SECTION-A (Multiple choice questions)

Q. 1-Answer

(i) c	**(ii) d**	**(iii) c**	**(iv) b**	**(v) c**	**(vi) b**	**(vii) b**
(viii) b	**(ix) b**	**(x) c**				

SECTION–B (Descriptive type questions)

Q. 2-Answer

Isolation is segregation of population of a species into smaller units or the segregation of individuals of different species by certain mechanism, so as to prevent interbreeding among them and help in maintaining their hereditary integrity. Thus isolation helps in splitting the species into separate groups and their evolution into distinct species. According to Patterson, it can be also define as, "***It is a fact that each species of animals has devices which permit the recognition and bringing together of conspecific individuals of the opposite sex with such a degree of certainty that hybridization occurs only as an abnormal exception***".

Mechanism of Isolation:

The term isolating mechanisms was coined by Dobzhansky (1937) in his classic work "Genetics and the Origin of Species". He broadly separated isolation process into: 1. **Geographic isolation** and 2. **Reproductive isolation**.

A recent classification of isolating mechanisms, proposed by mechanism, is given below:

1. Isolating mechanisms which prevent interspecific crosses (Premating mechanism)

A. Potential mates do not meet; due to: 1. Geographic or special isolation, 2. Isolation due to distances, 3. Climatic isolation, 4. Seasonal isolation or temporal isolation, 5. Habitat isolation or ecological isolation

B. Potential mate meet but do not mate, due to: 6. Ethological or behavioural isolation

C. Copulation attempted but transference of sperms does not occur, due to: 7. Mechanical isolation 8. Physiological isolation

2. **Isolating mechanisms which reduce full Success of interspecific crosses (Postmating mechanisms)**

A. Sperms transferred but eggs are not fertilized, due to: 1. Gametic mortality

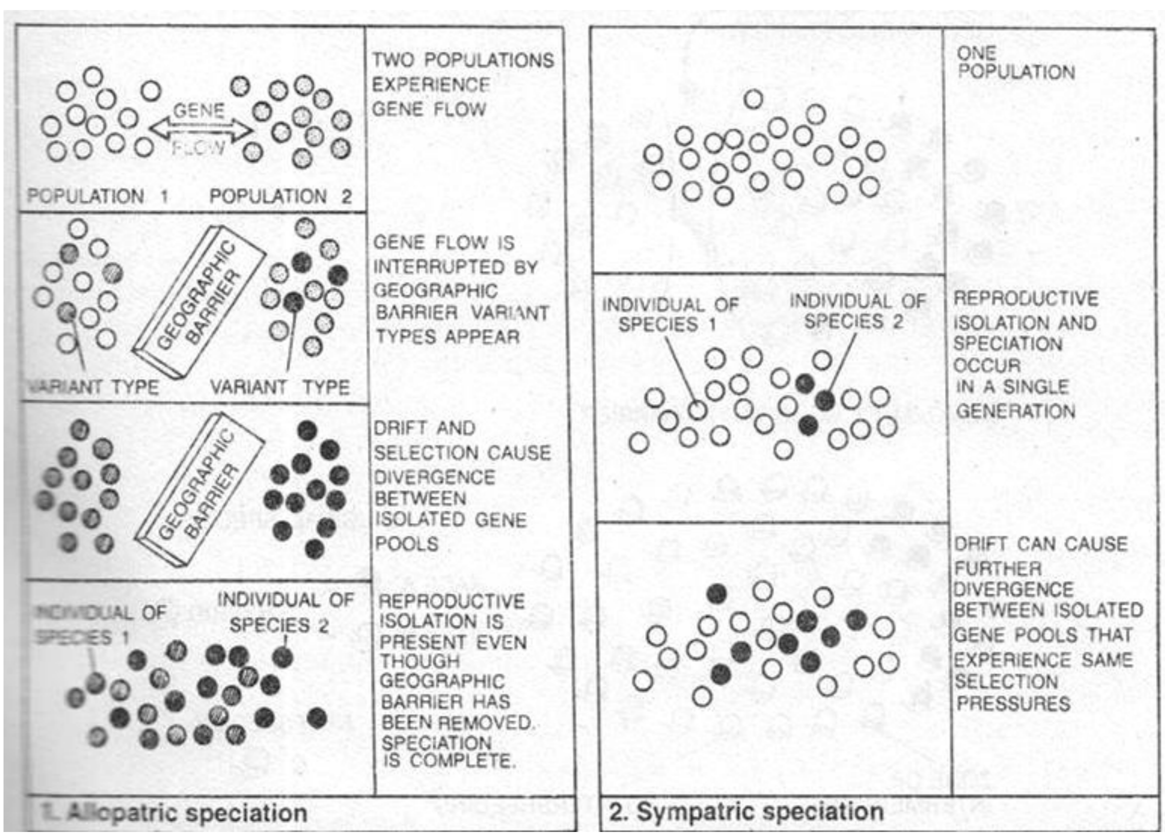
B. Egg is fertilized but zygote is unviable: 2. Zygote mortality

