GENES AND BEHAVIOUR

Q. 2. Write a note on gene and behaviour.

Like any other morphological or physiological character, behaviour patterns are also heritable. Their blue prints are fixed in the chromosomes and are passed on to offsprings generation after generation. The relationship between genes and behaviour can be traced by screening the behaviour of individuals which are known to differ in their genetic make-up. This helps in correlating the genetic variations with the behavioural patterns.

1. Known Single Gene Mutations that Influence Behaviour : A large number of mutant alleles which influence morphology or physiology of the organisms are found to influence their behaviour pattern. For example :

1. There are a number of mutant forms of mice which have recognizable morphogical characters and exhibit behavioural difference. The autosomal albino mice (morphological variant) are less active, are unable to nibble but more successful in mating.
2. In *Drosophila*, **yellow** mutation is sex-linked recessive. It alters the colour of cuticle (morphological change). The flies with yellow allele are found to be less successful in mating and exhibit abnormal courtship with more orientation but less vibration and licking.

2. Visible Differences in Chromosome Structure and their Correlation with Behaviour : Several *Drosophila* species are **inversion polymorphs**. These exhibit a number of behavioural differences. For example :

1. Different karyotypes of *D. persimilis* show different habitat preferences.
2. In *D. pseudoobscura* males with certain inversions have enhanced mating success.

3. Comparing Naturally Occuring Isolated Populations of a Species : In polytypic species populations exhibit genetic differences. In some cases members of such populations differ in their behaviour even when these are reared under identical conditions in laboratory. In such cases behavioural differences can be attributed to their genetic differences.

1. In *Drosophila,* males of *D. pseudo-obscura* derived from different regions differ in mating speed, in geotaxis and in phototaxis.
2. Offsprings of wild mice trapped from different parts of United States and raised under standard conditions differed in a variety of behavioural activities.

   Similar studies from various animal species indicate that naturally occuring differences in behaviour are often genetically determined.

MECHANISM OF GENES' INFLUENCE ON BEHAVIOUR

Q. 3. Enumerate various possibilities of how genes influence behaviour ?

How genes determine development of behaviours. Explain. *(Garhwal 2001)*

Genes, (DNA) are translated into proteins or enzymes which control morphological physiological, developmental and behavioural processes. The behavioural activities can be influenced at following different levels :

1. at neural level
2. at endocrine level
3. at the level of sense organs
4. at the level of effector organ (at neuromuscular junction)
5. at the structure level

1. Effects at Neural Level

The nervous mutants produce a variety of motor defects in mice. These defects develop due to loss of cerebellar Purkinje cells which are important in the feedback loop for the skilled movements. For example, mutant **unc5** in *Caenorhabditis elegans* makes the worms unable to move effectively but are able to flex their bodies. Due to this mutant the dorsal muscles do not get an organised nerve supply (a developmental defect) and a coordination between dorsal and ventral muscles is lost. This leads to erratic or uncoordinated movement of abdominal segments.

Low level of neurotransmitters-**Serotonin** and/or **noradrenalin** is found to be associated with susceptibility to seizures, when exposed to sound. These neurotransmitters countract the excitable effect of adrenalin. Due to lower level of these neurotransmitters, body takes longer to comeback to normal and the animal becomes susceptible to seizures. This is caused by an alteration in the gentic material coding for an enzyme which is necessary in the metabolic pathway for the synthesis of serotonin or noradrenalin.

2. Effects at Hormonal Level

A number of inherited behavioural differences are due to the effect of genes on the endocrine system. For example, mice with mutant **obese,** suffer from reduced synthesis of insulin and the sensitivity of body tissues to insulin. Because of this genetic abnormality the mice are obese and inactive.

3. Effects on Sense Organs

In cave-dwelling and river-dwelling populations of fish, *Astyanx mexicanus,* the difference in the body angle during feeding is due to alteration in the position of sense organs on the head. In the river dwelling forms, the sense organs are located on the mouth and lips but in cave-dwellers, these are spread over the lower jaw and underside of head. This difference in the location of sense organs is the result of mutations, subsequently affecting the behaviour.

4. Effect on Muscles and Neuromuscular Junctions

Development of defective neuro muscular junction is under the control of mutant genes. **Wing up mutant** of *Drosophila melanogaster* produces degeneration of wing muscles at the time of pupation. The reversible temperature sensitive mutant **shipbire** causes paralysis above 29°C in *D. melanogaster.* The mutant gene blocks neuromuscular transmission whereby nerve and muscle cells are unable to establish a functional contact and normal wing flapping does not occur.

5. Effects on the Structures associated with Behaviour

Vestigial wing mutant in *D. melanogaster* produces wingless flies. The wingless males being unable to fly, are also unable to perform effective wing vibrations during courtship. This impairs their mating success.

GENES, ENVIRONMENT AND BEHAVIOUR

Q. 4. 'Genes and environment interact to produce behaviour'. Comment.

Gene, Environment and Behaviour

Interactions between genes and environment are responsible for a variety of behaviours exhibited by the animals. The same genes are found to produce very different effect in different environments. Conversely, the same environmental conditions produce very different effects on different genotypes.

Example : Avoidance learning behaviour in mice :

Bovet, Bovet-Nitti and **Oiverio** (1969) presented a very good example of gene-environment interaction in the avoidance learning in mice. Inbred mice were made to learn a two-way avoidance. A mouse was placed in a chamber divided into two compartments by a wall. The two compartments were connected by a door. The mouse was made to learn to go through the door from one compartment to other within 5 seconds of the onset of light, lest it started receiving electric shock. It was found that different strains of mouse learned this shock avoidance behaviour with different rates. **Bovet** and coworkers compared avoidance learning in C3H and DBA mice. C3H mice learned better when trials were closely spaced than when they were widely spaced. On the contrary, DBA mice learned more poorly when trials were closely spaced than when they were spaced. Thus the same treatment produced diametrically opposite effects when given to mice of different genotypes.

This experiment shows that same factor may produce different effects an animals of different genotypes.