ISOLATING MECHANISM

The term isolating mechanism was coined by Dobzhansky (1937). The various biological and behavioural characteristics of living organisms which act to prevent or reduce interbreeding among members of closely related populations of species are called isolating mechanism. Not only one but several such mechanism function and interact together bringing about reproductive isolation in population of species.

Isolating mechanism have been classified and studied by Mayr, Patterson, Henby and Stebbins. A recent classification by Mecham classifies it into two broad categories

(1) Premating Mechanism (2) Post mating mechanism

(1) Premating Isolating mechanisms are prior to mating, preventing interbreeding of population. These are:

1) Geographic Isolation – In this, two populations of same species are separated by some physical or geographic barrier. These barrier may be mountain ranges, desert, thick forests, water bodies etc, which would separate population and hence there would be no chances of meeting and interbreeding. This reduces exchange of genes and then a single gene pool is splitted into two gene pools. As a result the new mutations, genetic drift and action of natural selection occur independently in isolated population and ultimately leads to formation of new species or sub species

eg Indian giant squirrel Ratufa indica, lives in forest. It rarely jumps in deciduous forest of Cuttack is different from the one living in evergreen forest of Meharashtra

(ii) Spatial Isolation - occurs due to large terrain barriers without natural barriers, but interbreeding is prevented because of inability to cover greater distances

(iii) Seasonal or Temporal Isolation - Differences in breeding season prevent mating and interbreeding among individual of different population.

eg Rana clamitans, R. pipens and R sylvatica breed in the same pond in America, but they do not interbreed because R. sylvatica breeds at about 44°F, R. pipens at 55°F and R. clamitans breeds at temperature above 60°F

(iv) Habitat or Ecological or Environmental Isolation - It is caused due to differences in the habits and habitats of organism such as food and physiological requirements and place of living.

eg Bull frog (Rana grylio) is aquatic and occurs in deep ponds, lakes and breeds in deep water. On the other hand, gopher frog (Rana areolata) prefers margins of swampy areas and breeds in shallow water. The difference in ecological preference eliminates the possible mating between the two species

(v) Ethological or Psychological or Behavioural isolation - The males of every species have specific courtship reactions and only females of the same species are receptive to these displays. These specific behaviours of males towards females are known as species recognition. The act of mating is completed

only when there is appropriate exchange of stimuli. Therefore ethological isolation refers to the barrier to mating among the individuals of different species due to differences in their courtship behaviour.
These are divided into 3 categories
(i) Visual stimuli - They include colour patterns on the body, their body form, size and movements of the oak toad is smaller in length while the coast toad is bigger in length. The size alone prevents inter breeding as in either case male fails to grasp the female
(ii) Auditory stimuli - These include song calls. Species specific sounds play important role in courtship of frogs, toads and birds
(iii) Chemical stimuli - Many species produce species specific odours. They are detected either on contact or by olfactory organs
6. Mechanical Isolation - The complex structure of genitalia in many animals does not permit copulation among different species. The genitalia in insects are developed on lock and key principle and even slight deviation in structure of either makes copulation impossible.
7. Physiological Isolation - Certain species are established only on the basis of physiological differences.
eg. in certain species of Drosophila, mating among the members of different species is not possible because vaginal mucous membrane swells up after copulation. The swelling lasts for few hours if mating is among the members of same species but continues for days if mating is interspecific. As a result

the fertilised eggs perish in the parent body in the absence of being laid down.

(2) Postmating Mechanism – are the ones which reduce full success of Interspecific Crosses. The potential mates of two populations copulate but either no offspring are produced or the hybrids have reduced vitality or fertility.
They can be classified into following 5 categories
i) Gametic Mortality – is seen in both internal an internal fertilization. The sperm may fail to fertilise the eggs and both of them perish. A male with non functional gonads but with normal sex behaviour may induce a female to lay eggs but the eggs soon die.
In forms with internal fertilization the spermatozoa have to pass through genital tract of female. The sperms from the male of different species may encounter an antigenic reaction during their passage through female genital tract and may be killed before they reach eggs.
ii) Zygotic Mortality – The gametes from two different species may fuse but the zygote may not survive, or the hybrid zygote is irregular and ends up at any stage during development without reaching adulthood. eg eggs of fishes can be inseminated by sperms of different species and genera, but development does not proceed normal

(iii) Hybrid Inviability – In some interspecific interbreeding, the zygote develops normally but the hybrid does not survive

(iv) Hybrid Infertility – Many naturally occurring hybrids have been found to leave no offsprings, even though they seem fully fertile. The weakness of the hybrids is attributed to some physiological disturbance or ecological difference.

(v) Hybrid Sterility – The hybrids of certain interspecific crosses are found to be sterile or semi sterile. Either the chromosomes fail to pair at meiosis or abnormalities like the formation of spindle or failure of cell division occur in the spermatocyte rendering the individuals sterile. Hybrid sterility could be because of

a) Developmental hybrid sterility – Hybrids are sterile because gonads develop abnormally or meiosis breaks down before completion because chromosomes fail to pair

b) Segregational hybrid sterility – Hybrids are sterile because of abnormal segregation of the whole chromosomes, chromosome segments or combinations of genes to the gametes. Gametes with lacks or excess of chromosomes or genes may not survive leading to sterility.

c) F_2 breakdown – The F_1 hybrids are normal, vigorous and fertile, but F_2 hybrids are either inviable or sterile.

I. Isolating Mechanisms which Prevent Interspecific Crosses (Premating Mechanisms)

A. Potential mates do not meet

1. Geographic or spatial isolation
2. Isolation due to distances
3. Climatic isolation
4. Seasonal isolation or temporal isolation
5. Habitat isolation or ecological isolation

B. Potential mates meet but do not mate

6. Ethological isolation or behavioural isolation

C. Copulation attempted but transference of sperms does not occur

7. Mechanical isolation
8. Physiological isolation

II. Isolating Mechanisms which Reduce Full Success of Interspecific Crosses (Postmating Mechanisms)

A. Sperms transferred but eggs are not fertilised

1. Gametic mortality

B. Egg is fertilised but zygote is unviable

2. Zygote mortality

C. Zygote produces F_1 hybrid of reduced viability

3. Hybrid inviability

D. Hybrid is viable but partially or completely sterile

4. Hybrid sterility
   - (a) Developmental hybrid sterility
   - (b) Segregational hybrid sterility
5. F_2 breakdown