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	BSC 19			
	Zoo 1999			
	Ethology, Biometry			
	Bioinformatics			

UNIT I - Ethology - I

1. Classification of Animal Behaviour.
 - ① Inborn or stereotyped animal behaviour - Taxa and Instincts with example.
 - ② Acquired animal behaviour - Imprinting, Conditioning, Habituation, Reasoning.
 - ③ Social behaviour in Insects - Honey bees.

UNIT II - Ethology - II

2. Communication in animals.
 - ① Auditory communication
 - ② Chemical communication.
 - ③ Visual communication.
 - ④ Tactile communication.
 3. Mimicry and coloration.
 - ① Introduction and types of mimicry - protective, conspecific and aggressive.
 - ② Introduction and types of coloration - Protective, Aggressive and Warning.

UNIT III - Biometry

4. Collection and classification of data.
 - ① Types of data - geographical, chronological, quantitative, qualitative, continuous, Discontinuous.
 - ② Methods of collection of data.
 5. Measures of central tendency.
 - ① Arithmetic Mean, Median and Mode.
 - ② Measures of Variability - standard deviation & S.D., error

6. Graphic representation of data.

- ① Histogram.
- ② Pie diagram.
- ③ Polygon frequency curve.

UNIT IV - Bioinformatics

① Computer and their applications in biology.

② Internet and its uses.

③ Search engines.

④ World wide web(WWW)

⑤ Introduction to Bioinformatics.

⑥ Applications of bioinformatics.

⑦ Introduction to biological database.

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UNIT I Ethology - I

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* Introduction to ethology.

① The most important ways of adapting to environmental change, at least for animal, is behaviour and its success depends to a great extent upon its degree of variability.

② Generally, the term behaviour is used to refer to all those responses to environmental changes that involve the integrated functioning of the entire organism.

③ The study of animal behaviour from a biological point of view forms a new and young branch of biology called "ethology." [ethos - characteristic disposition or habit; logos - study]

④ S. Hilarie used the term ethology in late nineteenth century.

⑤ In simple terms, what an animal does, how it acts is called behaviour.

⑥ Behaviour is evolved in the success of the animal in caring for itself, in seeking appropriate shelter, in obtaining food, in escaping enemies, in courtship and mating & caring of the young ones.

⑦ Niko Tinbergen (1966) has provided a very significant definition of behaviour: Behaviour is the movements animals make. These involve more than running, swimming, crawling and other types of locomotion.

⑧ Raven et al. (2005) have defined behaviour as the way an animal responds to stimuli in its environment. A stimulus may be as the odour of food.

Pattern of movement in stereotyped behaviours.
Fixed action patterns (FAPs)

The stereotyped acts are considered to be fixed and the behaviour patterns are called fixed action patterns.

A FAP involves a series of events in a well ordered sequence.

Such action patterns in animals were first described by K. Lorenz.

He attributed FAPs to those which were "innate and invariant" i.e. being endogenous they did not vary between individuals or between repetition by the same individual.

All stereotyped actions are not fixed i.e. some FAPs are stereotyped, others are not.

FAPs were triggered by the external stimuli. Once triggered, the FAPs had become independent of the external world.

Classification of animal behaviour.
Behaviours may be broadly classified into two main types:

1. Group behaviours
2. Individual behaviours

Group behaviours.
It include behaviour of group or species.
It is subdivided into two types:-

- (i) stereotyped behaviour
- (ii) Acquired behaviour

(1) stereotyped behaviour.
A behaviour is called stereotyped when an individual repeats the same pattern of behaviour again and again.

(2) In case of stereotyped behaviour, the animal is to a large extent stimulus bound, where a pattern of stimuli trigger a sequence of responses.

(3) Since this kind of behaviour is essentially the outcome of inherited properties of the nervous system of the animal, it is also known as innate or inborn or inherent behaviour.

Characteristics of Stereotyped Patterns (SPs)

1. They are complex in origin and are predictable.
2. They are species-specific or sex-specific.
3. They are initially stimulus-dependent.
4. They do not result as a consequence of experience.
5. They consist of a chain of acts in a definite sequence.

✓ Sweet birds help bend them to avoid predators.
 ✓ Homing in ants & birds are guided by the earth's magnetic field.
 ✓ -ve phototaxis: puts larvae in dark places. **SAATHI**
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(2)	A toxic response is directional.	(2)	These types of behavioural patterns are considered to be "instinctive".
(3)	If the response is movement towards the stimulus it is a positive response and an avoiding reaction is a negative response.	(3)	Instincts are often used to refer to broad behavioural tendencies which are widely believed to be innate.
(4)	With respect to the type of stimulus, a taxis might be classified as one of the following:-	(4)	For scientists, "instinctive" generally implies innate or inborn - the opposite of learned or reasoned.
(i)	Thermotaxis :- Response to heat.	(5)	Lorenz writes about the characteristics of instinct behaviour as being hereditary, individually fixed and thus open to evolutionary analysis.
(ii)	Phototaxis :- Response to light rays. Ex. <i>Euglena</i> .	(6)	Tinbergen refers similarly to instinctive act as being highly stereotyped coordinated movements, the neuromotor apparatus which belong, in its complete form, to the hereditary constitution of the animal.
(iii)	Thigmotaxis :- Response to contact.	(7)	Tinbergen postulated that various instinct centres in the body were arranged in a hierarchy. This helps the animal in saving the energy required for the stimulation of a particular behaviour.
(iv)	Chemotaxis :- Response to chemical substances. Ex. <i>Paramecium</i> .	(8)	For example, initiation of reproduction in animals lead to a number of associated behaviours, such as nest-building, courtship and parental care.
(v)	Hydrotaxis :- Response to moisture.	(9)	Thus, instinctive behaviour is innate, comprise of motor patterns that can be carried out correctly the first time they are evoked.
(vi)	Rheotaxis :- Response to currents of air or water.	(10)	Instinctive behaviour depends on the activation of preprogrammed neuronal circuits.
(vii)	Galvanotaxis :- Response to constant electric current.	(11)	Appropriate fixed action responses are made the first time the animal sees the necessary release signs.
(viii)	Geotaxis :- Response to gravity, etc. Ex. <i>Staphylococcus</i> .		
(ix)	Distinguishing features of taxis:		
1.	It is fixed action as well as stereotyped pattern.		
2.	It involves spatial orientation.		
3.	There must be orientation of the whole body.		
4.	The direction of the movement should be continuously guided by the external stimulus.		
5.	The orientation movement is directly proportional to the stimulus strength.		
2.	Instincts.		
(i)	Among animals there are many examples of elaborate behaviour that show adherence to a plan that is relatively constant throughout a species and is not acquired through previous experience or learning.		

Examples of instincts:

- ① Food-begging behaviour of quail chicks.
- ② Nest building behaviour in tailor birds.
- ③ Building of spiders orb web.

Characteristics of Fixed Action Patterns.

Ideally, a pattern of behaviour should have all the following characteristics if it is to be described as fixed action pattern (FAP):

- 1. Stereotypy: → This behaviour always occurs in the same form.
- 2. Universality: → The behaviour occurs in all members of a species.
- 3. Independence of individual experience: → Fixed action patterns should occur regardless of the individual animal's past history.
- 4. Ballisticness: → A ballistic response is one that cannot be varied if circumstances change after the response has been launched.

Adaptive significance of instincts.

Instincts or FAPs are helpful for animals. An instinct renders the animals to acquire a prehand knowledge of aversive (hostile) situations in the environment and thus the animal is always ready to meet the challenges.

(ii) Acquired behaviour: Learning

(1) W.H. Thorpe has defined learning as that process which manifests itself by adaptive changes in individual behaviour as a result of experience.

(2) In a way learning is the acquisition of new behavioural patterns based upon past experiences.

(3) Lorenz has defined learning as an adaptive change in behaviour that results from experience.

(4) Following two criteria are used to distinguish learning from other modifications of stereotyped behaviour:

① Learning must be permanent and not the result of fatigue or fluctuations in motivation.

② Learning must not be simply a permanent change in behaviour resulting from maturation.

(5) For example, if a baby toad encounters a tiny moving bug for the first time after losing its tadpole tail and hopping of onto land, it will be able to perform the stereotyped prey-capture behaviour of its species.

1. Habituation.

① It is a non-associative type of learning.

② It is a simple learning not to respond to repeated stimuli which tend to be without significance in the life of the animal.

③ Unlike the other forms of learning, habituation involves not only the acquisition of new responses

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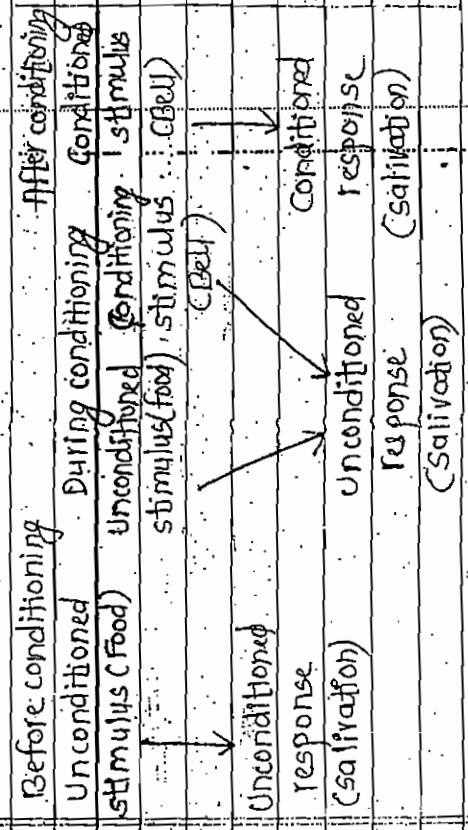
- but the loss of old ones.
- ① If an animal is repeatedly given a stimulus which is not associated with any reward or punishment, it ceases to respond.
 - ② Thus, the phenomenon in which repeated applications of stimulus result in decreased responsiveness is called habituation.
 - ③ Razran has defined habituation as learning what not to do.
 - ④ Habituation is a way of eliminating responses to stimuli which are sometimes important but which in a particular case, are irrelevant.
 - ⑤ Classical examples of habituation.
 - (i) The escape response of fish to a shadow passing overhead diminishes progressively if the stimulus is repeated every few minutes, until the fish ceases to react at all.
 - (ii) The orientation response of the toad (*Bufo bufo*) toward potential prey progressively declines of non-edible prey-like objects are presented repeatedly.
 - (iii) The reaction of spiders to vibrating tuning forks.
 - (iv) Sea hare: the *Aplysia* has learned not to respond to an apparently harmless stimulus.
 - ⑥ Certain characteristics of habituation.
 - ① Stimulus specificity: → In habituation, the decrease in responsiveness occurs only with reference to the habituating stimulus.

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- ② Length of the interstimulus interval (ISI): → The longer the ISI, the less habituation we expect.
 - ③ Dishabituation: → If a novel stimulus is presented during the process of habituation, then there is an increase in responsiveness. This is called dishabituation.
 - ④ Sensitisation: → Sensitisation is the opposite kind of change. Habituation means to become less sensitive to a stimulus, sensitisation means to become more sensitive to a stimulus.
2. Conditioning:
- ① Russian physiologist, Pavlov discovered that it is possible to train a dog to salivate at the sound of a bell. This type of learning is called classical conditioning, which is a type of associative learning.
 - ② Pavlov's classical experiment with dogs often involved the 'salivary reflex'.
 - ③ Dogs salivate when food is put into their mouths and Pavlov could measure the strength of their response by arranging a fistula through the cheek from the salivary duct, so that the drops of saliva fell from a funnel and could be counted.
 - ④ A hungry dog was placed on a stand, restrained by a harness and every precaution was taken to exclude disturbances.
 - ⑤ In this position, it could be given various controlled stimuli such as lights, sounds or touch, and meat powder could be puffed into the mouth through a tube.

