART I

1. Answer the following questions in maximum 25 words-
(a) What is the main food of Silk moth?
(b) What is pisciculture?
(c) Give the names of any two crustacean larvae.
(d) Write the full form of ASE.
(e) What is meant by imprinting?
(f) What are pheromones?
(g) What is the mode of communication in honey bees?
(h) What are Pie diagrams?
(i) Define standard deviation.
(j) Write the formula to calculate standard error.

1x10=10

PART II
SECTION A

2. What is Vermiculture? Discuss vermicomposting in detail.

1+5=6

3. Write short notes on the following-
(a) Pearl formation

(b) Biological insect control.

3+3=6

4. Write an essay on the economic importance of Protozoan's.

6

SECTION B

5. WHAT IS LEARNING? Describe the concept of learning in detail.

1+5=6

6. Write short notes on the following-
(a) Pheromones in mammals
(b) Neurophysiological method of studying behavior.

3+3=6

7. Describe the social behavior in primates giving special reference to Indian langurs and Rhesus monkeys.

3+3=6

SECTION C

8. What is cumulative frequency? Construct a continuous frequency table from the given data-

5,	7,	11,	10,	10,	17,	20,	25,	24	
30,	31,	30,	5,	10,	10,	16,	5	8,	40
45,	50,	40,	5,	41,	47,	49,	60,	62,	64
65,	65,	55,	10,	64,	65,	60,	51,	52,	17
16,	10,	11,	9,	8,	10,	10,	17,	18,	20

1+5=6

9. Construct a Histogram and a frequency polygon from the following observations-

Length (in cm)	120-130	130-140	140-150	150-160	160-170	170-180
Number of People	5	10	20	26	23	16

4+2=6

10. Define mode and median and write a note on their significance.

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Part-I

1. Answer following questions in maximum 25 words-
   (i) Write the names of any two species of earth worms that can be cultured to prepare vermicompost.
   (ii) Write zoological names of any two edible fresh-water fishes.
   (iii) Write the names of two species of Entamoeba, which cause two different diseases in man.
   (iv) What is a continuous series?
   (v) What are demerits of arithmetic mean?
   (vi) Write the names of two insect pheromones.
   (vii) Define standard error.
   (viii) Define motivation.
   (ix) What is the role of dopamine in the brain?
   (x) Write the zoological name of "Hanuman Langoor".

1x
10

Part-II

Section-A

2. What are the specific features of crustacean larvae? Draw labeled diagram of any four major types of crustacean larvae and write their habit and habitat.

2+4

3. Write an essay on beneficial protozoa.

6

4. Describe basic requirements for Pisciculture.

6

Section-B

5. What is society> Compare behavioural patterns of deer and monkey society.

6

6. Write short notes on the following-
   (i) Types of Learning
   (ii) History of Ethology.

   3+3

7. Explain the concept of fixed action pattern and action specific energy with suitable examples.

6

Section-C

8. Tabulate and draw a suitable type of diagram from the following data-
   178, 114, 110, 161, 164, 71, 87, 94, 92, 93, 62, 83, 116, 164, 156, 124, 146, 149, 42, 121, 30, 130, 167, 122, 87, 40, 204, 143, 148, 83, 161, 71, 150, 101, 184, 177, 160, 110, 112

3+3

9. What is mode? Calculate mode from the following data-

Values	*Frequency*
10-30	10
30-50	15
50-70	42
70-90	30
90-110	3

1+5

10. Discuss applications of biostatistics

6

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.

PART-I

i. Write the zoological name of lac insect.
ii. Write zoological names of major species of honeybees.
iii. Write the name of species of Namatode which causes 'Elephantiasis' in man.
iv. Define frequency distribution.
v. Write the formula of median of a discrete series.
vi. Define Data (Descriptive) biostatistics.
vii. Define Altruism.
viii. Write the full name of 'CT' Scan.
ix. Who is the father of Ethology?
x. Which layer of shell is called a mother of Pearl ?

PART-II
SECTION-A

1. Discuss chemical control of insect pests.

2. What are coral reefs ? Give an account on coral reefs.

3. Write an essay on sericulture and its position in India.

SECTION-B

4. Write an essay on social organization in honeybees.

5. Write short notes in the following :
   i. Innate Releasing Mechanism (IRM)
   ii. Neurophysiological study.

6. Write an essay on pheromones and behavior.

SECTION-C

7. Draw a suitable type of histogram from the data as given below :

Class Intervals	01-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Frequency	3	4	7	8	9	9	2	6

8. Define standard deviation. Calculate the standard deviation from the following data :

Class Interval	Frequency
2-2.9	6
3-3.9	13
4-4.9	11
5-5.9	8
6-6.9	12

9. Write an essay on frequency distribution.

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Attempt FOUR questions in Part II, selecting at
Least ONE question from each Section

Part I is compulsory to attempt

Attempt FOUR questions in Part II, selecting at least ONE question from each question.

Part-I

11. Answer following questions in maximum 25 words-
    (xi) Write the names of any two species of earth worms that can be cultured to prepare vermicompost.
    (xii) Write zoological names of any two edible fresh-water fishes.
    (xiii) Write the names of two species of Entamoeba, which cause two different diseases in man.
    (xiv) What is a continuous series?
    (xv) What are demerits of arithmetic mean?
    (xvi) Write the names of two insect pheromones.
    (xvii) Define standard error.
    (xviii) Define motivation.
    (xix) What is the role of dopamine in the brain?
    (xx) Write the zoological name of "Hanuman Langoor".

1x
10

Part-II
Section-A

12. What are the specific features of crustacean larvae? Draw labeled diagram of any four major types of crustacean larvae and write their habit and habitat.

2+4

13. Write an essay on beneficial protozoa.

6

14. Describe basic requirements for Pisciculture.

6

Section-B

15. What is society> Compare behavioural patterns of deer and monkey society.

6

16. Write short notes on the following-
(iii) Types of Learning
(iv) History of Ethology.
3+3

17. Explain the concept of fixed action pattern and action specific energy with suitable examples.

6

Section-C

18. Tabulate and draw a suitable type of diagram from the following data-
178, 114, 110, 161, 164, 71, 87, 94, 92, 93, 62, 83, 116, 164, 156, 124, 146, 149, 42, 121, 30, 130, 167, 122, 87, 40, 204, 143, 148, 83, 161, 71, 150, 101, 184, 177, 160, 110, 112

3+3

19. What is mode? Calculate mode from the following data-

Values	*Frequency*
10-30	10
30-50	15
50-70	42
70-90	30

90-110 3

1+5

20. Discuss applications of biostatistics

6

Bibilography

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