DNA Fingerprinting

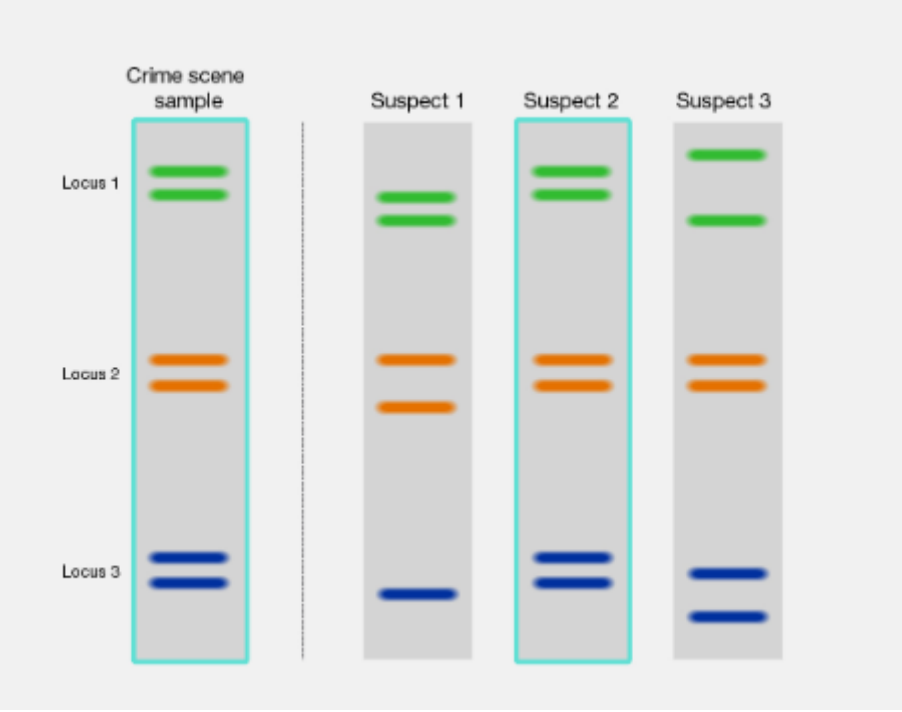
Syllabus: GS III – Science and Technology- Developments and their applications and effects in everyday life.

Why in News?

In the Pune rape case, police conduct DNA fingerprinting of the accused to match with the forensic evidence collected from the crime scene.

What is DNA Fingerprinting?

- **DNA fingerprinting** - It is a forensic technique , also known as DNA profiling, that identifies individuals based on unique patterns in their DNA, particularly in repetitive DNA segments called short tandem repeats (STRs).



