

Gene Concept

Microbiology VI

History

- The term '**Gene**' was coined by **W. Johansen** in 1909.
- E. R. Garrod (1908) proposed One gene – one product hypothesis.
- Gene theory was proposed by T. H. Morgan in 1911.

- L. Pauling and Ingram (1949) established the role of genes in **protein synthesis**.
- G W Beadle and E L Tatum (1948) proposed One gene – one enzyme hypothesis.
- The fine structure of gene was proposed by Seymour Benzer (1962).

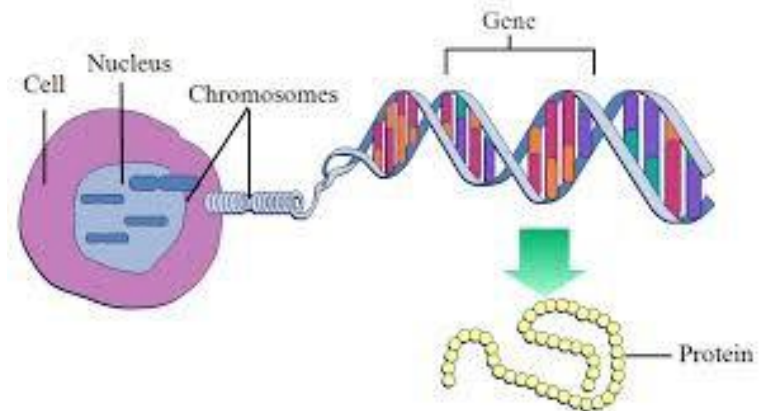
- Yanofsky (1965) proposed One gene (cistron) – one polypeptide hypothesis.
- Gene Concept was given by SUTTON.

Evolution of Gene concept:

YEAR	SCIENTIST	GENE CONCEPT
1866	G.J. MENDEL	A UNIT FACTOR THAT CONTROLS SPECIFIC PHENOTYPIC TRAIT
1902	SIR A.E.GARROD	ONE GENE –ONE METABOLIC BLOCK THEORY
1940	BEADLE & TATUM	ONE GENE-ONE ENZYME THEORY
1957	U.M.INGRAM	ONE GENE-ONE POLYPEPTIDE THEORY
1960s	C.YANOFSKY & CO-WORKERS	GENE IS A UNIT OF RECOMBINATION

Definitions of the Gene:

- The gene is to genetics what the atom is to chemistry.
- The **gene** is the unit of **genetic information** that controls a specific aspect of the phenotype.
- The gene is the unit of genetic information that specifies the synthesis of **one polypeptide**.
- Genes are the fractions or part of DNA molecule which regarded as the genetic material.



T.M Morgan proposed the **gene theory** which state that:

1. **Chromosomes** are bearers of **hereditary units** and each chromosome carries hundreds or thousands of **genes**.
 2. The **genes** are arranged on the chromosomes in the **linear** order and on the special regions or **locus**.
- Until 1940, the gene was considered as the basic unit of genetic information as defined by following criteria.
 - The unit of function, controlling the **inheritance** of one “character” or **phenotypic** attribute.
 - The unit of **structure**, operationally defined by **recombination** and by **mutation**.

Gene related terminology:

- **RECON:** It is the smallest unit of DNA capable of undergoing Crossing Over and **Recombination**.
- **MUTON:** It is the smallest unit of DNA which can undergo **Mutation**.
- **CISTRON:** It is the unit of Function. It is the Gene in real sense capable of synthesizing a **Polypeptide chain** of an Enzyme.
- **COMPLON:** It is the unit of **Complementation**. Certain enzymes are formed of **two or more polypeptide** chains. Whose active groups are complimentary to each other.
- **OPERON:** is the combination of **operator** gene & sequence of **structure** genes which act together as a **unit**. It is composed of several genes. The effect of operator gene may be additive or suppressive.
- **REPLICON:** it is the unit of **replication**. Several replicons constitute a chromosome.