- ⑥ At first, this stimulus caused no response, the dog pricked up its ears momentarily.
- ⑦ However, after five or six pairings of metronome followed by food, saliva began to drip from dog's mouth soon after the metronome started and before the meat powder arrived.
- ⑧ Eventually the amount of saliva produced to the metronome alone was the same as that which was given by the meat powder.
- ⑨ Thus, the dog had learnt to respond to a new stimulus, previously neutral, which Pavlov called the conditioned stimulus (CS).
- ⑩ The salivation response to the CS is the conditioned response (CR).
- ⑪ Prior to learning, only the meat powder's called unconditioned stimulus (UCS) produced salivation as an unconditioned response (UCR).



- 1. Law of contiguity: → It states that the stimuli to be associated must occur together in time and space.
- 2. Law of repetition: → It means that the conditioned response becomes progressively stronger and more probable in occurrence with progressively greater number of training trials.
- 3. Law of reinforcement: → It states that if the conditioning stimulus (such as ringing bell) is presented to a conditioned animal without being associated with the normal stimulus (the meat powder) for a large number of times, the conditioned response (salivation) will gradually disappear (i.e. the behaviour becomes extinguished).
- 4. Law of interference: → It states that conditioning (learning) may disappear (be forgotten) by new conditioning that interferes with the original conditioning.

Types of classical conditioning.

- 1. First order conditioning: → If unconditioned stimulus (UCS) is paired with conditioned stimulus (CS) for a number of times, CS alone elicits a response. This direct pairing of CS with UCS is called first-order conditioning.
- 2. Second order conditioning: → If pairing and presentation of CS (sound of bell) with a second CS (light) reconditions the dog to second CS (light), it is called second order conditioning. In this type of conditioning, the animal is conditioned to a second CS presented along with first CS.

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3. Positive conditioning → If conditioned response (CR) is beneficial as unconditioned response (UR), it is said to be the positive conditioning.
 4. Negative conditioning → If CR becomes a negative reinforcer, it is said to be negative conditioning.
- ⇒ Significance of classical conditioning.
- (1) Classical conditioning is useful to an ethologist in understanding of conditioning of animals to the environment stimuli.
 - (2) The conditioning has been applied to explain certain types of asthma, skin allergies and gastric ulcers.
 - (3) Bed-wetting (medically known as enuresis) is cured in children through classical conditioning.
 - (4) Many human's psychosomatic disorders are thought to be due to the classical conditioning of autonomic functions such as changes in blood pressure and dilation and constriction of blood vessels.
 - (5) The Russians have provided many elegant demonstrations of the conditioning of many responses usually classed as involuntary in both animals and humans.
 - (6) Around year 1970s, interest has centred on conditioning faster or slower heart rates.

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3. Reasoning
- ① Reasoning is the ability to solve complex problems by behaving according to general principles rather than simply responding to the situation with simple trial and error behaviour or modification of stimulus response behaviour.
- ② It is a type of insight learning.
- ③ The animal should be able to put together elements from its past experience into new arrangements to meet different situations.
- ④ Several types of tests have been devised to test an animal's reasoning ability.
- ⑤ For instance, a detour problem consists of placing the animal in an environment where it must follow a circuitous route to a food source or a escape path.
- ⑥ Another example of a reasoning problem is the discrimination learning test in which animal must choose between two or more responses depending upon the conditions.
- ⑦ We can set up such a test using two doors, one black and the other white. The animal must learn to choose the white door if the light is on, but it must choose the black door if light is off.
- ⑧ This is an if-then reaction: if the light is on, then choose the white door; if the light is off, then choose the black. Higher primates are good at this type of reasoning problem.

- ④ Other types of reasoning tests include the oddity principle where an animal is presented with several objects and it must choose the one that is different from the others.
- ⑤ The delayed reaction tests in which the animal must find an object that has been hidden from view for a specified period.
- ⑥ The triple-plate problem, in which the animal must learn a prescribed series of steps in order to receive a reward or escape punishment.

4. Imprinting

- ① It is a type of phase specific learning.
- ② In 1910, Oscar Heinroth first of all described that goslings tend to follow a large moving object soon after hatching and to reject in specific ways to that kind of object later in life.
- ③ He is often given the credit for being the first to use the term *imprinting*, prior to him Spalding had conducted extensive studies on imprinting in domestic chicken many years earlier (1877-1880).
- ④ Lorenz (1935) confirmed Heinroth's observations on goslings and also studied imprinting in mallard ducklings, pigeons, jackdaws and many other birds.
- ⑤ He argued that imprinting, unlike ordinary learning, took place at a particular stage of development and was irreversible.

- ⑥ Lorenz first discovered this phenomenon in greylag geese. A gander (male goose) which he had hand reared came to follow him everywhere, and when it reached sexual maturity it attempted to mate with him.
- ⑦ In other words, it treated him in all respects as though he was a mother goose. Lorenz called this kind of learning as imprinting.
- ⑧ Imprinting is a method of rapid learning of the mother's appearance by newly hatched chicks.
- ⑨ This type of learning is pre-programmed to take place as part of the normal process of development and in whatever circumstance pertaining at the time.
- ⑩ Lorenz argued that imprinting must have involved a special process, distinct from ordinary learning, since it was exceptionally fast, was irreversible and could only occur within a sharply defined critical period.
- ⑪ But the concept of a critical period has been replaced by that of a more loosely specified sensitive period: imprinting is most likely to occur within the sensitive period, but can occur outside it.
- ⑫ Recent experiments have shown that sometimes imprinting can be reversed and though imprinting is certainly a rapid kind of learning, this can be reasonably explained by the fact that the animal concerned has had virtually no previous learning experience and so there is no scope for what learning psychologists call "proactive interference" from previous tests.

But if imprinting probably does not involve any special process, its occurrence in specific contexts does seem to involve specific adaptations to each species particular mode of life.

Types of imprinting.

Imprinting is of following two types:-

1. Filial imprinting.

Filial imprinting is the imprinting of the following response which young animals make to their parents. It takes place in many species of birds and mammals. These are the animals with most extensive parental care. It is adaptive because it enables the young to recognise and follow their parents. If they are to survive, it is important that the young should choose the right animals to follow.

2. Sexual imprinting.

Sexual imprinting normally functions in the wild to ensure that the animal will, when it grows up, choose a mate of the correct species. It concerns the species to which the animal will direct its sexual behaviour. In nature to look at your parents is a good method of learning the characteristics of your own species.

Social behaviour in insects - Honey bees

Honeybees live in colonies of hundred bees. Each colony has a queen which is somewhat larger than the worker bees.

The queen lays the eggs which develop into new workers (drones (males) and queens.

She also emits a complex series of chemical secretions, the pheromones, that regulate much of the behaviour of the workers.

Genetically both queens and workers are diploid and both are females.

Queens, however, are fed a special rich larval food, a white, creamy, yogurt-like royal jelly that is necessary for normal queen size and sexual development.

In fact, workers can develop into sexually reproducing females but their reproductive organs are kept underdeveloped through influence of the queen's pheromone.

Drones are haploid genetically and are males that are produced by the laying of unfertilized eggs, i.e. parthenogenetically. Drones are produced at the same time as new queens.

When a hive of honeybees prepares to swarm or when an old queen becomes weak, the regulating pheromones of the queen become weak. This serves as signal for workers to begin raising new queen larvae. In the case of swarming, the old queen leaves with a group of workers and forms a new colony.

- (10) In case of an aging queen, new queen displaces the old one. When a new queen hatches out and develops, she kills any other newly-hatched rivals and flies off to mate.
- (11) By this time, drones have left the hive and have aggregated in traditional sites in large flying clouds. The drones from several neighbouring hives may all combine in such a cloud.
- (12) When newly-hatched queens approach such a drone cloud, the drones rush at the queens avidly and several of them may mate with a queen in succession.
- (13) The new queen then returns to her hive, lay her eggs and regulate the behaviour of workers.
- (14) A honeybee worker lives for about six weeks as an adult and her activities are to some extent synchronized with her physiology. Thus, she spends the first three days cleaning out cells and then begins feeding the older larvae, a mixture of pollen and honey which she picks up from the storage cells in the hive.
- (15) During this period the pharyngeal or nurse glands in her head have been developing.
- (16) They secrete royal jelly and from about 6th to 10th day of her life the worker feeds this secretion to the younger larvae and any queen larvae in the hive.
- (17) Royal jelly is fed to all larvae for a brief period early in their development, but those larvae intended to become queens, develop in a larger

- (18) cell and are fed royal jelly throughout their life. The workers wax-secreting glands on the abdomen become active from the 10th day and at the same time the pharyngeal glands begin to regress.
- (19) Worker gradually changes her behaviour from feeding larvae to cell construction. From about 18th day she may leave the hive occasionally for a few brief orientation flights.
- (20) At this stage she may be found guarding the hive entrance and inspecting incoming bees.
- (21) From 21st day of age onwards the worker is primarily a forager bringing back nectar, pollen and water and usually remains so for the rest of life (i.e. 2 to 3 weeks).
- (22) A bee hive is a marvellous society which has elaborate mechanisms that maintain hive homeostasis.
- (23) When the hive is hot, worker bees fan air throughout it and cool it off.
- (24) When the nurse workers attending the larvae are short of water, they turn to the nearest workers and signal a need of water and that need is provided by other workers.
- (25) When a predator or parasite enters the hive, workers rush forward and defend the colony with the result they may die.
- (26) It is noted that it is almost as if the hive itself, and not the individual bees, hence termed as social behaviour.

UNIT II

Ethology - II

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* Communication in animals

- (1) Communication can be said to have occurred when an animal performs an act that alters the behaviour of another animal.
- (2) Each social grouping must have a precise system of communication, for it is the only mode through which an animal alters its behaviour in response to the performance of others.
- (3) When we consider the relationship between a signal transmitted by one animal and the response it elicits in another we consider it as a continuous function.
- (4) When animals communicate with each other, information of various different sorts passes between them as a signal.
- (5) In the strict scientific sense as defined, in the information theory, many bits of information pass from one animal to another as a result of signal.
- (6) The more information received, the more uncertainty of the recipient as to what will happen next is reduced.

Types of communication

Animals communicate some message an encoded signal. The signals used for communication include vision, sound, olfaction, tactile, etc.

According to the types of signals, the following types of communication have been recognised :-

1. Visual communication

- ① Changes in posture and colour are the main ways that animals communicate through the visual channel.
- ② Vision is the most important signal used in private and short-range communication.
- ③ Such communications are meant for communication between two rivals in a fight for a territorial dispute.
- ④ During visual communication both the sender of a signal and receivers display special facial expressions or postures to convey the message to conspecifics.
- ⑤ For example, the communication between the male Siamese fighting fish at a territorial boundary in which the fish raises fins when it sees broadside to its rival but closes its gill covers when face to face.

2. Auditory communication.

- ① In auditory communication, the signals used will not remain limited between sender and receiver, but it will rapidly transverse round corners and across the environment.
- ② Sound signals are very specific.
- ③ A particular function is associated with particular signal.

