



Government of Tamilnadu

Department of Employment and Training

Course : TNPSC Group II Exam

Subject : Zoology

Topic : **Genetics**

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**Commissioner,
Department of Employment and Training.**

GENETICS

- ❖ Branch of science deals with heredity
- ❖ Heredity means transmission of characters from parents to offsprings
- ❖ Father of genetics G.J. Mendel
- ❖ Birth 1822 Chekoslovakia – Heidendendraft – sisilian
- ❖ Work as a Teacher in Imperial royal school
- ❖ He did his research in brunne for 9 years (1856 -1865)
- ❖ Book experiments on plant hybridization
- ❖ He used Pisum Sativum plant for his research
- ❖ Pisum Sativum is called as garden peas

Reason for using Pisum Sativum :

- ❖ Self pollinating flowers of peculiar structure
- ❖ Short growth and short life style
- ❖ Easy for artificial cross pollination
- ❖ Had contrasting heritable characters
- ❖ Various available varieties
- ❖ In 34 characters he made research in 7 characters

Character	Dominant	Recessive
Length	Long	Short
Flower position	Axial	Terminal
Pod Shape	Inflated	Constricted
Pod colour	Green	Yellow
Seed shape	Round	Wrinkled
Seed coat colour	Grey	White
Colour of cotyledon	Yellow	Green

Mendel work was rediscovered by three biologists

1. Huger de vries
2. Carl correns
3. Erich Von Tschermak

F1 First filial Generation :

- ❖ The Resultant hybrids of parent generation by cross fertilization

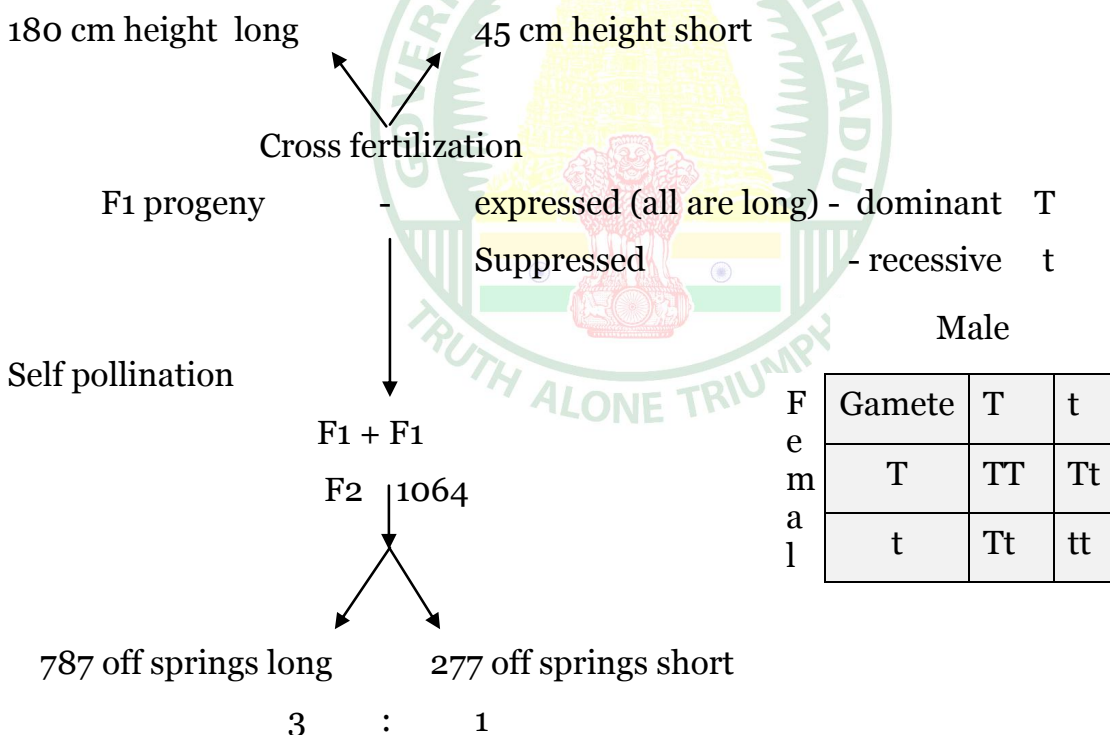
F2 Second filial Generation :

- F1 progeny is allowed to self fertilize among themselves, they produce F2

Result

Monohybrid cross	phenotypic ratio	-	3 : 1
	Genotypic ratio	-	1 : 2 : 1
	Test cross ratio	-	1 : 1
Dihybrid cross	phenotypic ratio;	-	9 : 3 : 3 : 1
	Test cross ratio	-	1 : 1 : 1 : 1

Monohybrid cross phenotypic ratio



- ❖ Punnett has made square for proving Mendel's results.
- ❖ It is called Chequered square

HISTORICAL BACKGROUND

Mendel's laws:

1. Mono Hybrid cross

- ❖ Law of dominance
- ❖ Law of segregation (or) Law of purity of gametes

same or different chromosomes.