Classical Concept of a Gene

Classical gene definition:

- Gene is the Unit of Function (one gene specifies one character), Recombination, and Mutation.
- Introduced by **Sutton** (1902) and was elaborated by **Morgan** (1913).
- Bidge (1923), Muller (1927) and others which outlined as follows:
 - Genes are discrete particles inherited in Mendelian fashion that occupies a definite **locus** in the chromosome and responsible for **expression** of specific **phenotypic** character.

- Number of genes in each organism is more than the number of chromosomes; hence several genes are located on each chromosome.
- The genes are arranged in a single linear order like beads on a string.
- Each gene occupies specific position called locus.
- If the position of gene changes, character changes.
- Genes can be transmitted from parent to offspring.

- Genes may exist in several alternate forms called **alleles**.
- Genes are capable of combining together or can be replicated during a cell division.
- Genes may undergo sudden changes in position and composition called mutation.
- Genes are capable of self duplication producing their own exact copies.

Modern Concept of Gene

Modern Gene definition:

- Gene is the Unit of **Genetic Information**, i.e., the sequence of DNA that specifies one **polypeptide**.
- Includes coding as well as non-coding regulatory sequences.

Modern concept of Gene:

- S. Benzer (1957) coined different terms for different nature of gene and genetic material in relation to the **chromosome** on the basis of **genetic phenomena** to which they involve.
 - Genes as unit of transmission or **cistron**.
 - Genes as unit of recombination or **recon**.
 - Gene as unit of mutation or **muton**.

1. **Cistron** – Genes as unit of **transmission**:

- The part of DNA specifying a **single polypeptide** chain is termed as cistron.
- A cistron can have 100 nucleotide pairs in length to 30,000 nucleotide pairs.
- It transmits characters from one generation to other as unit of transmission.

2. Recon – Genes as unit of Recombination:

- The smallest segment of DNA capable of being separated and exchange with other chromosome is called recon.
- A recon consists of not more than two pairs of nucleotides.

3. Muton – Gene as a unit of mutation:

- Muton is the smallest unit of genetic material which when changed or mutated produce a phenotypic trait.
- Muton is delimited to a single nucleotide.

Gene Types:

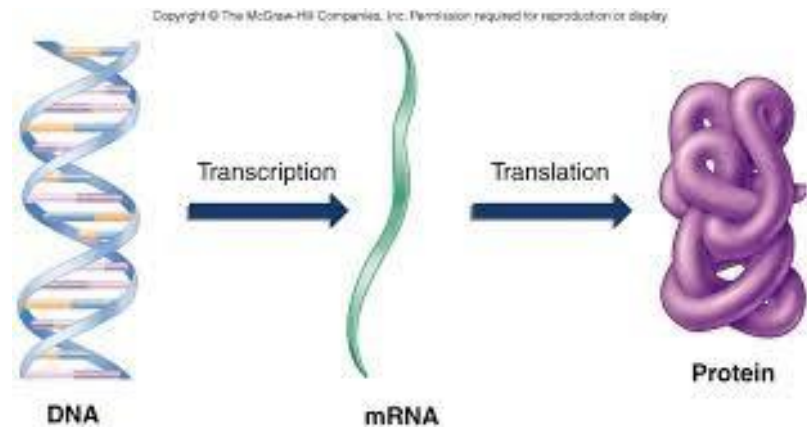
On the basis of their behaviour the genes may be categorized into the following types:

- **Basic genes:** These are the fundamental genes that bring about expression of particular character.
- **Lethal genes:** These bring about the death their possessor.
- **Multiple gene:** When two or more pairs of independent genes act together to produce a single phenotypic trait.
- **Cumulative gene:** Some genes have additive effects on the action of other genes. These are called cumulative genes.

- **Pleiotropic genes:** The genes which produce changes in more than one character is called pleiotropic gene.
- **Modifying gene:** The gene which cannot produce a character by itself but interacts with other to produce a modified effect is called modifier gene.
- **Inhibitory gene:** The gene which suppresses or inhibits the expression of another gene is called inhibitory gene

Gene action

- The influence of **gene** resulting in the **expression** of a **genetic character** is called gene action.
- The genes are generally associated with the production of enzymes,
- which they synthesize from chemical substance available in the body cells through a process of autocatalysis.



As a rule, one gene affects one enzyme.

