

Topic – Genetic and Evolution

DNA FINGERPRINTING OR GENETIC FINGERPRINTING

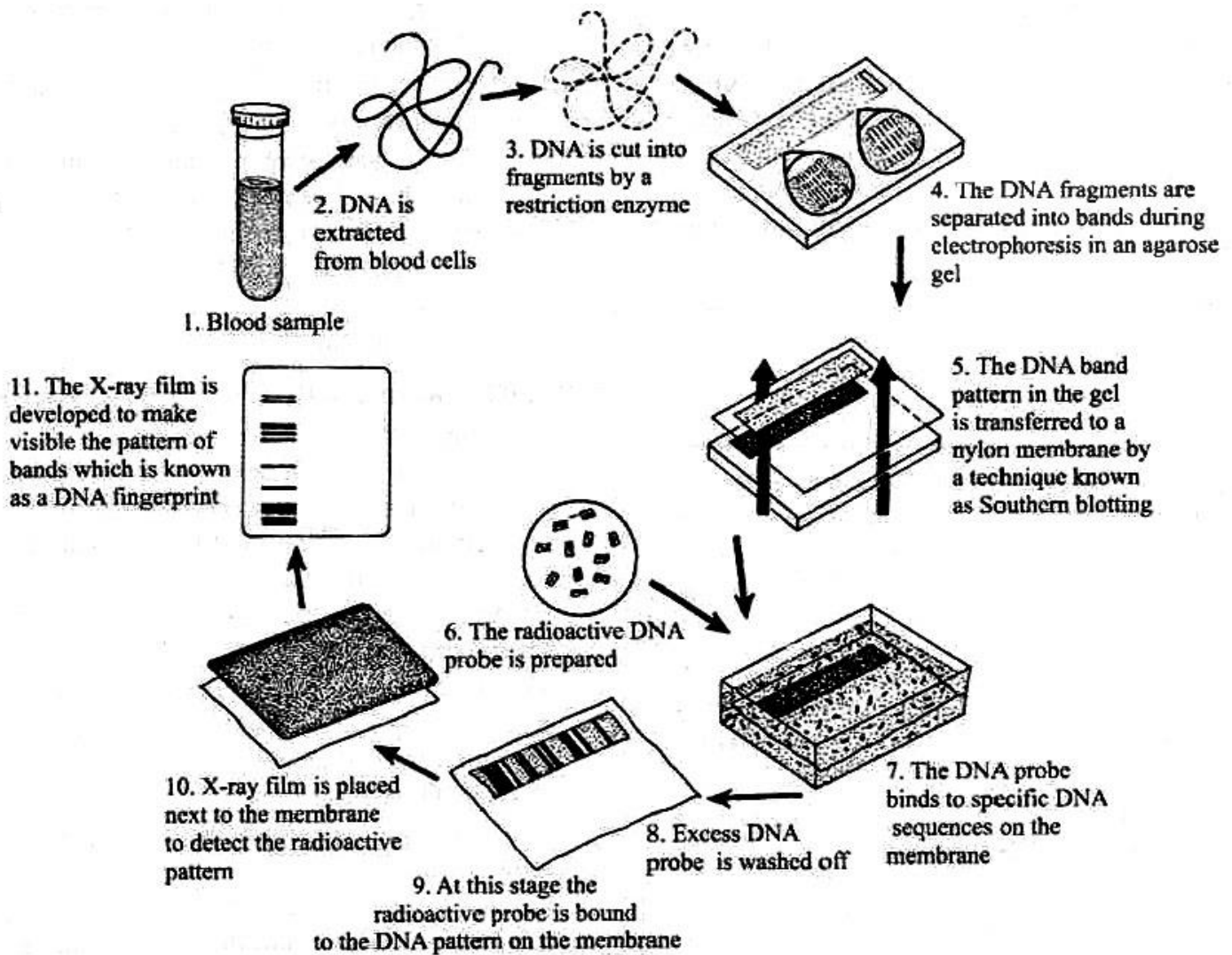


Fig.: The DNA fingerprinting process.

CONCEPT MAP

Genetics

Branch of biology that deals with study of heredity and variations.

Heredity

Study of inheritance of characters from parents to offsprings.

Variations

Difference in traits shown by individuals of a species.