C. Zygote produces F1 hybrid of reduced viability: 3. Hybrid inviability

D. Hybrid is viable but partially or completely sterile, 4. Hybrid sterility 5. F2 breakdown

Role of isolation process in evolution:

Isolation has been recognized as one of the most important factor in the process of speciation i.e. species formation. It helps in allopatric speciation (evolution of species occurring in the different areas) as well as in sympatric speciation (evolution of species occurring in the same area). Diagrammatic representations of isolation mechanism involve in evolution or speciation is given below:



Q. 3-Answer

Selection coefficient: The coefficient of selection (denoted as'ś') is usually taken to be a measure of the extent to which natural selection is acting to reduce the relative contribution of a given genotype to the next generation. It is used by researchers to calculate the rate at which gene frequencies change from generation to generation within a population.

The selection coefficient (s) is a number between zero and one. If s = 1, selection against the genotype is total, and it makes no contribution to the next generation. If s = 0, the genotype is not selected against at all.

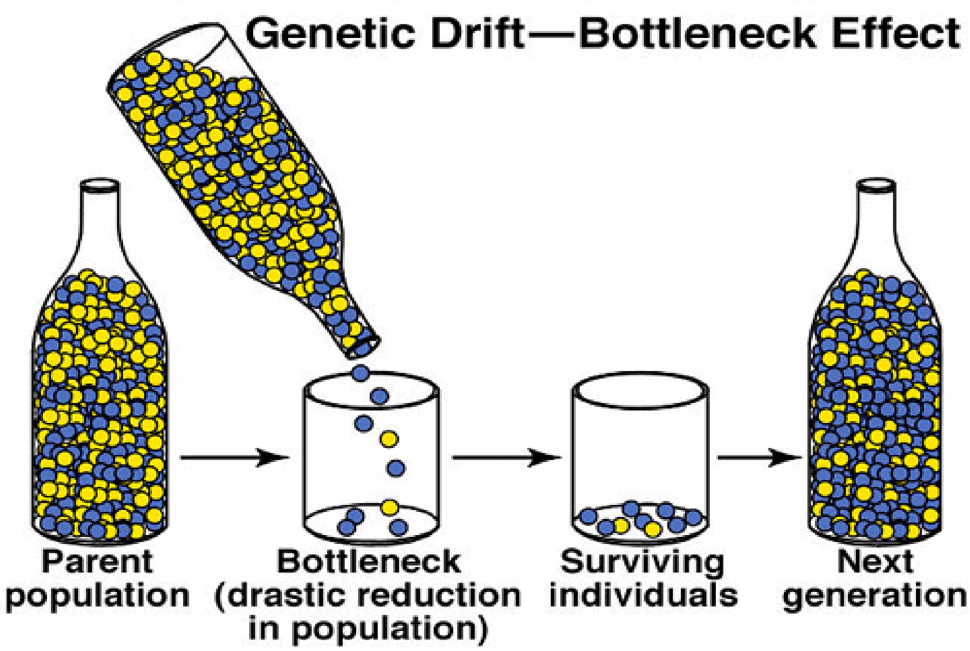
Example: Suppose there are two alleles (dominant 'A' and recessive 'B') for a particular gene in a population. If gene frequency of allele A is p and of B is q, according to Hardy Weinberg's law of equilibrium, in panmictic population p + q = 1 and the three genotypes produced as a result of combinations of these will be: AA = p^2, AB = 2AB and BB = B^2