④ This pattern of communication is advertisement signal.

- ① in the sense that,
- ② The message can be sent.
- ③ The frequency and speed of advertisement signal.

(ii) The message can be conveyed to longer distance unlike the visual communication.

(5) For example, the mole cricket prepares a burrow in a horn-shaped design to enhance transmission of sound waves.

3. Tactile communication.

(1) This mode of communication is not used commonly.

(2) In this communication, signals are transmitted through touch.

(3) Many invertebrates and few vertebrates have been found to transfer message through physical contacts.

(4) For example, blind workers of termites communicate through tactile communication in their subterranean tunnels.

(5) Elephants use tactile communication during courtship. The trunk plays an important role.

(6) Touch is used to comfort to establish dominance and to establish bonds.

(7) Touch is very important in many primate species. Primates are social animals. They live in large groups. Touch helps the group form bonds and stay peaceful.

(8) Primates often groom each other. Female primates often hold and frequently cuddle & comfort their young.

(9) Mother tigers lick and nuzzle their babies; chimpanzees groom each other; and bear cubs wrestle with each other.

4. Chemical communication.

(1) Many animals use chemical communication or pheromones to communicate.

(2) They may leave their scent to make territory or attract mates.

(3) They often use smell to find prey and identify other animals, hence also called olfactory communication.

(4) The communication is generally used between sexual partners, between predator and prey, in territorial limitations, in locating food and water resource and also in the advertisement of the information among members of society.

(5) Olfactory communication is not the best mode of communication, for smells diffuse only slowly through the environment, their speed and direction of travel being highly wind dependent and they can carry little information.

(6) However, there are situations where smells are ideal, e.g. pheromones produced by a female moth are detected by its male several hundred metres away.

(7) Territorial marking is very good example of this type of communication.

(8) The male mountain lion, the Canada lynx leaves a scent post by urinating on trees & tree trunks.

(9) Snakes use their forked tongues to taste or collect pheromones of prey animals that are in the air. The have receptors in mouth that helps them taste and smell the pheromones.

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(1) Some animals use scent to identify members of their family. The male deer has scent glands on its hind legs right above its hooves. Young deer will often identify their mothers by sniffing at the glands.

(2) Domestic cats have scent glands near their mouth, on their forehead and at the base of their tails. They use these glands to mark territory.

⇒ * Kullitragg Pheromones:

(1) Pheromone is a chemical that is produced and released into the environment by one organism and affect the behaviour of another organism of the same species.

(2) Pheromones are also called ectohormones and released in minute quantity bringing about major effect by functioning as chemical messengers.

(3) They are released by the exocrine glands and transmitted externally through the environment.

(4) Pheromones are species-specific and produce specific behavioural, reproductive and developmental responses in the bodies of other members of the same species.

(5) Pheromones are mostly used as a signal in chemical communication in insects & vertebrates.

- Ex. (i) Hippopotamus make use faeces for scent marking.
 (ii) Fox & chetah use its urine for scent marking.
 (iii) Bighorn sniffs his females posterior for mating.

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* Mimicry

(1) The word mimicry (that derives from the Greek term mimeitros = imitation) was firstly being used to describe people who have the ability to imitate.

(2) Mimicry is the ability of an organism develops to imitate one or more traits from another organism so that it can obtain some benefit.

(3) Sometimes, the term mimicry is used as a synonym of "camouflage" or "crypsis".

(4) Mimicry is to look like smell or sound like something else to gain some advantage of protection.

(5) For many animals including insects and spiders, a key problem is how to eat without being eaten. By mimicking something else, they gain some protection and increase their chances of survival.

(6) In the insect and spider world, the term mimicry is commonly applied to the resemblance of one insect or spider (mimic) to another (model) so that a third insect or other observer is deceived into confusing the two.

(7) In the most studied mimetic relationships the advantage is one-sided, one species (the mimic) gaining advantage from a resemblance to the other (the model).

⇒ Types of mimicry

- Mimicry can be classified into three categories:-
 1. Protective mimicry
 2. Aggressive mimicry
 3. Conscious mimicry

1. Protective mimicry

(1) It is of highly specialized character and the organisms mimic themselves in the form, as well as in colour to protect the animals from enemies or predators.

(2) It is also responsible for camouflage of an animal by its close resemblance to its general background or to some dead or dull objects which is of no interest to its enemies.

(3) Protective mimicry has two aspects :-
 (a) Concealing and
 (b) Warning.

(a) Concealing mimicry.

(1) It is a very common amongst animals.

(2) In some cases the animals mimic the shape and colour of other organisms or object.

(3) In other cases the animals conceal themselves either by changing their colouration or search a background which matches with their colours.

(4) A very typical example of the concealing is given by the crab, *Cryptolithodes* whose smooth rounded form and texture & white colour very closely harmonize with the white pebbles of the beach and the true organic nature of the animal is apparent only when the animal, by accident, is turned over. The animal thus secures immunity from enemies of its own station.

(5) There are some other examples of crab which resemble wave worn dead corals; in this case

the animal is carnivorous and the concealment has two functions: protection against its enemies and aid in securing its prey.

(6) The caterpillars of geometrid moths are not only protectively coloured but may mimic the twigs and smaller branches of various plants.

(7) The most perfect example of this type of mimicry is the leaf insect known as *Phyllium*. It closely resembles a green leaf in colour. Flattened wings, expanded body and limbs. Even the irregular or small yellowish spots similar to the benign growths upon leaf are also seen.

(8) Another noteworthy example is that of *Kallima paractea* from India. In this butterfly, when it is sitting the wings are bled and colour resembles a dead leaf, in which red and brown alternate with spots of scales similar to dew drops.

(9) Many of the walking stick insects (*Phasmodae*) are also good mimics with their slender body, attenuated limbs, sympathetic colouration and slow movement.

(10) Australian fish, *Phyllipteryx* eques resembles like bonds of seaweed, due to presence of leaf like cutaneous outgrowths over the body.

(b) Warning mimicry.

(1) In this are included such forms which mimic the apparently harmful creatures, though in itself it is entirely harmless.

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② This type of mimicry is helpful in self-defence because by imitating these are able to ~~reduce~~ delude and frighten the enemy and escape themselves.

③ For example:- among reptiles, certain snakes of the family Elapidae are deadly poisonous and are beautifully coloured.

④ Each of these coral snakes is mimicked by other species of harmless snakes belonging to different genera so that it renders the imitators practically immune from attack.

⑤ Non-poisonous hog-nose snakes (Chironomys) are capable of blattering the head rendering it triangular like the hood and hiss so as to show that they are dangerous.

⑥ Among insects also there are examples of warning mimicry... clear winged moths *Sesia crabroniformis* mimics to the dangerous wasp *Lespa crabro*. Rower flies are brilliantly coloured resemble the wasps and sting bees.

⑦ In some butterflies, caterpillars, peacock, etc. possess black spots on their wings or body. Their sudden display the animal at the time of danger brightens of insectivorous birds.

⑧ The butterfly of genus *Thecla* exhibit a dummy head as the hind end of the wings by converging colours stripes on the wings and having antennae like appendages on wing tips.

2. Aggressive mimicry
It is shown by certain carnivorous forms.

(1) In this case the imitation is not for protection but to attack and prey upon other animals.

(2) The aggressive mimicry is divisible into:-
(a) Concealing mimicry and (b) Alluring mimicry.

(a) Concealing mimicry.
Here the animals develop cryptic colours so as to blend with the surroundings.

(b) Some of the spiders found on golden-rod and other flowers, with their yellow bodies, so harmonize with the flowers where they rest that they are invisible to the visiting insects which form the spider's prey.

(c) Other spiders resemble oak galls and other vegetable growths, yet others the drooping of birds. These are all instance of concealing aggressive mimicry.

(b) Alluring mimicry.

(1) In this type, mimics advertise themselves and allure or attract their prey.

(2) Some species of spider which resembles an orchid blossom both in colour and form; the resemblance is an alluring one and is advertising rather than sympathetic.

(3) Certain African lizards are protectively coloured except for a brilliant coloured spot at the corner of mouth which attracts insects.

④ Ceratophrys, the American frog, sits still and moves one finger of the hand. This arouses the attraction of other animals, when they attempt to capture the apparent prey, are preyed upon by ceratophrys.

3. Conscious mimicry or Simulation of Death.

① Certain animals exhibit conscious imitation and on the approach of danger behave as if they are dead.

② The common example is the American opossum, Didelphis, which poses to have been dead when it is attacked by an enemy.

③ Many insects such as hard bodied beetles drop down like a pebble when attacked and to be seized.

⇒ Conditions for protective mimicry.

Wallace has given the conditions which must be fulfilled whenever protective mimicry occurs, they are:

1. Imitative species must occur in the same area and occupy the same station as the mimicked.
2. The imitators are always more defenceless.
3. The imitators are always less numerous in numbers.
4. The imitators differ from the bulk of their allies.
5. The imitation is external, never extending to internal characters.

* Colouration.

(1) Animal coloration is the general appearance of an animal resulting from the reflection or emission of light from its surface.

(2) Some animals are brightly coloured, while others are hard to see.

(3) In some species, such as the peacock, the male has strong patterns, conspicuous colours and is iridescent, while the female is far less visible.

(4) There are several separate reasons why animals have evolved colours.

(5) Camouflage enables an animal to remain hidden from view.

(6) Animals use colour to advertise services such as cleaning to animals of other species; to signal their sexual status to other members of the same species and in mimicry, taking advantage of the warning coloration of another species.

(7) Some animals use flashes of colour to divert attacks by startling predators.

(8) Zebras may possibly use motion dazzle, confusing a predators attack by moving a bold pattern rapidly.

(9) Some animals are coloured for physical protection, with pigments in the skin to protect against sunburn, while some frogs can lighten or darken their skin for temperature regulation.

(10) Pigments are particles of coloured material. Chromatophores are cells containing pigment.

which can change their size to make their colour more or less visible.

(11) Some animals, including many butterflies and birds, have microscopic structures in scales, bristles or feathers which give them brilliant iridescent colours.

(12) Other animals including squid and some deep-sea fish can produce light sometime of different colours.

Types of coloration:

Coloration can be classified into three categories:

- 1. Protective coloration.
- 2. Warning coloration.
- 3. Aggressive coloration.

1 Protective coloration.

① Coloration or color pattern of an animal that

helps its protection from observation either by its predators or by its prey is called protective coloration.

② The most widespread form of protective coloration is called cryptic resemblance, in which various

objects that supplement the similarity of color between the animal and its surroundings enables the creature to blend into the background of its habitat.

③ Disruptive coloration, or irregular patches of contrasting colors, serve to distract the observer's eye from the outline of the animal.

④ Thus the stripes of tiger and the zebra make detection among the jungle grasses is more difficult whereas the leopard's spots are more suited to the mottled light and shade of the low branches from which it drops onto its prey.

⑤ Many other creatures e.g. frogs, lizards and snakes are dappled, barred, speckled, mottled, or otherwise distinctively marked or colored so that they blend with sand, water, snow, or specific vegetation, depending on their natural habitat.

⑥ The pigmentation of some animals e.g. chameleons changes to resemble different backgrounds.

⑦ In countershading, the upper surface of the animal is darker than the under surface and produces the illusion of flatness.

⑧ Countershading also aids many fish and birds by blending them with the sky.

2. Warning coloration.

① Sometimes it is referred as aposematic coloration, which is found in a wide variety of animals, including insects, mites, spiders and frogs.