Traits

Features (similarities or differences) of an individual.

Caused due to

- Crossing over
- Reshuffling of genes
- Chance combination of chromosomes during meiosis and fertilization

Types

Somatic variations

Variations that occur in somatic (body) cells due to environmental factors or use and disuse of organ or conscious efforts.

Germinal variations

Variations that occur mostly in germinal cells and are inheritable.

Causes

Recombination (crossing over)

Shuffling of genes that occurs as a result of interchange of corresponding parts between the chromatids of homologous chromosomes.

Mutations

Sudden inheritable discontinuous variations which occur due to permanent changes in genotypes. They can be spontaneous or induced. Basically mutations are of three types.

Chromosomal mutations

Genomic mutations

Gene mutations

Acquired traits

Non-genetic and non-heritable

Inherited traits

Genetic and inheritable

Inheritance of traits

Sex determination

Mechanism by which sex of a new born is determined. Sex of an individual also affects inheritance of some traits.

Genetic disorders

- Mendelian disorders
- Chromosomal disorders

Deciding factors

Environmental

Genetic/Chromosomal

- XX-XY method
- XX-X0 method
- ZW-ZZ method
- Z0-ZZ method
- Haploid-diploid method

Effect on inheritance of traits

- Sex linked traits
- Sex limited traits
- Sex influenced traits

Pedigree Analysis

Analysis of a family pedigree to find the movement and distribution of certain genetic traits. It helps to find out dominance or recessive etc. nature of certain chromosomes.

Mendelism

Factors (now termed genes) are the carriers of traits. Their inheritance follows three laws.

Law of dominance

The allele of a gene shows dominance over the other.

Law of segregation or purity of gametes

Alleles present in a generation retain their purity (do not mix up) and segregate in next generation.

Law of independent assortment

Alleles of genes for two different characters can assort independent of each other.

Chromosome theory of inheritance

Sutton and Boveri (1902) proposed this theory which states that Mendelian factors or genes are located at specific loci on chromosomes and it is the chromosome that segregates and assort independently during meiosis.

Linkage

Phenomenon of certain genes staying together and their *en-block* inheritance from one generation to another. This affects inheritance of traits and interferes with independent assortment.

- Complete linkage
- Incomplete linkage

CONCEPT MAP

Chromosomes

'Carriers of heredity'. They are thread like structures composed of chromatin that carry the genes in linear sequence. They determine the individual characteristics of an organism.

Gene

Unit of heredity that is composed of DNA.
Gene is visualised as a discrete particle that determines particular characteristics.

Expression

Gene expression is the mechanism at the molecular level by which a gene is able to express itself in the phenotype of an organism. In the process the information in DNA is transformed into proteins via following sequential process.

Regulation

The mechanism of switching off and switching on of the genes depending upon the requirement of the cells and the state of development. In prokaryotes, operon system is responsible for gene regulation.

DNA

DNA is a long polymer of deoxyribonucleotides that consists of deoxyribose sugar, phosphoric acid and nitrogenous bases (A, T, C, G). DNA contains hereditary information in the form of sequence of nitrogenous bases. Three bases together constitute a codon and the whole array of these codons is termed genetic code.

Replication

Formation of new exact copy of the DNA is a semiconservative and semidiscontinuous process. DNA replication is essential for maintaining quantity and quality of genetic material in every new cell generation.

Types

Positive regulation

Positive regulation is the one in which the genes remain unexpressed unless they are induced to do it. It is therefore inducible regulation.

Negative regulation

Negative regulation is the one in which the genes continue to express till their activity is repressed. It is also called repressible regulation.

Exerted at five levels

- Transcriptional level when primary transcript is formed.
- Processing level of primary transcript
- Translational level
- Post translational level
- During transport of mRNA

Transcription

Genetic information of DNA is transferred to RNA(mRNA) via transcription. RNA polymerase enzyme in presence of several other factors prepares single stranded RNA that is complementary to DNA with the substitution of thymine by uracil.