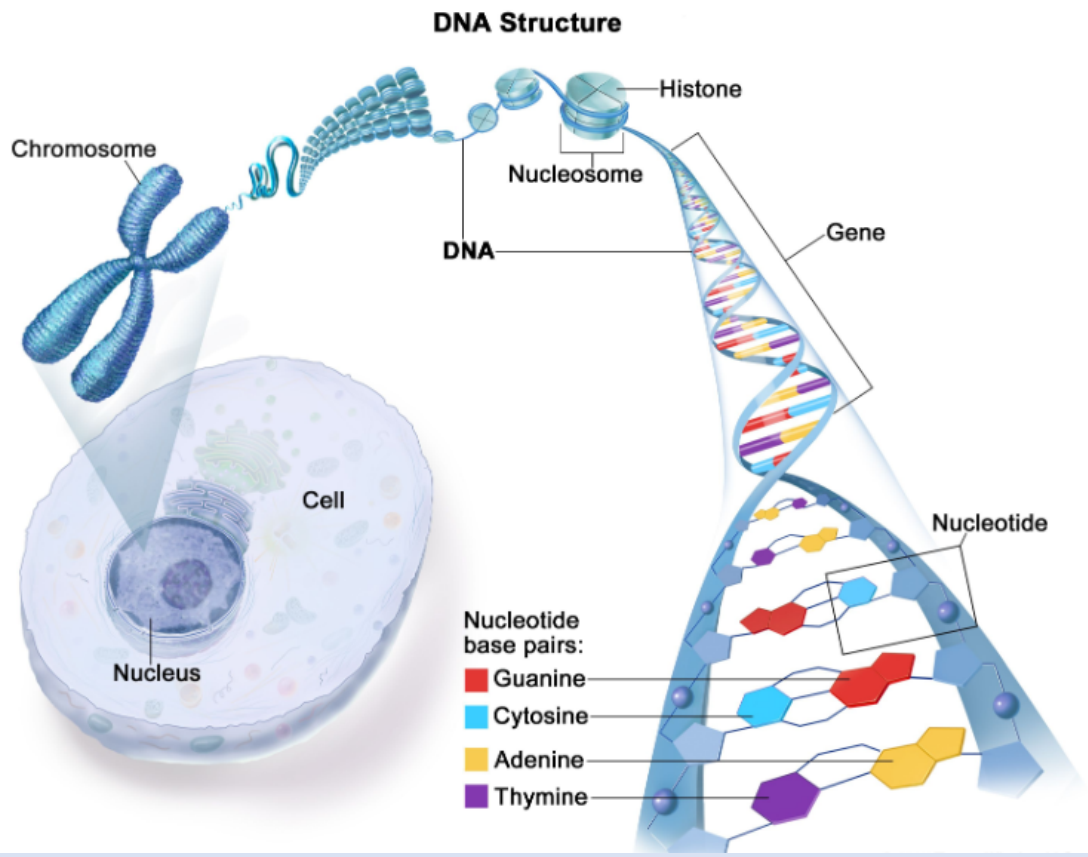
- **DNA Sample** - Fingerprint can be established using DNA from teeth, bones, blood (a drop is enough), spit, semen, skin cells, etc.

Centre for DNA Fingerprinting and Diagnostics (CDFD), an autonomous organization funded by the Department of Biotechnology (DBT), is located in

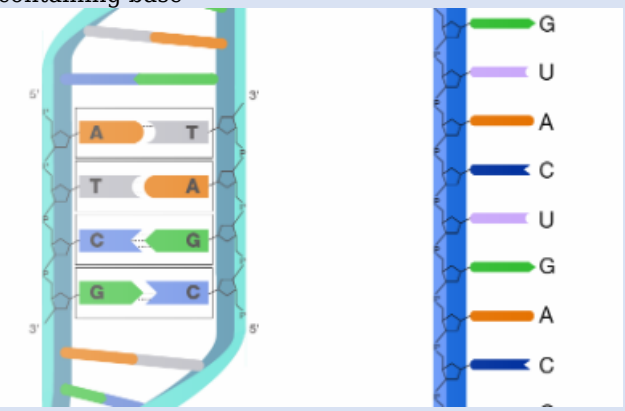
Hyderabad.

DNA Basics

• **Chromosome** - Each of an individual's cells — in one's skin, blood, teeth, bone, etc. — contain 46 DNA molecules.
• One set of 23 is inherited via sperm from the father and the other 23 via the egg from the mother.
Sperm and egg cells are exceptional because they have only one copy of the genome each, not two.
• The DNA is packed inside chromosomes.



• **DNA polymorphisms** - It refers to variations in DNA sequences, including single nucleotide differences (SNPs), that occur among individuals or populations.
A nucleotide is the basic building block of nucleic acids (DNA and RNA), composed of a sugar molecule (deoxyribose in DNA, ribose in RNA), a phosphate group, and a nitrogen-containing base