② Some animals have evolved a way to enjoy the benefits of warning coloration. These animals mimic the coloration of the poisonous animals.

③ The best example is the Viceroy butterfly that looks remarkably like the poisonous monarch butterfly, so birds would end up eating Viceroy butterfly.

- ④ It describes a family of anti predator adaptations in which a warning signal is associated with the unprofitability of a prey item to potential predators.
- ⑤ Aposematism always involves an advertising signal.
- ⑥ The warning signal may take the form of conspicuous animal coloration, sounds, odours or other perceivable characters.
- ⑦ Aposematic signals are beneficial for both the predator and prey, since both avoid potential harm.
- ⑧ California mountain kingsnake which has yellow red and black bands similar to those of highly venomous coral snake which is successful aposematism.
- 3. Aggressive coloration.
 - ① In aggressive colorations, the animals look like something else, it may be background or other animals of same or different species.
 - ② It is mostly seen in predators or parasites.
 - ③ They may attract the prey or hosts to fulfill their need of shelter, food, etc.
 - ④ For example, Snapping turtle has a tongue that looks like a worm. Fish try to eat & being eaten.
 - ⑤ Scorpion fish is drably coloured, but when threatened by predator, become brightly coloured to distract predator.
 - ⑥ Spiders uses a pattern in its web which mimics the nectar guides in flowers, which attracts bees.

Biometry

- (1) Biometry is the analysis of biological data using mathematical and statistical methods. OR It is the science of collection, analysis and interpretation of facts and numbers connected with biology.
- (2) Biometrics is also called as biostatistics.
- (3) A simple example to explain biometry is the estimation of oxygen in a few water samples.
- (4) The water samples form a population.
- (5) The estimation of O₂ in each water sample is the collection of data.
- (6) The amount of oxygen in the water samples is the data.
- (7) Arranging values in columns is called tabulation.
- (8) In one water sample, the amount of oxygen will be higher and another it is lower. This is an interpretation.

Water samples	Amount of O ₂
1	4.5
2	6.9
3	6.2
4	5.3

Scope of biometry.

Without a proper statistical data, it is not at all possible to draw a conclusion for most biological problems. Hence statistics is considered

to be an important tool in biological investigations.

In biology, statistics is required for:

- (i) Presenting facts in a definite order.
- (ii) Simplifying the mass of figures.
- (iii) Facilitating easy comparison.
- (iv) Formulating and testing hypotheses.
- (v) Prediction of correlations between cause & effect.
- (vi) Formulation of suitable biological indices.
- (vii) Developing new policies.

* Data:

- (1) The values recorded in an experiment or observation are called data.
- (2) The word 'data' can be used both as singular and plural. There is no word like 'datas'.
- (3) The data is of two types, namely primary data and secondary data.
- (4) The data collected by an investigator is called primary data. It is the first hand information.
- (5) The person collecting the data is called investigator.
- (6) The data collected from another source, is called secondary data. Data collected from News papers and Journals is a secondary data.

⇒ Types of data.

- 1. Geographical data. 4. Qualitative data.
- 2. Chronological data. 5. Continuous data.
- 3. Quantitative data. 6. Discontinuous data.

1. Geographical data.

Arranging data according to the geographical location is called geographical data.

It describes an object with spatial reference on the Earth's surface.

It can be used to determine a variety of characteristics of a population.

Information gained from geographical data enable details such as economic status, average age, and ethnic diversity in different areas of the country.

Ex. Data of countries, states, districts, etc.

The number of cows reared in different villages can be given as follows:

Name of village	No. of cows
Village 1	70
Village 2	60
Village 3	90

Geographical data: No. of cows reared in three villages.

2. Chronological data.

Data is arranged on the basis of time is called chronological data.

This data is arranged in sequential, ordered, historical, progressive, consecutive manner.

It is relating to or in accordance with chronology.

Ex. In order of time of occurrence.
Ex. Data on years, months, weeks, days, etc.

(5) The coconut yield in four years in a garden is an example of chronological data

Year	No. of coconuts
1995	10000
1996	12000
1997	11000
1998	15000

Chronological data: → Coconut yield in 4 years.

3. Quantitative data.

- (1) The data which is arranged on the basis of quantity is called quantitative data.
- (2) Quantitative data describes whereas qualitative data defines.
- (3) This data can be quantified and verified and is amenable to statistical manipulation.
- (4) The data is generally expressed as a number.
- (5) The data can be measured numerically.
- (6) It is an objective data produced through a systematic process that is verifiable & replicable.
- (7) Ex. Data based on age, weight, height, price, score.
- (8) The different weights of fishes which are captured from a pond is an example of quantitative data.

Sl. no.	Wt. in gms
1	8
2	6
3	7

Quantitative data: Weight of fishes.

4. Qualitative data.

- (1) The data which is arranged on the basis of qualities or attributes is called qualitative data.
- (2) The data approximates or characterizes but does not measure the attributes, characteristics, properties of a thing or phenomenon.
- (3) Quantitative data defines whereas qualitative data describes.

(4) Analysis of qualitative data is difficult and requires an accurate observation.

(5) Qualitative data is extremely varied in nature and it includes virtually any information that may or may not be numerical.

(6) Ex. Data based on colour, sea, literacy, etc.

(7) The fishes captured from a pond can be classified into males and females.

Sex	No. of fishes
Males	20
Females	10

5. Continuous data.

- (1) The data which is arranged on the basis of continuous events is called continuous data.
- (2) It is an information that can be measured on a continuum scale.
- (3) It has almost numeric value.
- (4) Money, temperature, time, volume, size, marks etc. are continuous data.

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(5) Continuous data are not restricted to distinct separate values, but can occupy any value over a continuous range.

(6) Between any two continuous data values there are may be an infinite number of other values.

(7) The continuous data may be presented with class intervals.

(8) 10th class students passed every year with distinct percentage range.

(9) Ex. In Latir board, percentage range of students is given below:

Percentage range	No. of students
95% - 100%	887
90% - 95%	1600
80% - 90%	3500
70% - 80%	6239
60% - 70%	4279
50% - 60%	2517
40% - 50%	918
35% - 40%	123

% Range of SSC students in Latir board

6. Discontinuous data.

(1) The data which is not continuous or broken or interrupted or intermittent is called discontinuous data.

(2) It consists of distinct or unconnected elements, such as physical features of a landscape.

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(5) It is being without sequential order or coherent form.

(6) It can be also called as discrete data.

(7) The data can be numeric like number of apples but it can also be categorical like red or blue, or male and female or good and bad.

(8) In discontinuous data, the items having some values are grouped together.

(9) Ex. Fishes captured in a pond are grouped under some weight categories as below:

Weight in grams	1	2	3	4	5	6	7	8	9
No. of fishes	1	3	1	2	3	4	1		

Methods of collection of data.

(1) The process of getting values and facts from observation or experiment is called collection of data.

(2) The person collecting the data is called as investigator.

(3) The data collected by investigator is called as primary data. It is the first hand information.

(4) If the data is obtained from already collected data is called secondary data.

(5) Following methods are used to collect data.

1. Direct personal interview.
2. Indirect oral interview.
3. Through correspondents.
4. Questionnaire.
5. Experiments.
6. Census.
7. Sampling.

1. Direct personal interview.

- (1) The investigator directly take interview of the individuals for collecting the data.
- (2) The data obtained by this method is original, reliable, authentic and accurate.
- (3) It is more expensive and time-consuming.
- (4) For example, the blood group of a class of students can be easily obtained by personal interview.

2. Indirect oral interview.

- (1) In this method, the data is obtained from witnesses.
- (2) This method is economical but data may not be reliable.
- (3) For example, the number of smokers among college students can be obtained by interviewing the shopkeeper or friends.

3. Through correspondents.

- (1) In this method, the data is collected through appointed persons called as correspondents.
- (2) News agents and reporters are typical correspondents for news papers and television channels.
- (3) The information collected by this method is mostly reliable.

4. Questionnaires.

- (1) Questionnaire is paper containing a set of questions to be answered by an individual for collecting data.
- (2) The questionnaire may be sent through post or through correspondents.
- (3) The questionnaire should possess the following characters :-
 - ① Purpose of questionnaire should be given on a covering letter.
 - ② The questionnaire should be small & simple. Yes/no type and MCQ type.
 - ③ The questions should be direct.
 - ④ Unambiguous questions should not be asked.
 - ⑤ Questions should not hurt to the sentiments.
 - ⑥ Questions related to age, politics, private life, etc. should be carefully worded.

for example. (i) Information of disease.

(ii) Population counting.

5. Experiments.

- (1) The data can be collected by doing experiments.
- (2) The amount of O_2 present in different water samples can be collected by titration experiments.

Water sample	Amount of O_2
Lake	9.0
Well	5.4
Hand pump	6.3

6. Census

- (1) Census is a method of collection of data.
- (2) It is the counting of all members of a population one by one.
- (3) Results obtained in census are reliable and more accurate, because it is a primary data.
- (4) Data is obtained from each and every individual.
- (5) It is very expensive.
- (6) It consumes time and labours.
- (7) Ex(i) Coconut trees of a particular area can be counted by census method.
- (ii) Human population is assessed by census.

7. Sampling

- (1) It is also a method of collection of data.
- (2) It is the process of getting a representative fraction of population.
- (3) Sample is the representative fraction of a population.
- (4) In sampling, a small group is taken from a large population, which is a sample.
- (5) Analysis of sample gives an idea of population.
- (6) When population is very large sampling is the suitable method of collection of data.
- (7) Ex. (i) O₂ content of pond ~~from~~ water can be found by titrating just 1000 ml. or 100 ml of water.
- (ii) One grape is tested before buying the bunch of grapes.

* Graphic representation of data
Presenting data in the form of graphs is called graphic representation of data.

1. Histogram

- (1) Histogram is a graph containing frequencies in the form of vertical rectangles.
- (2) It is an area diagram.
- (3) It is a graphic representation of frequency distribution with frequencies.
- (4) The X-axis is marked with class intervals and Y-axis with frequencies.
- (5) Vertical rectangles are drawn as per the height of the frequency of each class.
- (6) The rectangles are drawn without any gap in between.

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
No. of students	7	14	20	22	18	12	9	5	3	1

Scale: X-axis = Marks

1 cm = 10 marks

Y-axis = No. of students

1 cm = 5 students

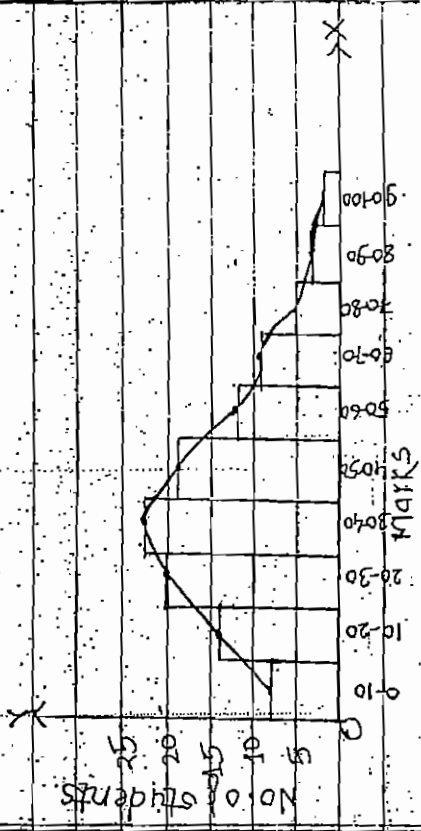


- (7) The width of the rectangle is equal to the range of the class.
 - (8) The height of each rectangle is equal to the frequency of each class.
 - (9) The histogram is a two dimensional diagram because the height and width of each rectangle are as per data.
- ⇒ Uses of histogram.
1. It gives a clear picture of the entire data.
 2. It simplifies a complex data.
 3. It is attractive and impressive.
 4. It is easily memorized.
 5. Median and mode can be located.
 6. It facilitates comparison of two or more frequency distributions on the same graph.
 7. It gives an idea of the pattern of distribution of variables in the population.

