Fundamentals of Genetics

Chapter 1

Pre-Mendelian Concepts of Heredity

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Genetics is concerned with the transmission, expression and evolution of genes, the molecules that control the function, development and ultimate appearance of individuals. A number of viewpoints were put forward prior to Mendel to explain the transmission of characters from parents to offspring. They are often called theories of **blending inheritance** as they believed that parents blended or got mixed during their transmission to the offspring.

1. **Moist Vapour Theory**

Pythagoras (580-500 B.C.) believed that each organ of the body male produced moist vapours during coitus which formed the body parts of the embryo.

2. **Fluid Theory**

Empedocles (504-433 B.C.), the pro-pounder of four humour theory, proposed that each body part produced a fluid. The fluid of different body parts of the two parents mixes up and is used in the formation of embryo. Any defect in the descent and mixing up of the fluids results in missing of characters of one parent or both the parents.

3. **Reproductive Blood Theory**

Aristotle (384-322) thought that the males produce highly purified reproductive blood containing the nutrients from all body parts. Females also produce reproductive blood but this is impure. The two reproductive bloods coagulate in the body of the female and form the embryo. Due to purity of reproductive blood, the contri-bution of characters by the male is more than the female.

4. **Preformation Theory**

The theory of preformation believes that the organism is already present, i.e., preformed in the sperm or egg in a miniature form called **homunculus**. Fertilization is required to stimulate its growth. Sperms were observed for the first time by Leeuwenhoek, in 1672. Preformation theory was given by Swammerdam (1679) and advocated by Malpighi (1673). It was believed by

a number of workers of that period like Hartosoeker (1694) and Dalepatius (1694). It was supported by Roux as late as 1888 but discarded by Wolff who suggested that organs are formed step by step (theory of epigenesis).

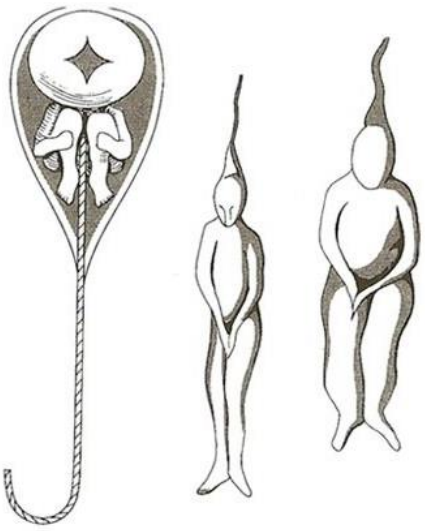

Figure 1 Homunculus or miniature embryo believed to be present in human sperm

5. **Theory of Epigenesis**

Proposed by a German biologist Wolff (1738-1794), the theory states that the egg and sperms are undifferentiated cells. The differentiation into various organs/parts takes place only after fertilization in the zygote resulting in the development of adult tissues and organs. This concept is universally accepted.

6. **Theory of Acquired Characters**

Proposed by the famous French biologist Lamarck (1744-1829) this theory states that a new character once acquired by an individual shall pass on to its progeny. It means if a man develops a strong muscle by exercise, all his children would have strong muscles. On the other hand, if a person becomes weak all his children would be weak. This concept was totally rejected by Weismann on the basis of experiment on rats performed through 22 generations.

7. **Theory of Pangenesis**

This theory, proposed by the famous English naturalist Charles Darwin (1809-1882), states that very small, exact but invisible copies of each body organ and component (called **gemmules**) are transported by the blood stream to the sex organs. These gemmules are

assembled in the gametes. After fertilization these gemmules move out to different parts of the body resulting in the development of respective organ.

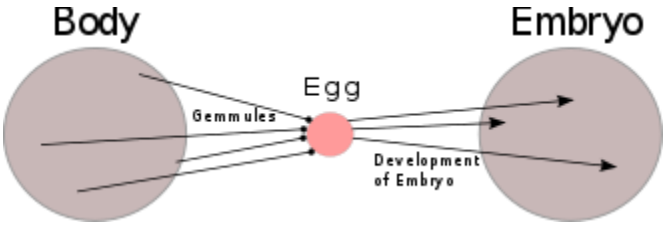

Figure 2 Gemmules are assembled in the gametes

A defective gemmule will lead to the development of defective organ in an individual. This theory too was rejected because it lacked scientific basis.

8. **Germplasm Theory**:

This theory, advocated by August Weismann (1889), a German biologist, states that body tissues are of two types, viz., germplasm and somatoplasm. The germplasm refers to the reproductive tissues or cells which produce gametes. The somatoplasm includes all other body tissues which are not related to sexual reproduction. Thus, transmission of characters from one generation to other takes place only through germplasm. Any change in the germplasm will lead to change in the next generation. This theory is accepted in a broad sense.

- **<u>Objections to Blending Inheritance:</u>**

1. The trait of sex does not blend itself in unisexual organisms. Such an organism can either be male or female.
2. Children of dark and fair coloured parents should be of intermediate colour if blend-ing inheritance is true. This is not the case. The children are often of different colours, some fair-coloured, some dark coloured and others of intermediate colour.
3. Many individuals show ancestral characters not found in immediate parents. The phenomenon is called atavism (L. atavus- great grandfather, grandfather or forefather), reversion or throw-back. For example, a short tail may be found in some babies. Some persons are able to move pinna or external ear.
4. Many characters appearing in children are not found in immediate parents but are similar to one or the other grandparents showing that characters may remain hidden in one generation and appear in the next.

5. Kolreuter (1760), a German botanist obtained fertile interspecific hybrids in Tobacco. The hybrids did not resemble either of the parents. Hybrids were self pollinated. Some offspring resembled the hybrids while remaining resembled one or the other grandparent in different characters. Thus both smooth and hairiness occurred on the leaves of one generation only to separate in the subsequent generation. This proved that the traits have particulate nature and remain discrete.
6. John Goss (1822) crossed yellow and green seeded pea varieties. The hybrids were all yellow seeded. They were self pollinated. Three types of offspring were produced: (i) yellow seeded (ii) green seeded and (iii) with both yellow and green seeds.
7. Naudin (1862) concluded that on repeated crossing of hybrids, their parental types appear in the offspring showing that hybrids contain traits of both the parents though they may not be visible externally.

- **Basic Features of Inheritance**

The work of Kolreuter (1760), Goss (1822), Naudin (1862) and other plant breeders showed six basic features of inheritance even prior to the work of Mendel.

1. Traits have alternate forms.
2. Traits are represented in the individuals by discrete particulate entities which do not get blended or modified.
3. One alternate of a trait may be exhibited more often than the other.
4. An alternate form of a trait may remain hidden for one or more generations and then reappear in the unchanged state.
5. Particular forms of two or more traits may occur together in one generation and separate in subsequent generations.
6. Out of the two alternate traits present together in an individual, only one is expressed.