i.e. AA + 2(AB) + B^2 = $p^2 + 2pq + q^2$

If the population is at equilibrium, these frequencies will remain unaltered. But if population exhibits differential reproduction due to selection operating against the recessive allele, the effect of selection is represented by selection coefficient (s) which represents the force of natural selection operating against the recessive allele. It means where the genotype AA and AB produced cent percent offspring, BB produce 1 – s. It means AA = 1, BB = 1 - s. The genetic contribution from them will be: AA = p^2 x 1, AB = 2pq x 1 and BB = q^2 (1-s). Since the gametic contribution is equal to the product of the frequency of genes, the genotype frequencies after selection will be p^2, 2pq and (1-s)q^2.

Bottle neck phenomenon:

A population may be formed of thousands of individuals but not in the next season or next year only a relatively few individual survive. The few individuals form the pregenerators for the future generation of the population which may multiply sporadically in the next generation and may be decline after one or two generations. This yearly or seasonal phenomenon of cyclic fluctuation in population density leading to periodic squeezing of some of the genes in a gene pool in random fashion is called bottle neck phenomenon, the term used by Stebbins. This is an example of genetic drift.



Q. 4-Answer

The mathematical treatment of the distribution of gene and genotype frequencies in the population was developed by GH Hardy and Weinberg. It is known as Hardy Weinberg's law of genetic equilibrium. According to this law, "The relative frequencies of various kinds of genes in a large and randomly mating sexual panmictic population tend to remain constant from generation in the absence of mutation, selection and geneflow'.

The relationship between gene frequency and genotype frequency can be expressed as:

1. If gene frequencies of two alleles of a gene are p and q, $p + q = 1$

2. the genotype frequencies in the population will be

$p^2 + 2pq + q^2 = 1^2$

$(p + q)^2 = 1$

It is known as Hardy Weinberg formula or binomial expression.

Significance of Hardy-Weinberg's principle:

This law is important primarily because it describes the situation in which there is genetic equilibrium and no evolution. Thus:

i. It provides a theoretical baseline for measuring evolutionary change

ii. The equilibrium tends to conserve gains which have been made in the past and also to avoid too rapid changes.

iii. Equilibrium maintains heterozygocity in the population.

iv. Equilibrium prevents evolutionary progress.

Q. 5-Answer

The superior fitness of some heterozygotes relative to homozygotes is called heterozyogote superiority or also described as heterosis.

In balanced polymorphism, individuals with two or more forms coexist in the same population of a species in stable environment and show almost constant ratio. It means the genotype frequencies of various forms occur at equilibrium.

Examples: 1. Sickle cell anaemia: In malaria infested areas, sickle cell heterozygote (Hb^A/Hb^S) or the carriers are resistant to malarial infection and are less infected with parasite than the homozygous dominant nonsicklers or normal haemoglobin (Hb^A/Hb^A) and sickle cell anaemia (Hb^S Hb^S). Thus the heterozygotes have better chances of survival than the normal homozygote. This advantage of heterozygotes results in stable polymorphism for gene Hbs.

Other examples of balanced polymorphism are ABO blood groups and Drosophila polymorpha.

Q. 6-Answer

The gross enlargement of the arms, legs or genitals to elephantoid size is known as Elephantiasis. Elephantiasis or Lymphatic Filariasis, is a rare disorder of the lymphatic system. It is caused by thread-like parasitic worms such as *Wuchereria bancrofti, Brugia malayi* and *B. timori,* all of which are transmitted by mosquitoes. Inflammation of the lymphatic vessels causes extreme enlargement of the affected area, most commonly a limb, parts of the head and genitals.

Wuchereria bancrofti **in blood**

It occurs most commonly in tropical regions. Elephantiasis puts at risk more than a billion people in more than 80 countries. Over 120 million have already been affected by it, over 40 million of them are seriously incapacitated and disfigured by the disease. One-third of the people infected with the disease live in India, one third are in Africa and most of the remainder are in South Asia.

There are 9 known filarial nematodes which use humans as the definitive host. They are divided into 3 groups according to the niche within the body that they occupy:

i. Lymphatic Filariasis
ii. Subcutaneous Filariasis
iii. Serous Cavity Filariasis

Microfilarial periodicity

Periodic form: Microfilaria in small numbers in circulating blood during the day and peak density at night (10 pm to 2 to 4 am).