- 2. Polygon frequency curve.
- (1) Polygon is a histogram with straight lines joining the midpoints of the top of the rectangles.
- (2) Polygon means a figure with many angles.
- (3) Polygon frequency curve is a graph of frequency distribution where the line is smooth.
- (4) It is just like a frequency polygon but in the polygon, the line is straight while in the curve the line is smooth.
- (5) It is an area diagram.

- (6) It is the graphical representation of frequency distribution.
- (7) The X-axis is marked with class intervals and Y-axis is marked with frequencies.
- (8) A histogram is drawn and the midpoints of the top of the rectangles are joined by a smooth line.
- (9) The beginning and end of the curve should touch the X-axis at the midpoints of first and last class intervals.

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
No. of students	7	14	20	22	18	12	9	5	3	1

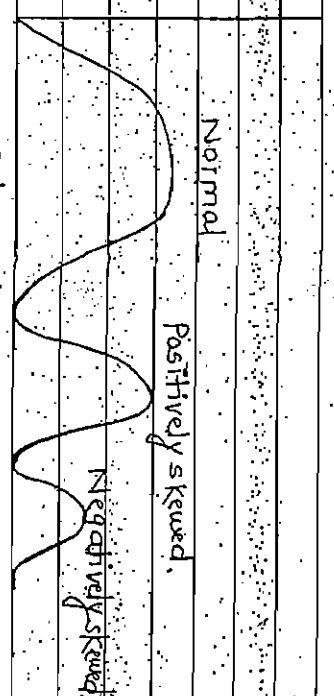


- (10) The area of the curve is equal to that of histogram.
- (11) The frequency curve is divided into 3 types based on the shape of the curve.
 - ① Normal distribution curve.
 - ② Positively skewed distribution curve.
 - ③ Negatively skewed distribution curve.

(12) The normal distribution curve is symmetrical and has an inverted bell-shape.

(13) The positively skewed distribution curve is asymmetrical. The low values of the variables have the highest frequencies.

(14) The negatively skewed distribution curve is also asymmetrical. High values of the variables have the highest frequencies.



Polygon frequency curves

⇒ Uses of frequency curve:

- (1) It gives a clear picture of the entire data.
- (2) It is easily memorized.
- (3) It facilitates comparison of two or more frequency distributions on the same graph.
- (4) It gives an idea of pattern of distribution of variables in the population.

3. Pie diagram

(1) Pie diagram is also called a circle diagram.

(2) The total area of a circle is 360° so the data is converted into degrees, and accordingly the circle is partitioned.

(3) In pie diagram, the data are presented in the form of a circle.

(4) As the data is drawn as per angles (degrees), pie diagram is also called angular diagram.

(5) The partitions are given different colours.

(6) It is an area diagram.

(7) It is a two-dimensional diagram.

⇒ Method of preparation of pie diagram:

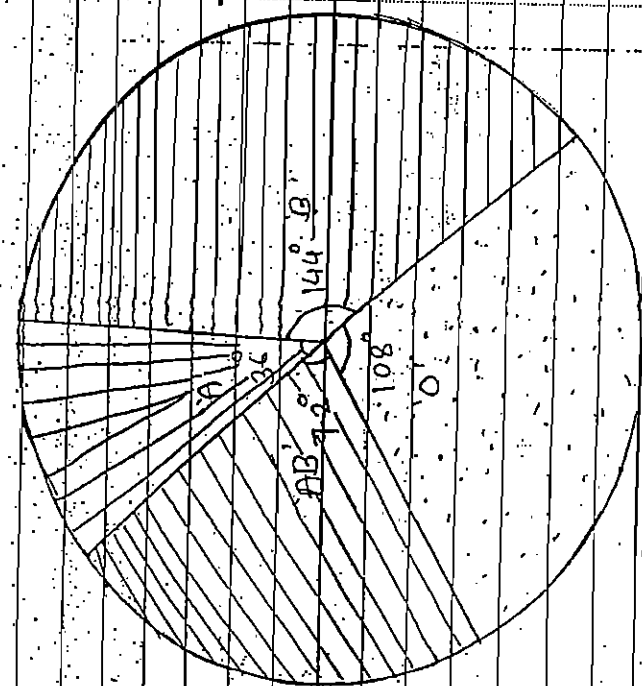
1. The values are added to get the total.
2. Then each value is converted into degrees. This is done by dividing each value by the total and multiplying it by 360 (360 is total degree of circle). A circle is drawn.
3. The degree for each value is measured with a protractor. Usually, the value of the highest degree is marked at 12 o'clock position on the circle.
4. other values are marked in the descending order in the clockwise direction.

Example: → Blood group of 50 students.

Blood Group	Students
A	5
B	20
AB	16
O	15

Blood group of 50 students given in degrees.

Group	Students	Degrees
A	5	$5 \times 960 = 36^\circ$
B	20	$20 \times 960 = 144^\circ$
AB	10	$10 \times 960 = 72^\circ$
O	15	$15 \times 960 = 108^\circ$
Total	50	360°



Pie diagram

* Measures of Central tendency.

- (1) The average of data is called a measure of central tendency.
- (2) The average lies in the middle of the lowest and highest values of data.
- (3) All the average values of population cluster are around average.
- (4) There are three types of averages, namely:
 1. Mean.
 2. Median.
 3. Mode.

1. Arithmetic mean.

- (1) Arithmetic mean is an average obtained arithmetically.
- (2) It is the common average used in our day today life.
- (3) It is commonly called as mean and represented as \bar{X} (X bar).
- (4) It is calculated by adding all the values and dividing the sum by the total number of items.
- (5) The simple formula for the calculation of mean is,

$$\bar{X} = \frac{\sum X}{N}$$

Where,

\bar{X} → Mean (X bar)

\sum → Sum

X → Value

N → Number of items

Merits of mean.

- ① Mean is well defined
 - ② Calculation is easy.
 - ③ All the items are considered for calculation.
 - ④ It is based on each and every observation.
 - ⑤ It is used for other statistical calculations.
- Demerits of mean.
- ① Mean will not be correct if certain values are big or very small.
 - ② It may give false conclusion.
 - ③ It gives absurd values.

For example, the mean children in families is given sometimes as $2\frac{1}{2}$ children.

2. Median.

(1) Median is the middle value of a data when the values are arranged in the ascending order.

- (2) Median is an average. It is a measure of central value.
- (3) Median divides a distribution into two equal halves.
- (4) There will be equal number of items above and below the median.

(5) Median is represented by the symbol Md.

(6) Median can be calculated for ungrouped data and grouped data.

(7) The formula for the calculation of median for ungrouped data is,

$$Md = \text{Value of } \left(\frac{N+1}{2}\right)^{\text{th}} \text{ item}$$

Where, Md → Median
N → Number of Items.

If there are odd number of items, then median is calculated as follows:-

$$Md = \frac{11+1}{2} = 12 = 6^{\text{th}} \text{ item}$$

∴ Median = Value of the 6th item, when the items are arranged in ascending order.

(9) When there are even number of items, the median falls between two items. The values of these two items are added and divided by 2 to get median.

If there are 12 items, the median is calculated as follows:-

$$Md = \frac{12+1}{2} = 13 = 6.5$$

∴ Median = Value of the 6.5th item. It is obtained by adding the value of 6th & 7th item and dividing the sum by 2.

(10) Median of grouped data with class interval can be calculated by the following formula:-

$$\text{Median} = L + \left(\frac{N/2 - CF}{f}\right) \times C$$

Where, L → Lower limit of the median class

N → Total frequency

- c.f → Cumulative frequency prior to the median class
 - c → class interval of the median class
 - f → Frequency of the median class.
- Merits of median.
- ① Simple to calculate.
 - ② It can be calculated without knowing the values of all the items.
 - ③ It is unaffected by extreme values.
 - ④ It can be calculated graphically.
- Demerits of median.
- ① It is not based on all the items.
 - ② It is not used as a common average.
 - ③ It is not used for further statistical calculation.

- Difference between Mean and Median.
- | | |
|------|--------|
| Mean | Median |
|------|--------|
1. It is the average calculated by dividing sum of all values by total no. of items.
 2. Represented as \bar{X} (or) \bar{x} .
 3. All items are considered.
 4. Calculated as $\frac{\sum X}{N}$.
 5. It is a mathematical average.
 6. Affected by extreme values.

- Mode
- (1) Mode is the value of the variable which occurs most frequently in a distribution.
 - (2) The value which occurs many times in the table is the mode.
 - (3) It is represented by the letter Mo.
 - (4) Mode is an average. It is a positional average.
 - (5) It is a measure of central value.
 - (6) When a data has one concentration of frequency, it is called unimodal, when it has two concentrations, it is called bimodal and when it has three concentrations of frequency, it is called trimodal.
 - (7) Mode can be calculated for ungrouped data and grouped data.
 - (8) To find out mode of an ungrouped data, the values are arranged in an ascending order. The value which occurs maximum number of times is the mode.
18, 21, 23, 23, 25, 25, 25, 27, 29, 29.
In the above data, 25 occurs maximum number of times, so 25 is the mode.
 - (9) The mode of a discrete distribution is the value of the variable which shows maximum frequency.
- | | | | | | | | |
|-----------------------------|----|----|----|----|----|----|----|
| No. of coconut trees | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| No. of coconuts (frequency) | 3 | 4 | 12 | 24 | 26 | 7 | 11 |
- In the above table, 14 is the mode because the values are maximum here.

⇒ Merits of Mode

- ① Mode can be easily found out.
- ② No calculation is needed.
- ③ It is not affected by extreme values.
- ④ It can be calculated graphically.
- ⇒ Demerits of Mode.
- ① It is not clearly defined.
- ② It is not based on all observations.
- ③ It is not reliable.
- ④ It is not used for further statistical calculation.

* Measures of variability.

(1) Measure of variability is the deviation of the individual values around the central value of a data.

- ② It is also called as measure of dispersion.
- ③ It is the measure of variation of items.
- ④ The measure of variation has the following significances.
- ① It helps to determine the reliability of an average.
- ② It serves as a basis for the control of variability.
- ③ It helps to compare two or more data regarding variability.
- ④ There are different types of measure of variability two important ones are given below:→

- 1. standard deviation.
- 2. standard error.

1 Standard deviation

① It is a measure of deviation.
 ② It is defined as the square root of mean of the squares of deviations from the mean.

③ standard deviation is represented by SD or σ (sigma).
 It is calculated by the following formula,

$$SD = \sqrt{\frac{\sum (X - \bar{X})^2}{N}}$$

Where, SD → standard deviation.

X → Value of an observation.

\bar{X} → Mean.

N → Number of items.

Σ → Sum of.

⇒ Merits.

- ① Standard deviation is rigidly defined.
- ② All the values are considered for calculation.
- ③ Squaring makes the negative signs into plus signs.
- ④ It is less affected by sampling.
- ⑤ It is used for further calculations.