- These elements called as transposable elements, transposons insertion, elements or jumping genes.

2. Di Hybrid cross

- ❖ Law of independent assortment (or) law of random assortment
- ❖ Mendel's laws were introduced to the world by the followers in 1900
- ❖ Holland – Hugo de Vries – *Oenothera lamarckiana*
- ❖ Germany – Carl Correns – *Xenia*, peas, maize
- ❖ Austria – Von Tschermak – flowering plants
- ❖ From this genetics is accepted as a new branch.
- ❖ It is a younger branch in science.
- ❖ 21st century is called as gene century

Glossary :

1. Genes - Factors controlling a single character.
2. Phenotype - expression of a character
3. Gene type - the genes are controlling a character.
4. Allele - each of two or more alternative forms of a gene (T, t)
5. Allelomorph - character having different phenotype
6. Homozygous - having identical alleles at corresponding chromosomal loci (TT, tt)
7. Heterozygous - having dissimilar alleles at corresponding chromosomal loci (T t)
8. Dominant - expressed character in F₁
9. Recessive - suppressed character in F₁
10. Hybrid - a composite of mixed origin

Jumping Genes

- Found by Barbara McClintock
- Working on Maize, presence of movable genetic elements which could detach from one site and move to new positions in either the

- ◆.....◆
11. Emasculation - neutering a male animal by removing the testicles
 12. Back Cross - mate a hybrid of the first generation with one of its parents
 13. Test Cross - a cross between an organism whose genotype for a certain trait is unknown and an organism that is homozygous recessive for that trait so the unknown genotype can be determined from that of the offspring.

Gene Therapy

- ❖ Gene therapy involves the replacement of corrective genes in place of defective genes in human.
- ❖ Types
 - Somatic cell gene therapy
 - Germ line cell gene therapy
- ❖ Both may be employed for treating the inherited diseases

Human Chromosomes

- Male xy
 - Female xx
- 23 pairs pedigree analysis

Genetic Engineering

- ❖ The technology of preparing recombinant DNA in vitro by cutting up DNA molecules and splicing together fragments from more than one organism.

Applications of Genetic Engineering in Biotechnology :

- ❖ The basic principle of genetic engineering is gene transfer, achieved by various methods to produce recombinant proteins, genetically modified microorganisms, transgenic plants and transgenic animals for commercial application.
- ❖ Genetic engineering, thus ultimately influences the growth of biotech industry.
- ❖ The two significant feature of genetic engineering is production of beneficial proteins and enzymes in surplus quantities and creation of transgenic plants, transgenic animals and genetically modified microorganisms with new characters beneficial for themselves using recombinant DNA technology.

HISTORICAL BACKGROUND

- ❖ The discovery of a new protein either with a therapeutic property or application in food industry by a researcher or scientist would not have reached humans, for the use by humans without the application of genetic engineering in mass producing such proteins.

Restriction Enzymes

- ❖ Restriction enzymes or to use their correct name, restriction endonucleases, are a type of enzyme which have the ability to cut molecules of DNA.
- ❖ They are often referred to as genetic scissors.
- ❖ The restriction enzyme recognises a unique sequence of nucleotides in the DNA strand, which is usually between four to six base – pairs in length.
- ❖ The complimentary DNA strand has the same sequence but in the reverse direction, thus ensuring both strands of DNA are cut at the same location.

Uses of Bio technology :

1. Manufacture of liquors
2. Manufacture of enzymes
3. Manufacture of antibiotics

4. Manufacture of acetic acid
5. Manufacture of vitamins
6. Manufacture of vaccines
7. Manufacture of steroids
8. Manufacture of monoclonal antibodies

Genetic Diseases

1. Sickle cell Anaemia
2. Thalassemia
3. Agammaglobulinemia
4. Albinism
5. Huntington's Chorea
6. Severe combined immunodeficiency (SCID)

Genetic Disorders

Mendelian Nature	Chromosomal Nature
Haemophilia	Downs
Sickle cell Anaemia	Klinefelter's
Phenylketonuria	Turners syndrome

Types of cloning :

1.Molecular cloning :

- ❖ Actually points to the procedure of the isolation of a defined DNA sequence (gene) and through which the obtaining of multiple copies of it within a living organism.