Subperiodic form: Microfilariapeak between noon and 8 pm

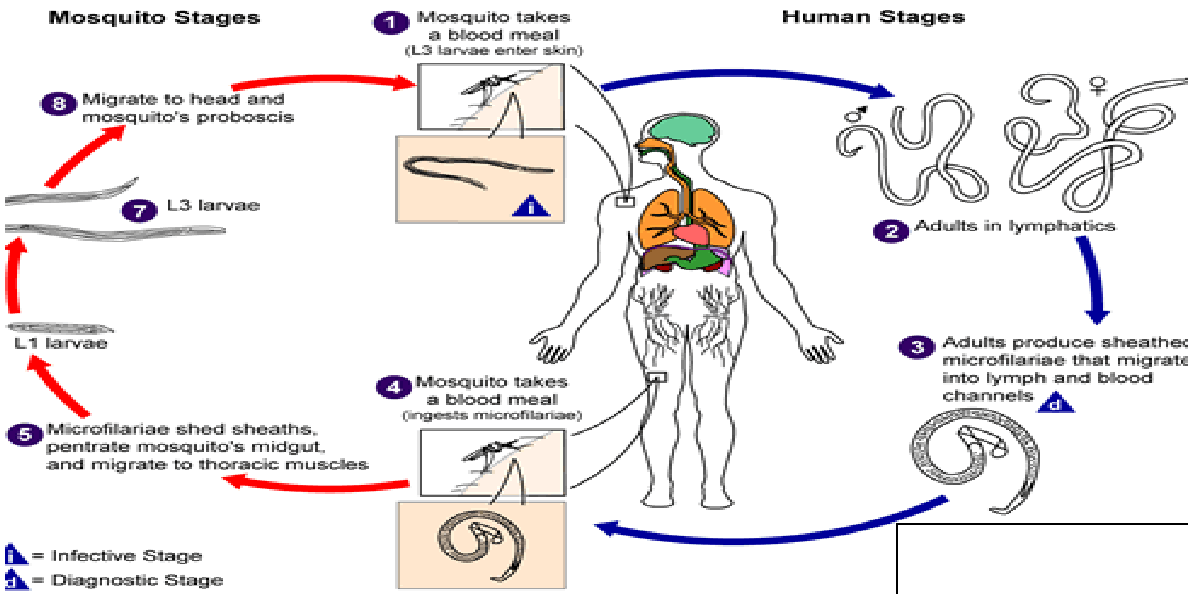
Periodic form mosquitoes feed at night; subperiodic form mosquitoes feed during the day.

Life Cycle of *W. bancrofti*

*W. bancrofti*a cquired via the bite of culex mosquitoes. When mosquitoes bite humans, they deposit third-stage infective larvae into the skin. These larvae travel through the dermis and enter local lymphatic vessels. Over a period of approximately nine months, these larvae undergo a series of molts and develop into mature adult worms, which range from 2 to 5cm in length.

These adults reside in the lymphatics, generally several centimeters from lymph nodes. They survive for approximately five years (occasionally up to 12 to 15 years), during which time male and females worms mate and produce microfilariae. Female parasites can release more than 10,000 microfilariaeper day into the bloodstream. These microfilariaeare also known as embryonic or first-stage larvae, and measure approximately 200 to 300 µm by 10 µm. Mosquitoes, which bite infected individuals, can take up these circulating microfilariae. Within the mosquito, these embryonic larvae develop into second then third stage larvae over a period of 10 to 14 days. The mosquito is then ready to bite and infect a new human host, thereby completing the life cycle.

The interval between acquisition of infective larvae from a mosquito bite and detection of microfilariae in the blood is known as the prepatent period. This interval is usually approximately 12 months in duration.



Life cycle of *Wuchereriabancrofti*

Signs and Symptoms

Many people never acquire outward clinical manifestations of their infections and there may be no clinical symptoms. However, studies have shown that victims, outwardly healthy, may have:

i. Hidden lymphatic pathology

ii. Kidney damage

iii. 10-50% of men suffer from genital damage including elephantiasis of penis and scrotum

iv. 10% women suffer from elephantitis of the breasts.