RNA

Single stranded, unbranched nucleic acid molecule consisting of ribose sugar, phosphoric acid and nitrogenous bases (A, U, C, G). They perform various functions in cells.

hnRNA

The primary transcript that consists of both introns (interrupting sequences) and exons (expressing sequences) is called heteronuclear RNA. It undergoes processing to produce mRNA.

tRNA

tRNA or transfer RNA works as the adapter molecule during protein synthesis (gene expression). It brings amino acids present in cytoplasm to the mRNA strand corresponding to the sequence of codons on the mRNA and facilitates protein synthesis.

rRNA

rRNA(ribosomal RNA) are the component of ribosomes. Ribosomes are essential for protein synthesis.

Processing

hnRNA splicing occurs to remove introns. Besides, polyA tail and a methyl guanosine triphosphate cap is added in order to increase its stability and to facilitate transportation of resulting mRNA.

mRNA

mRNA or messenger RNA carries the genetic information present in DNA inside nucleus to the cytoplasm where proteins are synthesized in accordance to the genetic code.

Translation

Translation is the process during which the genetic information stored in the sequence of nucleotides in an mRNA molecule are translated into proteins.

Proteins

Proteins are polymers of amino acids that are essential for body organization. They also act as enzymes for various biochemical processes.

Phenotypic expression

If proteins that catalyze a particular process are produced more, than that process will occur more efficiently causing changes in phenotype.

CONCEPT MAP

Origin of Life

Theories of origin of universe

Nebular Hypothesis

It was proposed by Kant-Leplace according to which earth originated about 4.5 - 5 billion years ago from a gaseous cloud solar nebula.

Big bang Theory

According to this theory of Abbe Lemaitre universe formed by a big bang (thermonuclear expansion) of a dense entity.

Chemical theory of origin of life

- Oparin - Haldane's of chemical origin theory is most widely accepted theory of origin of life. It involves some basic steps that are:
- **Formation of inorganic molecules**
- From the gases present in early earth's atmosphere.
- **Formation of simple organic compounds**
- From the inorganic compounds formed in previous step.
- **Spontaneous formation of complex organic molecules**
- Simple organic molecules combined to form large organic complex biomolecules like starch, proteins, fatty acids.
- **Spontaneous formation of molecular aggregates, coacervates, eobionts and first living cell**
- Complex organic compounds synthesized on primitive earth grouped together spontaneously and due to intermolecular attraction formed large colloidal aggregates called **coacervates** or **microspheres** which turned into **eobionts** (controlled by nucleic acids). These developed cell membrane and formed first living cells or **prokaryotes**.

Evolution

(Latin *evolvere*-to unroll). Multicellular organisms evolved from tiny eukaryotic unicellular ones.

Eukaryotes (Unicellular)

Evidences of evolution

Morphological and anatomical

Comparative studies of morphology and anatomy, homology of organisms provide evolutionary proofs, e.g., vestigial organs, atavism etc.

Embryological

Comparative study of embryonic development of various organisms shows various similarities and resemblance to embryos of lower organisms indicating evolution (Biogenetic law of Haeckel)

Paleontological

Paleontology is the study of fossils (preserved remains of dead organisms). It provides most direct and reliable evidences of evolution.

Connecting links

Connecting links are living organisms with characteristics intermediate between two groups, e.g., *Euglena* (link between plants and animals).

Molecular and physiological

Various physiological processes, cellular structure, biochemistry, genetic composition, etc. also provide evolutionary evidences, e.g., blood plasma proteins.

Theories of evolution

Lamarck's Theory

It says that "The changes in structure or function of any organ are acquired during the lifetime of an individual by use or disuse of that organ and are inherited" causing evolution.

Darwin's Theory

It says that variations occur in organisms and useful among them are selected by nature (i.e., natural selection) and get accumulated in the organism. This leads to evolution.

Mutation Theory

This theory put forward by Hugo de Vries says that evolution is a discontinuous, saltatory process that occurs due to sudden inheritable variations.

Modern Synthetic Theory

According to it five factors : genetic variations, heredity, natural selection, reproductive isolation and speciation lead to evolution.

Mechanism of evolution

Evolution starts with generation of variations. Variations in a population may occur by mutations, genetic drift, gene migration, gene recombination, hybridization, etc. Out of these variations inheritable variations undergo natural selection and the individual with highest survival value in the present environmental conditions evolve.

Human evolution

All human beings present today belong to a simple species *Homo sapiens* which has evolved bipedal locomotion high cranial capacity, opposable thumbs and etc. and dominates today's life forms.