- ❖ Molecular Cloning is used in a broad spectrum of biological experiments and technological applications which are the inclusive of large scale protein production.
- ❖ The DNA from an embryo is removed and replaced with the DNA from an adult animal. Then, the embryo is implanted in a womb and allowed to develop into a new animal.
- ❖ It has not been tried on humans.

2. Embryo cloning :

- ❖ It is basically a medical technique which duplicates the process that nature uses to produce twins or triplets.
- ❖ One or more cells are removed from a fertilised embryo and
- ❖ Encouraged to develop into one or more duplicate embryos. Twins or triplets are thus formed, with identical DNA.
- ❖ This has been done for many years on various species of animals, but only very limited experimentation has been done on humans.

3. Reproductive cloning :

- ❖ It involves producing a duplicate of an existing animal.
- ❖ It has been used to clone various mammals now, but the most famous cloned mammal is still "Dolly the Sheep".

4. Therapeutic cloning:

- ❖ It is a procedure that starts off like adult DNA cloning. However, the stem cells; cells that can replicate indefinitely and which can differentiate into other cells, are removed from the embryo with the intent of producing tissue or a whole organ for transplant back into the person who supplied the DNA.
- ❖ The embryo dies in the process. The goal of therapeutic cloning is to produce a healthy copy of a sick person's tissue or organ for transplant in order to avoid organ transplants from other people.
- ❖ The tissue or organ would have the sick person's original DNA so there would be no fear of an

HISTORICAL BACKGROUND

immune reaction to the donor organ

etc.) that transforms the signal resulting from the interaction of the analyte with the biological element into another signal (i.e., transduces) that can be more easily measured and quantified;

Bio – Sensors:

- ❖ A device which uses a living organism or biological molecules, especially enzymes or antibodies, to detect the presence of chemicals.

- ❖ Biosensor reader device with the associated electronics or signal processors that are primarily responsible for the display of the results in a user-friendly way.

Uses of Bio – Sensors :

- ❖ A biosensor is an analytical device, used for the detection of an analyte, that combines a biological component with a physicochemical detector.
- ❖ The sensitive biological element (e.g. tissue, microorganisms, organelles, cell receptors, enzymes, antibodies, nucleic acids, etc.), a biologically derived material or biomimetic component that interacts (binds or recognizes) the analyte under study.
- ❖ The biologically sensitive elements can also be created by biological engineering.
- ❖ The transducer or the detector element (works in a physicochemical way; optical, piezoelectric, electrochemical,

- ❖ This sometimes accounts for the most expensive part of the sensor device, however it is possible to generate a user friendly display that includes transducer and sensitive element.

Bio – Chips :

- ❖ a microchip designed or intended to function in a biological environment, especially inside a living organism.

Uses of Bio – Chips :

- ❖ Multi-purpose Tracking Device
- ❖ Medical / Scientific Device
- ❖ Identification System
- ❖ Military / Defense Mechanism
- ❖ Business

Stem cells

- ❖ Stem cells are undifferentiated biological cells that can differentiate into specialized cells and can divide (through mitosis) to produce more stem cells. They are found in multicellular organisms.
- ❖ In mammals, there are two broad types of stem cells: embryonic stem cells, which are isolated from the inner cell mass of blastocysts, and adult stem cells, which are found in various tissues.
- ❖ In adult organisms, stem cells and progenitor cells act as a repair system for the body, replenishing adult tissues.
- ❖ In a developing embryo, stem cells can differentiate into all the specialized cells-ectoderm, endoderm and mesoderm but also maintain the normal turnover of regenerative organs, such as blood, skin, or intestinal tissues.
- ❖ There are three accessible sources of autologous adult stem cells in humans:
 - Bone marrow, which requires extraction by harvesting, that is, drilling into bone (typically the femur or iliac crest),
 - Adipose tissue (lipid cells), which requires extraction by liposuction, and
 - Blood, which requires extraction through apheresis, wherein blood is drawn from the donor (similar to a blood donation), and passed through a machine that extracts the stem cells and returns other portions of the blood to the donor.
- ❖ Stem cells can also be taken from umbilical cord blood just after birth.
- ❖ Of all stem cell types, autologous harvesting involves the least risk. By definition, autologous cells are obtained from one's own body, just as one may bank his or her own blood for elective surgical procedures.
- ❖ Adult stem cells are frequently used in medical therapies, for example in bone marrow transplantation.
- ❖ Stem cells can now be artificially grown and transformed (differentiated) into specialized

HISTORICAL BACKGROUND

cell types with characteristics consistent with cells of various tissues such as muscles or nerves.