Diagnosis

The symptoms are graded by severity of the swelling known as a lymphœdema. These swellings usually occur in the legs and breast tissue. symptoms are as follows:

i. Swelling not reversible overnight
ii. Shallow skin folds at the ankle
iii. Alteration of skin texture and formation of knobs
iv. Presentation of deep skin folds
v. Presentation of mossy lesion
vi. Inability of patient to perform daily work
vii. Legs look like elephant leg

Treatment

i. Anti-parasite treatment can result in improvement of patients' elephantiasis.

ii. Rigorous hygiene to the affected limbs, with accompanying adjunctive measures to minimize infection and promote lymph flow which results both in a dramatic reduction in frequency of acute episodes of inflammation.

iii. Surgery can be performed to reduce elephantiasis by removing excess fatty and fibrous tissue, draining the swelled area, and removing the dead worms. With DEC treatment, the prognosis is good for early and mild cases of lymphatic filariasis.

Q. 7-Answer

Lac is a resinous exudation from the body of female scale insect. Since Vedic period, it has been in use in India. Its earliest reference is found in Atherva Veda. There, the insect is termed as ‘Laksha’, and its habit and behaviour are described.In India, Lac insect is known to have two distinct strains: kusumi and rangeeni. Thekusumi strain is grown on kusum or on other host plants using kusumi brood. The rageeni strain thrives on host plants other than kusum. The life cycle of lac insects take about six months, hence, two crops a year can be obtained.

Food plants

Lac insects thrive on twigs of certain plant species, suck the plant sap, and grow all the while secreting lac resin from their bodies. These plants are called host plants. Although lac insect is natural pest on host plant, these insects enjoy the privileged position not being treated as pest. About 113 varieties of host plants are mentioned as lac host plant. Out of which *Butea monosperma* (Palas),*Zizyphus*spp (Ber),*Schleichera oleosa* (Kusum), *Acacia catechu* (Khair) and *Acacia arabica* (Babul) are very common food plant in India for lac culture.

Lac is Nature’s gift to mankind and the only known commercial resin of animal origin. It is the hardened resin secreted by tiny lac insects belonging to a bug family. To produce 1 kg oflac resin, around 300,000 insects lose their life. The lac insects yields resin, lac dye and lac wax. Application of these products has been changing with time. Lac resin, dye etc. still find extensive use in Ayurveda and Siddha systems of medicine.

Lac insect belongs to family Lacciferdae which includes scale insects. Scale insects range from almost microscopic size to more than 2.5 cm. These insects attach themselves in great numbers to plants. The mouth part of these insects is piercing and sucking type. They can be very destructive to tree-stunting or killing twigs and branches by draining the sap.

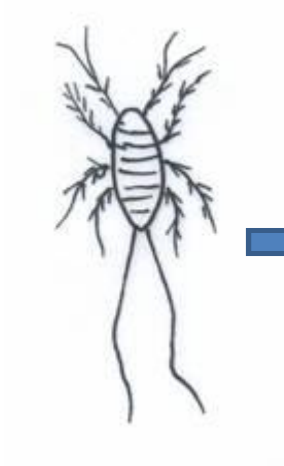
There are six genera of lac insects, out of which only five secrete lac, and only one, i.e. Laccifer secretes recoverable or commercial lac. The commonest and most widely occurring species of lac insect in India is *Laccifer lacca* which produces the bulk of commercial lac. Over 90% of Indian lac produced comes from the states of Bihar, Jharkhand, West Bengal, Madhya Pradesh, Chattisgarh, Eastern Maharashtra and northern Orissa. Some pockets of lac cultivation also exist in Andhra Pradesh, Punjab, Rajasthan, Mysore, Gujarat, and Mirzapur and Sonebhdra districts of Uttar Pradesh.

Life cycle of lac insect

Lac insect is a minute crawling scale insect which inserts its suctorial proboscis into plant tissue, sucks juices, grows and secretes resinous lac from the body. Its own body ultimately gets covered with lac in the so called cell. Lac is secreted by insects for protection from predators.