⇒ Demerits.

- ① Calculation is complex.
- ② It is affected by the value of each item.

2. Standard error.
- (1) It is the difference between the means of the population and its sample.
- (2) Standard error is defined as the ratio of standard deviation of the sample divided by the square root of the total number of observations.
- (3) It can be formulated as follows:

$$\text{standard error (SE)} = \frac{SD}{\sqrt{N}}$$
 Where, SD \rightarrow standard deviation
 N \rightarrow Total number of observations.
- (4) Standard error is abbreviated as SE.
- (5) It is given in the same unit as the data.
- \Rightarrow Uses of Standard error:
- ① It helps to understand the difference between two samples.
 - ② It helps to calculate the size of the sample.
 - ③ It helps to determine whether the sample is drawn from a known population or not.

Numerical Problems on Mean (Arithmetic mean)

(1) The weight of 10 fishes in gms is given below. find the mean.

Sl. No.	1	2	3	4	5	6	7	8	9	10
Weight	12	15	11	19	16	20	14	20	12	11.

\rightarrow Given data: $N = 10$.

$\Sigma X =$ Sum of all values i.e. weights of fishes

$\Sigma X = 12 + 15 + 11 + 19 + 16 + 20 + 14 + 20 + 12 + 11$

$\Sigma X = 150$ gms

$\therefore \text{Mean } (\bar{X}) = \frac{\Sigma X}{N}$

$X = \frac{150}{10}$

$\bar{X} = 15$ gms

(2) Calculate the mean for the following data.

Wt. of fishes	6	7	8	9	10	11
No. of fishes	15	17	20	16	19	13

\rightarrow Given data: \rightarrow

Weight (X)	No. of fishes (f)	f.X
6	15	15 X 6 = 90
7	17	17 X 7 = 119
8	20	20 X 8 = 160
9	16	16 X 9 = 144
10	19	19 X 10 = 190
11	13	13 X 11 = 143
	$\Sigma f = 100$	$\Sigma f.X = 846$

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$$\text{Mean } (\bar{x}) = \frac{\sum fx}{\sum f}$$

$$\bar{x} = \frac{846}{100}$$

$$\bar{x} = 8.46 \text{ gms}$$

(3) Find the mean for the following data.

Wt. of fishes (X)	10-20	20-30	30-40	40-50	50-60
No. of fishes (f)	15	17	16	19	13

Given data:

Wt. of fishes (X)	Mid-value (m)	No. of fishes (f)	f _m
(Classes)	(Class mark)		
10-20	$10+20/2 = 15$	15	$15 \times 15 = 225$
20-30	$20+30/2 = 25$	17	$25 \times 17 = 425$
30-40	$30+40/2 = 35$	16	$35 \times 16 = 560$
40-50	$40+50/2 = 45$	19	$45 \times 19 = 855$
50-60	$50+60/2 = 55$	13	$55 \times 13 = 715$
		$\sum f = 80$	$\sum fm = 2780$

$$\therefore \text{Mean } (\bar{x}) = \frac{\sum fm}{\sum f}$$

$$\bar{x} = \frac{2780}{80}$$

$$\bar{x} = 34.75 \text{ gms}$$

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Numerical Problems on Median.

(1) Find the median weight of fishes from the following data:

Sl. No.	1	2	3	4	5
Wt. in gms.	12	15	11	19	16

Given: \rightarrow No. of items, $N = 5$.

Arrange the data in ascending order.

Sl. No.	1	2	3	4	5
Wt. in gms.	11	12	15	16	19

Median (Md) = Value of $(\frac{N+1}{2})^{\text{th}}$ item

$$\text{Md} = \left(\frac{5+1}{2} \right)^{\text{th}} \text{ item value}$$

Md = Value of 3rd item

$$\text{Md} = 15 \text{ gms}$$

(2) Find the median of the following data.

Sl. No.	1	2	3	4	5	6
Wt. in gms.	11	12	15	16	19	17

Given: \rightarrow No. of items, $N = 6$.

Arrange the data in ascending order.

Sl. No.	1	2	3	4	5	6
Wt. in gms.	11	12	15	16	17	19

$$\text{Md} = \text{Value of } \left(\frac{N+1}{2} \right)^{\text{th}} \text{ item}$$

$$\text{Md} = \text{Value of } \left(\frac{6+1}{2} \right)^{\text{th}} \text{ item}$$

$\therefore Md = \text{Value of } 3.5^{\text{th}} \text{ item}$

So, median is in between 3rd and 4th items

Value of 3rd item = 15

Value of 4th item = 16

$\therefore \text{Median} = 15 + \frac{16}{2}$

2

$\therefore Md = 31$

2

$\therefore Md = 15.5 \text{ gms}$

(2) 16% of an animal was recorded as 6, 7, 4, 5, 5, 3 and 4 mg/100ml - Calculate the median.

→ Arrange the data in ascending order:

3, 4, 4, 5, 5, 6, 7

No. of items, $N = 7$

$\therefore \text{Median (Md)} = \left(\frac{N+1}{2} \right)^{\text{th}} \text{ item's value}$

$\therefore Md = \left(\frac{7+1}{2} \right)^{\text{th}} \text{ item's value}$

$\therefore Md = \text{Value of } 4^{\text{th}} \text{ item}$

$\therefore Md = 5\%$

(4) Find the median weight of fishes from the following data:

WT of fishes (gms)	6	7	8	9	10	11
No. of fishes	15	17	20	16	19	13

→ Given data:

WT of fishes (gms)	No. of fishes (N)	Cumulative frequency (cf)
6	15	15
7	17	32
8	20	52
9	16	68
10	19	87
11	13	100
N = 100		cf = 100

$\therefore \text{Median (Md)} = \text{Value of } \left(\frac{N+1}{2} \right)^{\text{th}} \text{ item}$

$\therefore Md = \text{Value of } \left(\frac{100+1}{2} \right)^{\text{th}} \text{ item}$

$\therefore Md = \text{Value of } 50.5^{\text{th}} \text{ item}$

In the data, 50.5th item lies in between 52 and 52 of cumulative frequency. So, take the highest cumulative frequency 52 and its corresponding weight 8 gms.

$\therefore Md = 8 \text{ gms}$

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(5) Find out the median weight of fishes from the following data :-

Weight in gms	10-20	20-30	30-40	40-50	50-60
No. of fishes	15	17	16	19	13

Classes	Frequency	Cumulative Frequency
10-20	15	15
20-30	17	32
30-40	16	48
40-50	19	67
50-60	13	80

Given \rightarrow L = Lower limit of median class = 30

N = Total frequency = 80

CF = Cumulative frequency prior to

median class = 32

C \rightarrow class interval of median class = 10

F = frequency of the median class = 16

$$\therefore \text{Median (Md)} = L + \left(\frac{N/2 - CF}{F} \right) \times C$$

$$\therefore \text{Md} = 30 + \left(\frac{80/2 - 32}{16} \right) \times 10$$

$$\therefore \text{Md} = 30 + (8/16) \times 10$$

$$\therefore \text{Md} = 30 + 5$$

$$\therefore \text{Md} = 35 \text{ gms}$$

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* Numerical problems on Mode

(1) Find the mode from the following data showing weight of fishes :-

Weight of fishes (gms)	10	14	11	12	14	13	15	14
------------------------	----	----	----	----	----	----	----	----

Arrange data in ascending order :-

10, 11, 12, 13, 14, 14, 14, 15.

The value 14 is repeated 3 times, so 14 is mode
 \therefore Mo = 14 gms

(2) Find the mode of following data.

Wt. of fishes (gms)	18	19	20	21	22	23
No. of fishes	30	35	28	26	24	25

Given \rightarrow There is maximum number of 35 fishes

with the weight 19 gms. Therefore 19 gms is the mode.

$$\therefore \text{Mo} = 19 \text{ gms.}$$

(3) Water % of 16 fishes of pond were recorded as

60, 64, 62, 76, 70, 74, 70, 84, 82, 72, 78, 84, 86, 68,

70 and 62. Find out the mode of the series.

Arrange the data in ascending order.

60, 62, 62, 64, 68, 70, 70, 70, 72, 74, 76, 78, 82, 84, 84, and 86.

The value 70 is repeated 3 times, so 70 is mode

$$\therefore \text{Mo} = 70\%$$

* Numerical problems on Standard deviation

(1) Calculate standard deviation for the following data:

Weight of fishes (gms) = 8, 6, 7, 5, 6, 10, 8, 6, 7, 7

→ Given data: $N = 10$.

$$\sum X = 8 + 6 + 7 + 5 + 6 + 10 + 8 + 6 + 7 + 7$$

$$\therefore \sum X = 70$$

$$\text{Mean } (\bar{X}) = \frac{\sum X}{N} = \frac{70}{10}$$

$$\therefore \bar{X} = 7 \text{ gms}$$

Wt. in gms (X)	(X - \bar{X})	(X - \bar{X}) ²
8	1	1
6	-1	1
7	0	0
5	-2	4
6	-1	1
10	3	9
8	1	1
6	-1	1
7	0	0
7	0	0
$\sum X = 70$		$\sum (X - \bar{X})^2 = 18$

$$\therefore \text{Standard deviation (SD)} = \sqrt{\frac{\sum (X - \bar{X})^2}{N}}$$

$$\therefore \text{SD} = \sqrt{18/10}$$

$$\therefore \text{SD} = \sqrt{1.8}$$

$$\therefore \text{SD} = 1.3 \text{ gms}$$

(2) Hb% of a class was recorded as 23, 22, 20, 24, 16, 17, 18, 9 and 21. Calculate the standard deviation.

→ Given data: $N = 9$.

$$\sum X = 23 + 22 + 20 + 24 + 16 + 17 + 18 + 9 + 21$$

$$\therefore \sum X = 180$$

$$\therefore \text{Mean } (\bar{X}) = \frac{\sum X}{N}$$

$$\therefore \bar{X} = 180/9$$

$$\therefore \bar{X} = 20\%$$

Percentage % of Hb (X)	(X - \bar{X})	(X - \bar{X}) ²
23	-3	9
22	-2	4
20	0	0
24	-4	16
16	4	16
17	3	9
18	2	4
19	1	1
21	-1	1
$\sum X = 180$		$\sum (X - \bar{X})^2 = 60$

$$\therefore \text{Standard deviation (SD)} = \sqrt{\frac{\sum (X - \bar{X})^2}{N}}$$

$$\therefore \text{SD} = \sqrt{60/9}$$

$$\therefore \text{SD} = \sqrt{6.66}$$

$$\therefore \text{SD} = 2.56\%$$

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(3) Calculate standard deviation for the following data which shows the length of fishes

Length in cm	5	6	7	8	9	10	11
No. of fishes	1	2	5	5	3	3	1

(4) Calculate standard deviation for the following data which shows the weight of fishes in gms.