1. The various actions of genes are expressed in their development of:

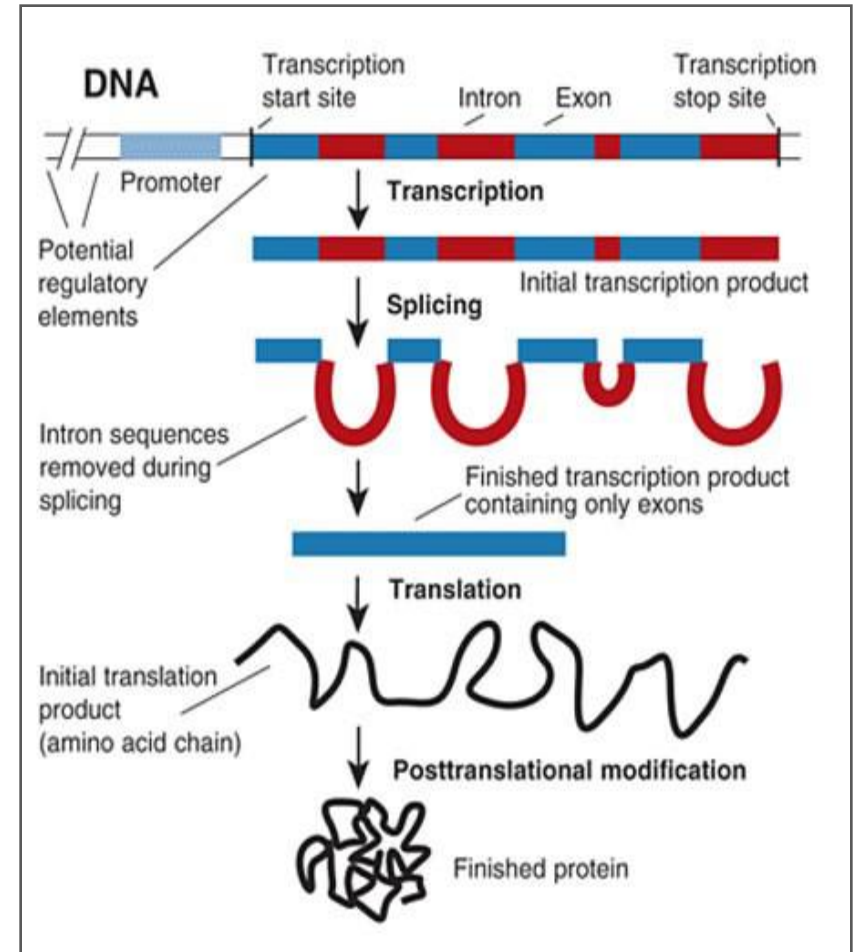
- Pigments
- Colours
- Hormones
- Size and form
- Production of proteins
- Antigen and antibody

2. Production decisive effect on human disease like:

- Albinism
- Tyrosinosis etc.

Genes in Protein Synthesis:

- Jacob and monad proposed “Operon model”
- To explain the mechanism of gene action.
- Protein synthesis is regulated by three specific genes located on chromosomes
 - 1. Structural genes
 - 2. Operator genes
 - 3. Regulator genes



- **Structural genes:** It regulates to produce specific mRNA determine the kind of protein to be synthesized.
- **Operator genes:** These genes act as switches to turn on or turn off the activities of structural genes regulating the elongation and termination of polypeptide chain.
- **Regulator genes:** These genes produce certain protein substance called repressors, which prevent the operator genes from their action.

Important features of Gene:

- Determines the physical as well as physiological **characters**.
- Situated in the **chromosome**.
- Occupies a specific position known as **locus**.
- Arranged in single **linear** order.
- Occur in functional states called **alleles**.
- Some have more than 2 alleles known as **multiple alleles**.
- Some may undergo sudden change in expression called as **mutant gene** (mutation).

- May be transferred to its homologous (**Crossover**) or non-homologous counterpart (**Translocation**).
- Can duplicate themselves very accurately (**Replication**).
- Synthesizes a particular **Protein**.
- Determines the sequence of amino acid in the polypeptide chain (**The Genetic Code**).