The Life cycle of lac insect takes about six months and consists of stages: egg, nymph instars, pupa and adult. The lac insects have an ovoviviparous mode of reproduction. Female lays200-500 ready to hatch eggs, i.e. the embryos are already fully developed in eggs when these are laid. Eggs hatch within a few hours of laying, and a crimson-red first instar nymph called crawlers come out. The crawler measures 0.6 x 0.25 mm in size. The emergence of nymph is called swarming, and it may continue for 5 weeks. The nymphs crawl about on branches. On reaching soft succulent twigs, the nymphs settle down close together at rate of 200-300 insects per squire inch. At this stage, both male and female nymphs live on the sap of the trees. They insert their suctorial proboscis into plant tissue and suck the sap. After a day or so of settling, the nymphs start secreting resin from the glands distributed under the cuticle throughout the body, except mouth parts, breathing spiracles and anus. The resin secreted is semi-solid which hardens on exposure to air into a protective covering. The nymphs molt thrice inside the cells before reaching maturity. The duration of each instar is dependent on several factors, viz. temperature, humidity and host plant.

Eggs



Lac nymph

Adult lac (winged)

After the first moult, both male and female nymphs lose their appendages, eye and become degenerate. While still inside their cells, the nymphs cast off their second and third moult and mature into adult. Both the male and female larvae become sexually mature in about eight weeks. Only the male one undergoes a complete metamorphosis or transformation into another form; it loses its proboscis and develops antennae, legs and a single pair of wings. It is containing a brood cell somewhat slipper like with a round trap door (operculum) through which it emerges. The adult male is winged and walks over the females to fertilize them.

The female brood cell is larger and globular in shape and remains fixed to the twig. The female retains her mouth parts but fails to develop any wings, eyes or appendages. While developing, it really becomes an immobile organism with little resemblance to an insect. Females become little more than egg producing organisms.

Male is red in colour and measures 1.2 - 1.5mm in length. It has reduced eyes and antennae. Thorax bears a pair of hyaline wings. Female is larger than male, measures 4-5 mm in length and has a pyriform body. The head, thorax and abdomen are not clearly distinct. The antennae and legs are in degenerated form, and wings are absent.

The female increases in size to accommodate her growing number of eggs. Lac resin is secreted at a faster rate, and a continuous layer coalesces or grows into one body. After fourteen weeks, the female shrinks in size allowing light to pass into the cell and the space for the eggs. About this time, two yellow spots appear at the rear end of the cell. The spots enlarge and become orange coloured. When this happens, the female has oviposit a large number of eggs in the space called 'Ovisac'. The ovisac appears orange due to crimson fluid called lac dye which resembles scochineal. It indicates that the eggs will hatch in a week time. When the eggs hatch, larvae emerge and the whole process begins again.

After the cycle has completed and around the time when the next generation begin to emerge, the resin encrusted branches are harvested. They are scraped off, dried and processed for various lac products. A portion of brood lac is retained from the previous crop for the purpose of inoculation to new trees.

Q. 8-Answer

Rearing the bees in artificial hives for the production of honey is known as bee keeping or apiculture. In India the bee keeping industry was started about 50-60 years ago. In the old age people give smoke to comb at night for collection of honey. This was a crude method. Therefore artificial method of bee keeping was adopted.

Apisi ndica, Apis mellifera, Apis dorsata and Apis florea are very common species used for apiculture. *Apis indica* have black stripes on their abdomen and they live close to hilly areas and are sometimes seen in plains regions also. These are less aggressive and also display less swarming behavior than any other wild bees such as *Apis dorsata* and *Apis florea* and therefore can be easily used for beekeeping.

Honey is a light brown colour viscous fluid produced by honey bees. It contains 78% sugar, 17% water and 7% enzymes and minerals. To produce honey, honey bees suck the nectar from the flower with the help of their proboscis and glossa and collect in comb. During sucking process some saliva is also get mixed with to the nectar. This collected material is filled in the honey chamber and dried with the help of fanning the wings. When it is ready the mouth of honey chamber is closed with the wax. Honey is a very nutritious food with medicinal value.

In addition to thousands of worker adults, a colony normally has a single queen and several hundred drones during late spring and summer. The social structure of the colony is maintained by the presence of the queen and workers and depends on an effective system of communication. The distribution of chemical pheromones among members and communicative dances are responsible for controlling the activities necessary for colony survival. Labor activities among worker bees depend primarily on the age of the bee but vary with the needs of the colony. Reproduction and colony strength depend on the queen, the quantity of food stores, and the size of the worker force.