Weight in gms	0-10	10-20	20-30	30-40	40-50
No. of fishes	2	4	6	5	3

Given :->

Length in cm (X)	Frequency (f)	f.X	$\bar{X} = 8$	$(X - \bar{X})^2$	$f.(X - \bar{X})^2$
5	1	5	-3	9	9
6	2	12	-2	4	8
7	5	35	-1	1	5
8	5	40	0	0	0
9	3	27	1	1	3
10	3	30	2	4	12
11	1	11	3	9	9
$\Sigma f = 20$		$\Sigma fx = 160$			$\Sigma f(X - \bar{X})^2 = 66$

Mean $(\bar{X}) = \frac{\Sigma f.x}{\Sigma f(N)}$

$\bar{X} = \frac{160}{20}$
 $\bar{X} = 8$

Standard deviation (SD) = $\sqrt{\frac{\Sigma f.(X - \bar{X})^2}{\Sigma f}}$

$\therefore SD = \sqrt{\frac{66}{20}}$
 $\therefore SD = \sqrt{3.3}$

$\therefore SD = 1.5 \text{ cm}$

Given :->

Classes (m)	Midvalue (m)	Frequency (f)	F.m	$\bar{X} = 26.5$	$(m - \bar{X})^2$	$f.(m - \bar{X})^2$
0-10	5	2	10	-21.5	462.25	924.5
10-20	15	4	60	-11.5	132.25	529
20-30	25	6	150	-1.5	2.25	13.5
30-40	35	5	175	8.5	72.25	361.25
40-50	45	3	135	18.5	342.25	1026.75
$\Sigma f = 20$		$\Sigma fm = 590$				$\Sigma f(m - \bar{X})^2 = 2855$

Mean $(\bar{X}) = \frac{\Sigma f.m}{\Sigma f}$

$\therefore \bar{X} = \frac{590}{20}$
 $\therefore \bar{X} = 29.5$

Standard deviation (SD) = $\sqrt{\frac{\Sigma f.(m - \bar{X})^2}{\Sigma f}}$

$\therefore SD = \sqrt{\frac{2855}{20}}$
 $\therefore SD = \sqrt{142.75}$

$\therefore SD = 11.95 \text{ gms}$

Bioinformatics

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* Introduction to bioinformatics.

- (1) Bioinformatics is information technology dealing with the maintenance and use of data of molecular biology using computers.
- (2) In short, it is the information technology applied to molecular biology.
- (3) The term 'Bioinformatics' took its origin from two epithets 'Bio' meaning living and 'informatics' meaning information science.
- (4) It is also called computational molecular biology.

Components of Bioinformatics.

The major components of Bioinformatics can be understood through the Central Dogma.

These four components construct the frame work of bioinformatics.

1. Genomics: Genomics deals with the study of genomes of organisms. It includes sequencing, assembling and mapping the complete genome of organisms. Human genome is completely sequenced under the Human Genome Project.

2. Transcriptomics: Transcriptomics deals with the study of expression of genes through mRNA using DNA microarray. It studies the expression of a single gene in different cells or tissues. It helps to understand several molecular mechanisms and signalling pathways.

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3. Proteomics: Proteomics deals with the structure and functions of protein. It helps to understand the post-translational modifications, protein-protein interaction and the 3D structure of protein.

4. Metabolomics: Metabolomics deals with the study of cellular processes and the components involved in it. This field develops the profile of metabolites involved in the cellular processes of organisms.

DNA

Genomics

↓

RNA

Transcriptomics

↓

Protein

Proteomics

↓

Enzymes

Metabolomics

Components of Bioinformatics.

Bioinformatics in Life Science.

(1) With the advent of bioinformatics, scientists now formulate biological questions and interpret research results using the growing biological databases.

(2) Genome sequencing is the major breakthrough, by which, the genome of several organisms, including human are sequenced, mapped and stored in the database.

(3) These genome databases will provide new avenues for advances in Medicine, Biotechnology, Genetics, etc.

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- (4) Studies on these genomes have promoted the researches on the etiology of various disease like cancers, cystic fibrosis, liver diseases, etc.
- (5) It is possible to study a disease at gene level. Its evolutionary relationship with organisms like mice, fruitfly or yeast.
- (6) The analysis of similarities between DNA sequences of different organisms is also opening new avenues in the study of evolution.
- (7) It also leads to study of gene diversity in an ecosystem.
- (8) With the protein database scientists study its function, role in various diseases, its position in a metabolic pathway of a cell, etc.
- (9) As a whole bioinformatics has influenced various branches of life science from evolution to Nano technology.

⇒ Importance of Bioinformatics.

- (1) Bioinformatics gained its important through Human Genome Project.
- (2) Bioinformatics is a multidisciplinary subject involving Biology, Computer science, Physics, Chemistry, Mathematics, Statistics and Medicine.
- (3) It deals with the practice of storing, searching and distribution of biological data.
- (4) It is used to analyse the sequence data of nucleic acids and proteins to study the molecular structure.

- (5) It develops computational tools, database and methods for biological research.
- (6) It provides graphical interface for biological research like drug designing, protein engineering, phylogenetic analysis, etc.
- (7) It is highly important in Modern Molecular Biology, Research, etc.
- (8) It convert the properties of biological system into mathematical models to experiment on the computer.
- (9) It has greatly decreased the duration of drug discovery. It's from 15 years to 3-4 years.
- (10) It has brought out several evolutionary signifiants based on molecular study on various organisms.
- (11) Being an young field, it attracts young researchers due to the scope of computers in recent years.
- (12) It has now become impossible to perform biological research without the role of computer in it.

⇒ Applications of Bioinformatics.

- 1. Molecular medicine.
- 2. Personalized medicine.
- 3. Preventative medicine.
- 4. Gene therapy.
- 5. Drug development.

6. Microbial genome applications.

7. Waste cleanup.

8. Climate change studies.

9. Alternative energy sources.

10. Biotechnology.

11. Antibiotic resistance.

12. Bioweapon creation.

13. Evolutionary studies.

14. Veterinary science.

15. Crop improvement for,

① Insect resistance.

② Improved nutritional quality.

③ Drought resistant varieties.

1. Molecular medicine :-> The human genome has several applications in the fields of biomedical research and clinical medicine. Research on each and every disease is possible through the study of human genome.

2. Personalized medicine :-> Clinical medicine will become more personalized with the development of the field of pharmacogenomics.

3. Preventive medicine :-> Successful result in huge advances in our struggle to conquer disease can be brought to us by knowledge of bioinformatics.

4. Gene therapy :-> Gene therapy is the treatment of genetic diseases by using genes. It is possible only through the study of bioinformatics.

5. Drug development :-> More knowledge of proteomic and disease mechanisms enable us to identify and validate new drug targets, on which the drugs act selectively.

6. Microbial genome applications :-> All activities & properties of microbes are determined by their genome. Therefore, microbial genomics offers a greater insight into the microbial world. They have broad and far implications on environment, health, energy and industrial applications.

7. Waste cleanup :-> ~~Deinococcus radiodurans~~ is the world's toughest bacterium and it is the most radiation resistant organism known. Scientists are interested in this organism because of its potential usefulness in cleaning up waste sites that contain radiation and toxic chemicals.

8. Climate change studies :-> Extensive use of fossil fuels as energy source is the major cause for carbon dioxide pollution in the atmosphere. Increasing CO2 has much adverse effects in the global time. Recently, the DOE (Department of Energy, USA) has launched a program to decrease atmospheric CO2 levels by using some microbes.

9. Alternative energy sources :-> Scientists are studying the genome of the microbe *Chlorobium tepidum* which has an unusual capacity for generating energy from light, as an alternative energy source.

10 Biotechnology :-> Protechnology database offers much more information about microbial biodiversity and usefulness of different microbes that can be used in biotechnology industry.

Ex. Xanthomonas campestris is grown commercially to produce the exopolysaccharide xanthan gum, which is used as a viscosifying and stabilizing agent in many industries.

② Lactococcus lactis is one of the important microorganisms being used in dairy industry, which is helpful in many dairy products like buttermilk, yogurt and cheese.

11 Antibiotic resistance :-> Genomics database provide fine details about the genetic control of antibiotic resistance and mode of its transmission.

12 Bio weapon creation :-> Genomics database provide complete information for artificial synthesis of viruses, scientists have recently built the polio virus.

13 Evolutionary studies :-> The sequencing of genomes from all three domains of life, eukaryota, bacteria and archaea i.e. evolutionary studies can be performed. These studies are performed in order to determine the evolutionary tree of life and the last universal common ancestor.

14 Veterinary science :-> Sequencing projects in farm animals including cows, pigs and sheep will provide a better understanding of the biology of these animals which impacts on production & health of livestock & ultimately have benefits for human nutrition.

15

Crop improvement :-> Information about plant genome is essential for planning better breeding programs, leading to crop improvement. At present the complete genome of rice (Oryza sativa) is available. It takes for various purposes as,

① Insect resistance :-> Genomics enables us to know about details of gene coding for insect resistance & transfer of such genes through rDNA technology. Ex. Bt gene Bacillus thuringiensis is successfully transferred to cotton, maize and potatoes.

② Improve nutritional quality :-> Bioinformatics offers possible clues for which gene has to be chosen and transferred to improve the nutritional quality of plant products. Ex. Golden rice is rich in Vit-A. Drought resistance varieties :-> The idea of a genome of plants and microbes is very necessary to transfer genes with a view to developing plants with drought resistance and stress tolerance.

*** Introduction to biological database.**

A biological database is a collection of biological data that is organized, so that its contents can easily be accessed, managed and updated.

Biology is a data rich science. The data in biology includes :-
 Biological molecules.
 Nucleic acid sequences.
 Protein sequences.

Protein structure

Metabolic pathways

Molecular interactions

Mutations

Polymorphism in sequences

Polymorphism in structure

Polymorphism in organelle structure

Polymorphism in tissue types

Genetic maps

Gene expressions, etc.

Major databases in bioinformatics are :-

(a) NCBI and (b) PubMed

(a) NCBI

(1) NCBI stands for National Centre for Biotechnology Information.

(2) It is a part of the United States National Library of Medicine (NLM), a branch of the National Institute of Health.

(3) The NCBI is located in Bethesda, Maryland and was founded in 1988 through legislation sponsored by Senator Claude Pepper.

(4) The NCBI houses a series of databases relevant to biotechnology and biomedicine.

(5) Along with it major databases include GenBank for DNA sequences and PubMed - a bibliographic database for the biomedical literature

(6) NCBI is easily available online through entering in search engine.

(7) NCBI is directed by David Lipman, one of the original authors of the BLAST sequence alignment program and a widely respected bioinformatics.

(8) The NCBI has responsibility for making available Gen Bank for DNA sequence database.

(9) Gen Bank coordinates with individual laboratories and other sequence databases such as European Molecular Biology Laboratory (EMBL) and the DNA Data Bank of Japan (DDBJ).

(10) Since 1992, NCBI has grown to provide other databases in addition to Gen Bank.

(11) NCBI provides Genes and Mendelian inheritance information (i) the molecular modelling database (ii) protein structures

(iii) dbSNP (a database of single nucleotide polymorphisms).

(iv) a reference sequence collection.

(v) a map of the human genome.

(vi) taxonomy.

(vii) and coordinates with the National Cancer Institute to provide the Cancer Genome anatomy Project.

(12) The NCBI assigns a unique identifier to each species of organism in taxonomy. I number.

(3) The NCBI provides a facility of books which is freely downloadable.

(11) PubMed tries to answer clinical queries submitted by people all over the world to it.

(4) Online version of selected biomedical books are also available which includes the topics like molecular biology, biochemistry, cell biology, genetics, microbiology, disease states from a molecular and cellular point of view, research methods and virology.

(12) GoPubMed explores matters on Gene ontology. PubMed Tool provides clipboard facilities to use PubMed database.

(5) Pubmed stands for Publishers on Medicine.

(13) PubMed Reader is an alternative interface for PubMed PMID is an acronym for PubMed Identifier in PubMed.