- ❖ Embryonic cell lines and autologous embryonic stem cells generated through therapeutic cloning have also been proposed as promising candidates for future therapies

Totipotent Stem Cells

- ❖ Totipotent (omnipotent) stem cells

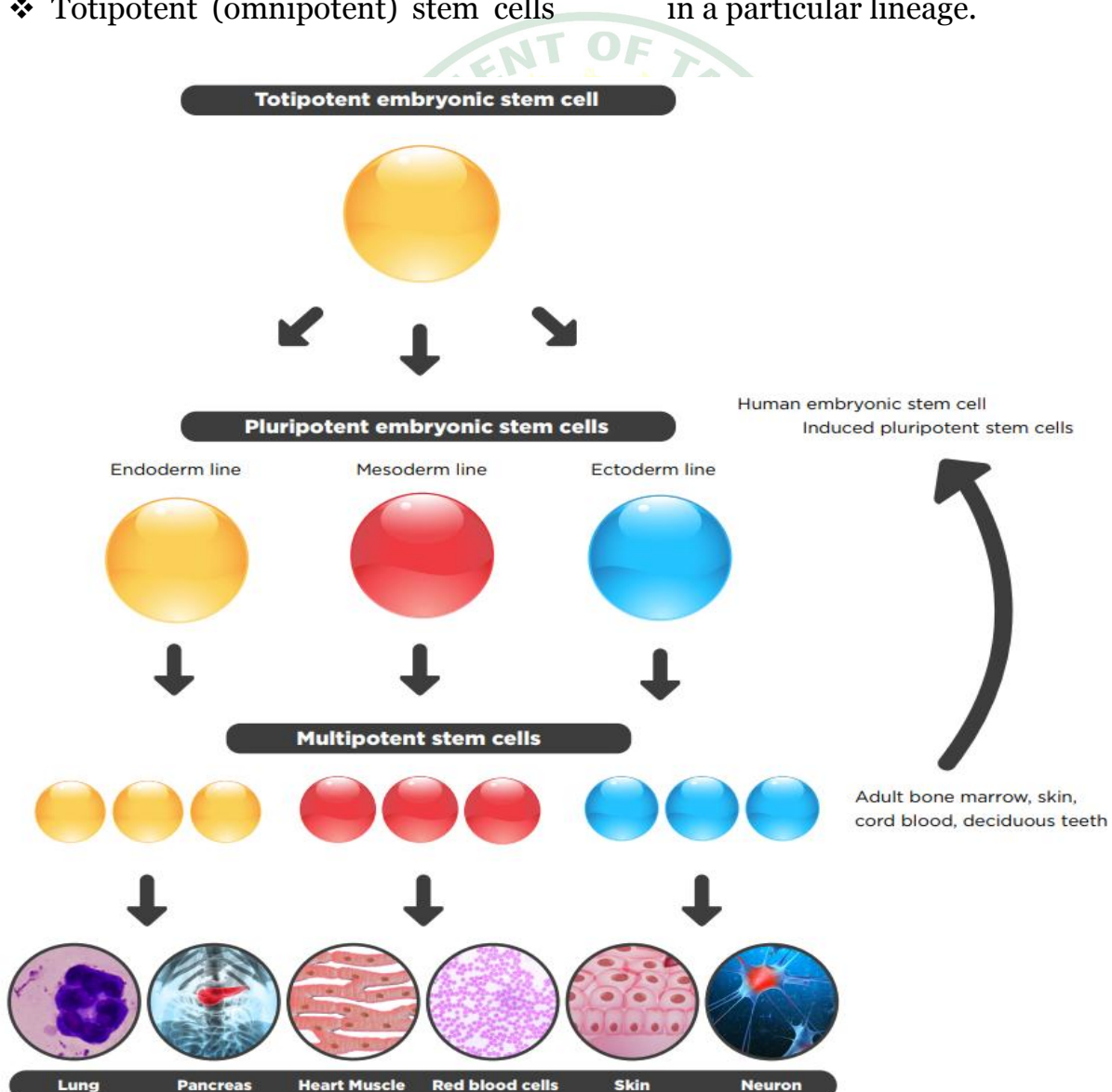
can give rise to any of the 220 cell types found in an embryo as well as extra-embryonic cells (placenta).