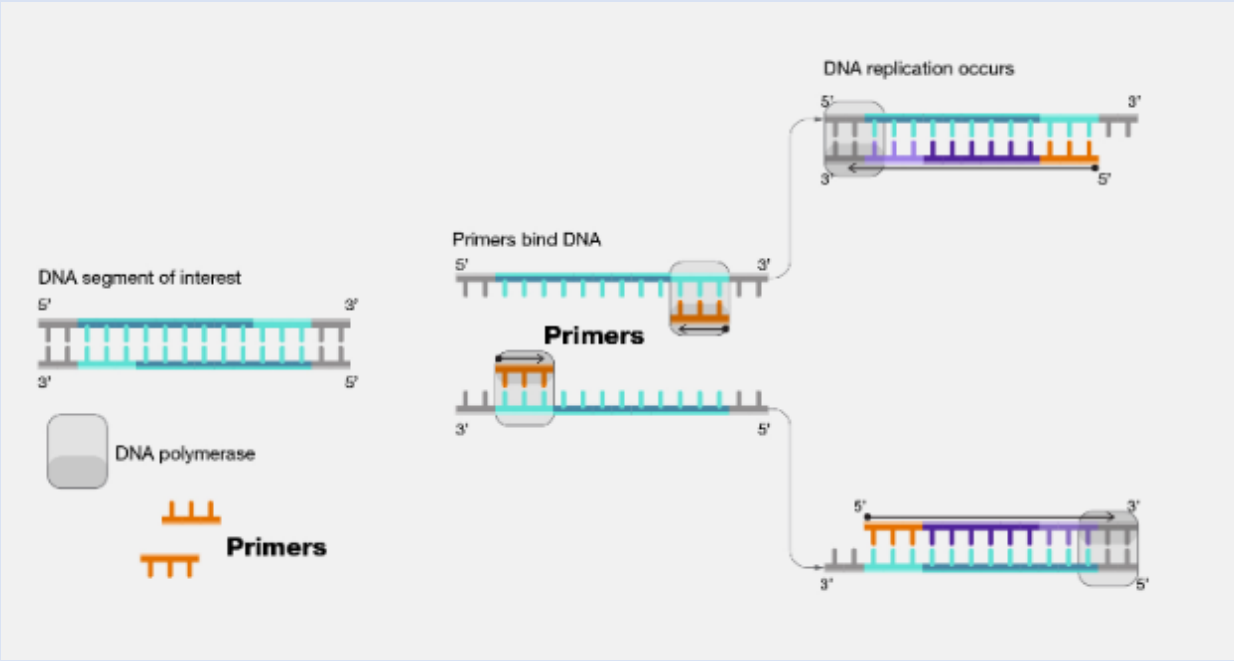
• It serves as genetic markers for analysis and can be used to differentiate one person from another.
• It is most often (but not exclusively) used together with technologies like PCR, capillary electrophoresis, and fingerprinting.
• **DNA profiles**- They are typically generated using polymorphisms in parts of the DNA called short tandem repeats (STRs).
• **Short tandem repeats (STRs)** - It is the short sequence of base-pairs on the DNA that is repeated some number of times, such as GATCGATCGATCGATC.
DNA has two strands and Each strand is a sequence of four chemical bases: adenine (A), cytosine (C), guanine (G), and thymine (T).
• **Uniqueness** – These STRs are unique for an individual and varies across people.

What are the applications of DNA Fingerprinting?

- The ability of DNA fingerprinting to analyze and match genetic markers makes DNA fingerprinting an invaluable tool across science, medicine, law enforcement, and more.
- **Biological identification** - Just like the Aadhaar number is used to uniquely identify an individual for social security purposes, a person's DNA fingerprint can be used for biological purposes.
- **Forensic science** - By comparing DNA found at crime scenes with that of suspects, authorities can establish links or rule out individuals.
- **Paternity and family testing** - DNA fingerprinting can confirm biological relationships, such as identifying parents, siblings, or other relatives.
- **Medical diagnostics** - It helps in identifying genetic disorders, mutations, or predispositions to certain diseases, enabling early diagnosis and personalized treatment plans.
- **Anthropology and evolutionary studies** - Scientists use DNA profiling to study human evolution, migration patterns, and historical connections between populations.
- **Wildlife conservation and management** - It aids in tracking genetic diversity in endangered species, solving poaching cases, and ensuring proper animal breeding practices.
- **Agriculture and food industry** - DNA fingerprinting is used to verify the authenticity of food products, improve crop strains, and study genetic characteristics in livestock.
- **Disaster victim identification** - It can be used to identify victims of accidents, natural disasters, or mass casualties by comparing DNA with family members.