(2) It is a biological database.

(14) The above interfaces are external links to PubMed web base.

(3) It is a search database.

(15) PubMed central is a digital archive of biomedical and life science journals.

(4) It helps to access the MEDLINE Database.

(16) It is available at <http://www.pubmedcentral.com> for advanced search. If a name of article is to be searched, it is typed in the box and clicked the Find Articles button, the particular article is displayed on the screen.

(5) It is a part of Entrez.

(17) PubMed also facilitates to select a journal and visualize all articles published in that journal.

(6) The National Library of Medicine (NLM) of United States maintains this database.

(18) Uses of PubMed

(7) PubMed offers access to articles on medicine, nursing and health disciplines.

(19) It provides articles on medicine, nursing & health.

(8) Full text articles on Biochemistry, cell biology and microbiology are also obtained from this site.

(20) It provides articles on cell biology, Biochemistry and Microbiology.

(9) About 14,000 users visit the PubMed to seek information per day.

(21) It provides articles free of cost.

(10) Many PubMed citations have links to full text articles available in the PubMed Central digital library.

(22) It gives answers for clinical queries.

Computer

- (1) Computer is an electronic device for data storage and processing to give desired results.
- (2) The word computer is derived from the Latin word 'Computare' which means 'to calculate'.
- (3) The computer is a programmable machine.
- (4) It accepts input data, processes the data according to the instruction given to it and produces the required output.
- (5) The instruction is given to a computer in the form of a step-by-step program.
- (6) The output may be in the form of numbers, graphs or images.
- (7) Like electricity, computer becomes an unavoidable machine in the ultra-modern society.
- (8) Computers play an important role in the day to day activities of human beings in recent years.
- (9) They are the major components of Information Technology (IT).
- (10) Computer is known for its tremendous speed.
- (11) It reduces the manual work and performs the complex task easily in a few seconds.
- (12) They are used in a variety of fields like education, medicine, sports, engineering, rocket launching, industry, banks, business, stores, etc.
- (13) Computer has four major parts. They are:-
 1. Keyboard. 3. Central Processing Unit (CPU)
 2. Mouse. 4. Monitor.

Applications in Biology

- (1) Scientists use computers to develop theories, to collect and test data and to exchange information electronically with colleagues throughout the world.
- (2) Researchers can access data in distant locations via email.
- (3) Scientists can use powerful computer to generate detailed studies of how earthquakes affect buildings or pollution affects weather patterns.
- (4) Scientists use computers to analyse percentage of materials present in the chemicals, soil samples and even the air we breathe.
- (5) Computers are used to solve complex mathematical equations to determine if a data is valid.
- (6) Computers are used to predict the erosion rate of beaches.
- (7) Computer programs are used to predict climate patterns.
- (8) Computers are used to diagnose the disease from various clinical and laboratory tests conducted in hospitals.
- (9) It is used to monitor surgical machines during surgery.
- (10) It is used to store patient data, medical history of the patient, previous treatments, tests, diagnosis, symptoms, etc.
- (11) Computers are used to conduct & examine many clinical imaging processes like X-ray, CT scan, etc.
- (12) Life support system which is the special computerized system is provided in case of emergency.

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* Internet

(1) A system of linking a lot of computers for enabling them to communicate with and share information from each other is known as Internet or network.

(2) It is also called Net.

(3) All computers in a network are connected together by telephone lines, cables, mobile devices and communication satellites.

(4) It is used to share information globally.

(5) It connects the thousands and millions of computers in the world.

(6) It serves as a global data communication system. It links billions of private, public, academic and business networks through various optical and electronic networking technologies.

(7) Internet is managed by several organizations and committees. They are:-

① The Internet Society.

② The Internet Activities Board.

③ The Federal Research Internet Coordinating Committee

④ The Federal Networking Council, etc.

(8) These groups framed a set of rules and standards for different computer networks to work together.

(9) The most important group that organizes Internet is the Internet Society. It is a private non-profit group.

(10) Internet Society supports the Internet Activities Board (IAB) to handle the Internet's architectural issues.

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(11)

Internet allows the users to send electronic mail (e-mail), to access multimedia information, to post information for others to access, etc.

(12) It is not managed by or belong to a single organization. It is managed by a number of organizations that own the computer network connected to the Internet.

(13) They follow a set of rules, known as protocols.

Internet Protocol (IP)

Internet Protocol is the method or protocol by which data is sent from one computer to another on the internet.

(2) Each website is associated with an Internet Protocol (IP) address.

(3) This address will be of 4 bytes integer and each integer is separated by a dot.

(4) This notation is known as dotted decimal notation.

(5) For example, 192.168.0.234 & 67.48.90.250 are typical IP address examples.

(6) Any device is connected to the internet using an IP address.

(7) IP address is used to identify other machines through the massive network.

Domain Names

- (1) Every computer connected to the internet is assigned a unique IP address.
- (2) Since it is difficult to remember this IP address hence, each IP address is associated with a corresponding domain names.
- (3) A domain name is a simple alphanumeric string hence instead of remembering the IP address of the website users needs to remember only the domain name of the website.

(4) Yahoo, com, live in are some of the examples of domain names.

- (5) These domain names are maintained by INTERNIC.
- (6) In order to create a new website, the domain name must be registered with the INTERNIC.

Uses of Internet (Internet applications)
Internet is a valuable tool for using in many significant ways. The important uses are listed below:

1. Education
2. Online communication
3. Software sharing
4. Blogging
5. Online shopping
6. Customer support service
7. Online journals and magazines
8. Social networking
9. Job search

1. Education

- (1) The internet is useful for students to gather information relevant to their research or to gather knowledge.
- (2) It provides online exams and immediate results.
- (3) Students can apply for online tutorials & study notes.
- (4) Distance education is offered through internet.
- (5) e-class, e-learning is carried out through internet.
- (6) Internet gives an opportunity to share their knowledge with others.

(7) With the effective use of internet technology, virtual universities have been created in some countries.

2. Online communication

- (1) Internet users use various e-mail services to communicate with each other. Ex. Gmail, Rediff, etc.
- (2) They use the internet for online video chatting and online video conferencing through Skype, Gmail, etc.
- (3) Internet telephony is a good tool of real time chatting.

3. Software sharing

- (1) The internet provides access to a large number of shareware software, development tools & utilities.
- (2) Ex. Compilers, mail servers, operating system.
- 4. Blogging

(1) The internet users can post numerous blogs in the internet portal.

(2) A blog is used as a communication platform to interact with people.

(3) The owner of the blog can create the blog of their choice.

Date ___/___/___

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5. Online shopping.

① Online shopping is becoming popular in this busy world.

② Anything can be bought with the use of internet.

③ There are many sites, using which the users can purchase any products by sitting in the home.

④ Ex. Amazon, Flipkart, etc.

6. Customer Support Service.

① Many organizations also use the internet to provide timely customer support.

② The companies help the customers to receive the ordered product in time.

7. Online Journal and Magazines.

① The internet has thousands of electronic subscribers found both for free and at low cost.

② There are many websites on the internet to view the journals and magazines online.

③ Ex. The times of India, The hindu, etc.

8. Social Networking.

① Today social networking sites have become an important part of online community.

② Almost all users are members of this site for personal and business purposes.

③ It is an awesome place to network with many entrepreneurs and to find school and college friends.

④ Ex. Facebook, twitter, etc.

9. Job search.

① Internet makes it easy for both employers and job seekers by providing many job recruiting sites.

② There are plenty of job sites which connect employers and job seekers to meet their needs.

③ Ex. Naukri.com, NAK, MonsterIndia, etc.

* Search Engines.

① A web search engine is a software system.

② It is designed to search for information on the world wide web.

③ The search results are generally presented in a line of pages.

④ The information may be present in the form of pages, images, files, etc.

⑤ Some search engines also make data available in databases or open directories.

⑥ Search engine also maintain real time information by running an algorithm on a web crawler.

→ Working of search engines.

① When a user enters a query into a search engine typically using keywords, the engine examines its index and provides a listing of best matching web pages according to its criteria.

② The information usually with a short summary containing the documents title and sometimes parts of the text.

③ The index is built from the information stored with the data and the method by which the information is indexed.

④ Most web search engines are commercial ventures supported by advertising revenue, thus they allow advertisers to show their products or data on their webpages.

⑤ Search engines that do not take money for their search results, they are make money by running search related advertise, alongside the regular search engine results.

⑥ Search engines make money every time when someone clicks on one of these advertise.

→ Some of the examples of search engines and their market shares in Dec-2010.

- (i) Google - 84.65%
- (ii) Yahoo - 6.69%
- (iii) Baidu - 8.39%
- (iv) Bing - 3.29%
- (v) Yandex - 1.3%
- (vi) Ask - 0.56%
- (vii) AOL - 0.42%

Google is the most popular search engine in the world. Yahoo, Bing and other search engines are more popular in the U.S. than in Europe.

Most Popular search engines are given below.

Google.

① Google stands for Global organization of oriented Group language of Earth.

② Google search is a web search engine owned by Google, headquartered at Mountain View, California.

③ Google is an American multinational technology company specializing in internet-related services and products.

④ These include online advertising technologies, search, cloud computing, software and hardware.

⑤ It is handled by more than three billion searches every day.

⑥ It provides at least 22 special features like weather, maps, earthquake, date, sports, etc.

⑦ It is launched on 15 Sept 1997 and founded in 1996 by Larry Page and Sergey Brin.

⑧ Alexa, a company that monitors commercial web traffic, listed Google.com as the most visited website in the world.

⑨ The Google webpage is given as follows:-

Google

Search

Images

Google+

More.....

Kesari.1995@gmail.com Sign out.

Preferences - Feedback - Help

© 2017 - Privacy

2. WWW. Yahoo.com

① Yahoo stands for Yet Another Hierarchical

② Official's Oracle.

③ It is a web search engine.

④ It is an American multinational technology

company headquartered in Sunnyvale, California.

⑤ Yahoo was founded by Jerry Yang and David

Filo in January 1994.

⑥ It is globally known for its web portal, search

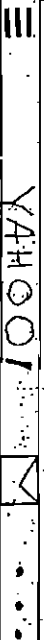
engine Yahoo! search and related services like

Yahoo! News, Yahoo! Finance, Yahoo! Groups,

Yahoo! answers, etc.

⑦ Over 7 billion visitors visit this website per month.

⑧ The webpage of Yahoo is given as follows:-



Search



* World wide web (WWW)

(i) WWW is the global collection of web servers

which contain several, different websites. Each

website may contain one or more web pages.

(ii) The web pages contain hyper text, simple text,

images, videos and graphics.

(iii) WWW was invented by Tim Berners-Lee

the year 1991.

(iv) URL of the websites begins with WWW.

(5) The website is accessed using the web browser.

(6) Web browsers use the URL (Uniform Resource

Locator) of the website to display the web page of

the website.

(7) Navigation of the World Wide Web is also called

surfing or browsing.

(8) Each page of the website is called web page,

web page is the document encoded in HTML

Hyper Text Markup Language).

(9) The web browser can access many existing data

through the Hyper Text Transfer Protocol (HTTP)

and a gateway.

(10) Uses of WWW

(i) WWW allows remote users to have

(ii) online communication.

(iii) software sharing.

(iv) Exchange of views on topics of common interest.

(v) Posting of information of general interest.

(vi) customer support.

(vii) Online journals and magazine.

(viii) Online shopping.

(ix) Video conferencing.