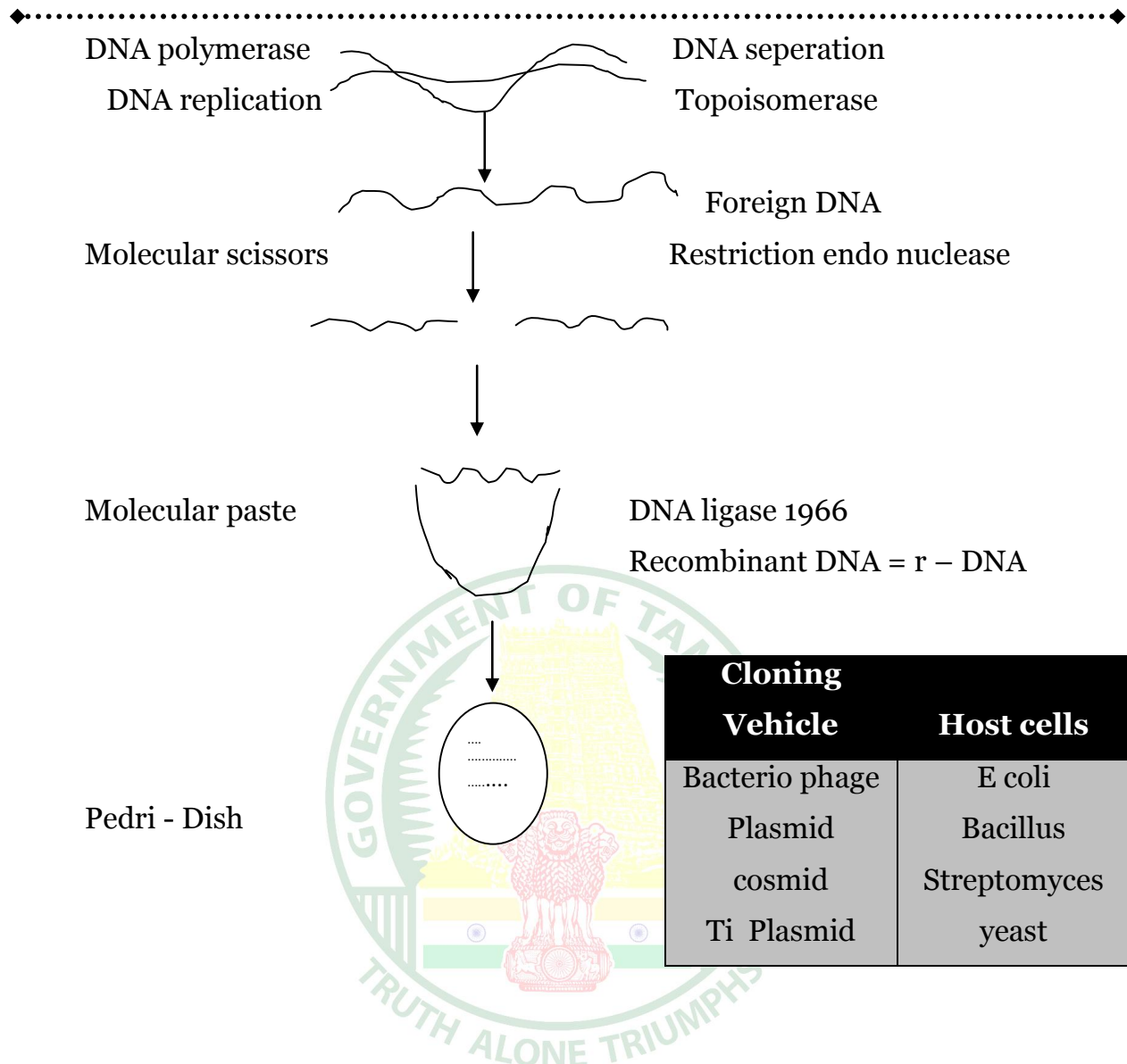
Pluripotent Stem Cells

- ❖ Pluripotent stem cells can give rise to all cell types of the body (but not the placenta).

Multipotent Stem Cells

- ❖ Multipotent stem cells can develop into a limited number of cell types in a particular lineage.





Heredity Diseases :

I. Body cell deficiency - dominant

- Huntington Chorea
- Cat Cry Syndrome
- Brachy dactyly

II. Sex cells deficiency - recessive

- Albinism
- Galactoseamia
- Phenylketonuria

III. Linked – dominant

- Haemophilia
- Christmas Disease
- Color blindness

IV. Linked – dominant

- Hypertrichosis

V. Linked – dominant

- Total color blindness