Queens, Drones and Worker bees

Honey bee issocial insect, which means that they live together in large, well-organized family groups. Social insects are highly evolved insects that engage in a variety of complex tasks not practiced by the multitude of solitary insects. Communication, complex nest construction, environmental control, defence, and division of the labour are just some of the behaviours that honey bees have developed to exist successfully in social colonies. These fascinating behaviours make social insects in general, and honey bees in particular, among the most fascinating creatures on earth.

A honey bee colony typically consists of three kinds of adult bees: workers, drones, and a queen. Several thousand worker bees cooperate in nest building, food collection, and brood rearing. Each member has a definite task to perform, related to its adult age. But surviving and reproducing take the combined efforts of the entire colony. Individual bees (workers, drones, and queens) cannot survive without the support of the colony.

Queens (perfect females)

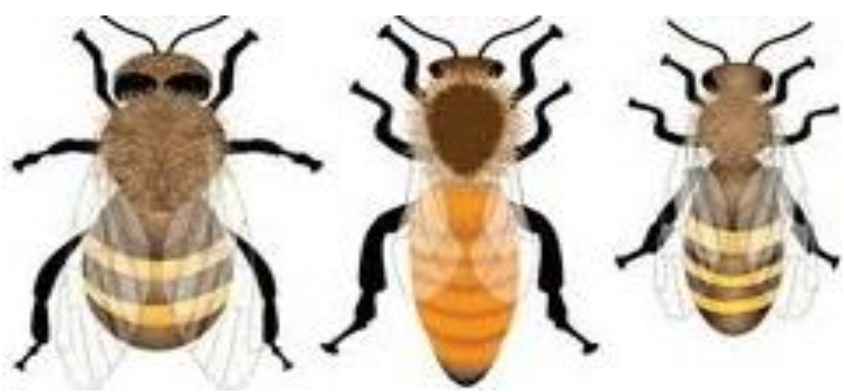
The queen honeybee is the product of a fertilized egg, as are all females in the hive, however, the queen receives a special diet throughout larval Queen Bee. That diet consists of royal jelly for the first 3 days and a modified jelly thereafter, and it takes 16 days to produce a queen from an egg. The queen bee is the biggest bee in the hive, mostly due to her elongated abdomen (for egg laying). She is the sole source of replacement bees for the many that die daily from a variety of causes (old age, predation and disease). And how many eggs the queen lays varies dependent on her age, health, and available clean and empty cells within the hive. She mates with a variety of drones during her maiden flights (mating does not occur within the hive), and can store enough sperm in her spermatheca1 to last her lifetime. Normally there is one queen in a hive but there can be exceptions and a queen may live 2 or more years.

Drones (Male)

Drones are the male bees and they have no father (being the product of an unfertilized egg). They are very specialized in that they are defenseless (no stinger), do not forage (early in life are fed by workers), come equipped with very large eyes and antennae with specialized receptors enabling them to locate a queen on her maiden flight. Their sole purpose is to impregnate a maiden queen and if successful their reward is death (upon uncoupling they leave behind part of their anatomy which causes their demise). In areas with a prolonged winter they are evicted from the hive as the weather gets colder and they often die of predation. A drone is produced from the egg after 24 days and can live for approximately eight weeks.

Worker bees (imperfect females or pollen collector)

Worker bees are all females. They spend the first few weeks of their lives tending brood2 then shift jobs to foraging for food. It takes 21 days for an egg to develop into a worker bee and she can live, during foraging time 6 to 8 weeks but can overwinter in the hive. Worker bees are fed a larval diet which is deficient in some ways (from that given to the queen larva), and results in the bees sex organs not being fully developed. There are times though some worker bees may develop functioning ovaries and lay Worker Honeybee unfertilized eggs (parthenogenesis) which normally will result in drone bees (it is a telltale sign of a queenless hive). Additionally, there is evidence from studies done with *Apis mellifera* (the Cape honeybee) that a worker bee can/may become a pseudo queen and produce female offspring from diploid eggs also through a form of parthenogenesis (without mating) called Thelytoky.



Drone **Queen** **Worker**