PCR

• **DNA Copies** - Scientists need to make many copies of the DNA present in particular STRs to make studying them easier.
• **PCR** - Polymerase chain reaction (abbreviated PCR) is a laboratory technique for rapidly producing (amplifying) millions to billions of copies of a specific segment of DNA.
• **PCR Method**:
- Genetic material is extracted from tissue that contains the DNA of interest.
- It is heated to about 95º C for 25 seconds to split the strands apart.
- A short single-stranded piece of DNA, called Primer, that binds to a single strand.
- The sequence of bases on the primer is configured so that it binds to the portion of interest on the DNA.



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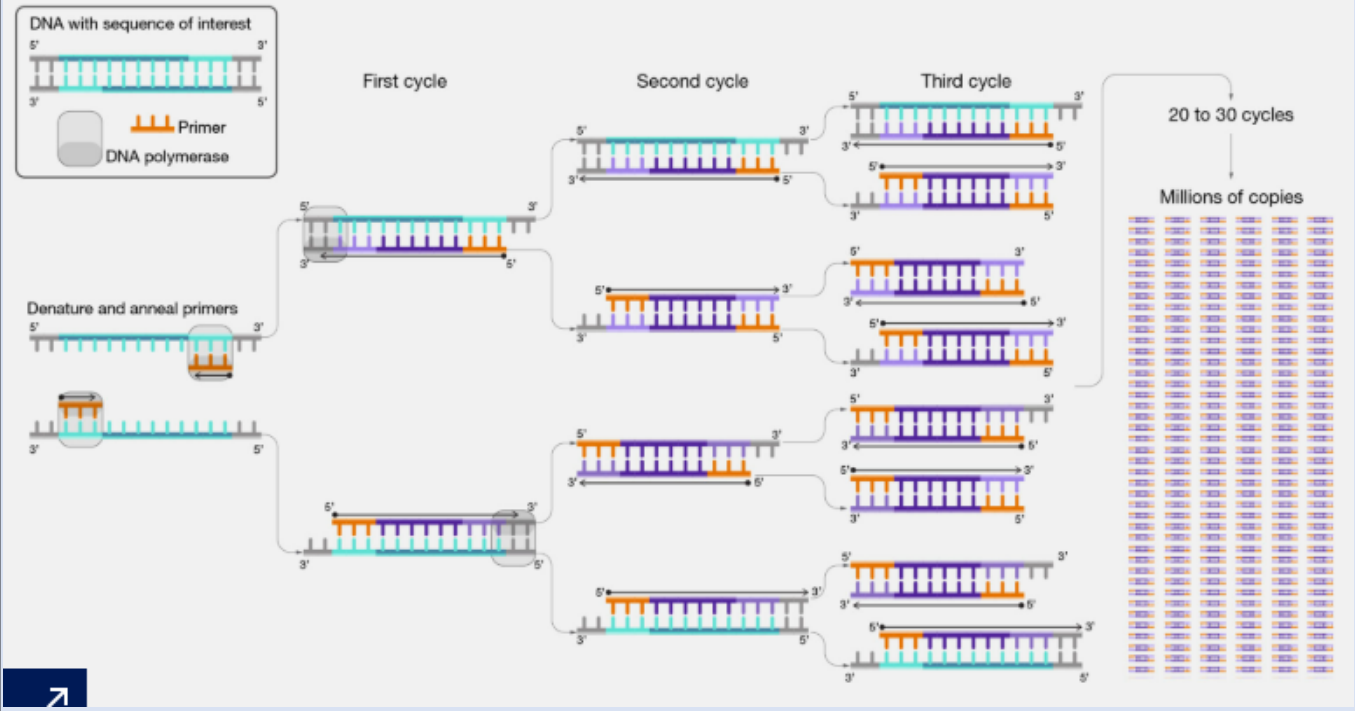
- The temperature in this phase is lowered to around 60º C.
- Another molecule called DNA polymerase is introduced to hold the primer and synthesises the rest of it according to the complementary bases on the strand.



References

[The Hindu | DNA Fingerprinting]