DNA Fingerprinting

9.1 INTRODUCTION

DNA fingerprinting involves several steps, including DNA extraction, PCR amplification of STR regions, and fragment analysis through capillary electrophoresis. The resulting DNA profile is a series of peaks representing the lengths of amplified STR regions, forming a unique genetic "fingerprint" for each individual. DNA fingerprinting, formally known as DNA profiling or short tandem repeat (STR) analysis, is a cornerstone of forensic biology. Developed by Sir Alec Jeffreys in the mid-1980s, DNA fingerprinting relies on the inherent uniqueness and stability of an individual's DNA. This technique identifies variations in specific regions of the genome called short tandem repeats, where a sequence of nucleotides is repeated a certain number of times. The number of repeats at different loci creates a distinctive pattern that is highly unlikely to match between unrelated individuals. The process, developed by Jeffreys in conjunction with Peter Gill and Dave Werrett of the Forensic Science Service (FSS), was first used forensically in the solving of the murder of two teenage girls who had been raped and murdered in Narborough, Leicestershire in 1983 and 1986. In the murder inquiry, led by Detective David Baker, the DNA contained within blood samples obtained voluntarily from around 5,000 local men who willingly assisted Leicestershire Constabulary with the investigation, resulted in the exoneration of a man who had confessed to one of the crimes, and the subsequent conviction of Colin Pitchfork.

9.2 PROCEDURE OF DNA FINGERPRINTING

In DNA fingerprinting, a DNA sample taken from a crime scene is compared with a DNA sample from a suspect. If the two DNA profiles are a match, then the evidence came from that suspect. Conversely, if the two DNA profiles do not match, then the evidence cannot have come from the suspect. DNA fingerprinting is also used to establish paternity. Initially a cell sample is taken usually a cheek swab or blood test, which is followed by DNA extraction and restriction digestion of DNA. Now these small fragments are amplified by the polymerase chain reaction and these fragments are separated by electrophoresis. The fragments are then transferred to a nitrocellulose membrane. The specific DNA fragments are then bound to a radioactive DNA probe and washed for excess probe. Finally an X-ray film is used to detect a radioactive pattern which is then compared to other DNA samples. Unlike the original DNA fingerprinting method, DNA profiling does not use restriction enzymes to cut the DNA now-a-days. Instead, it uses the polymerase chain reaction (PCR) to produce many copies of specific STR sequences. In recent years, research in human DNA quantitation has focused on new "real-time" quantitative PCR (qPCR) techniques. Quantitative PCR methods enable automated, precise, and high-throughput measurements. Inter-laboratory studies have demonstrated the importance of human DNA quantitation on achieving reliable interpretation of STR typing and obtaining consistent results across laboratories.

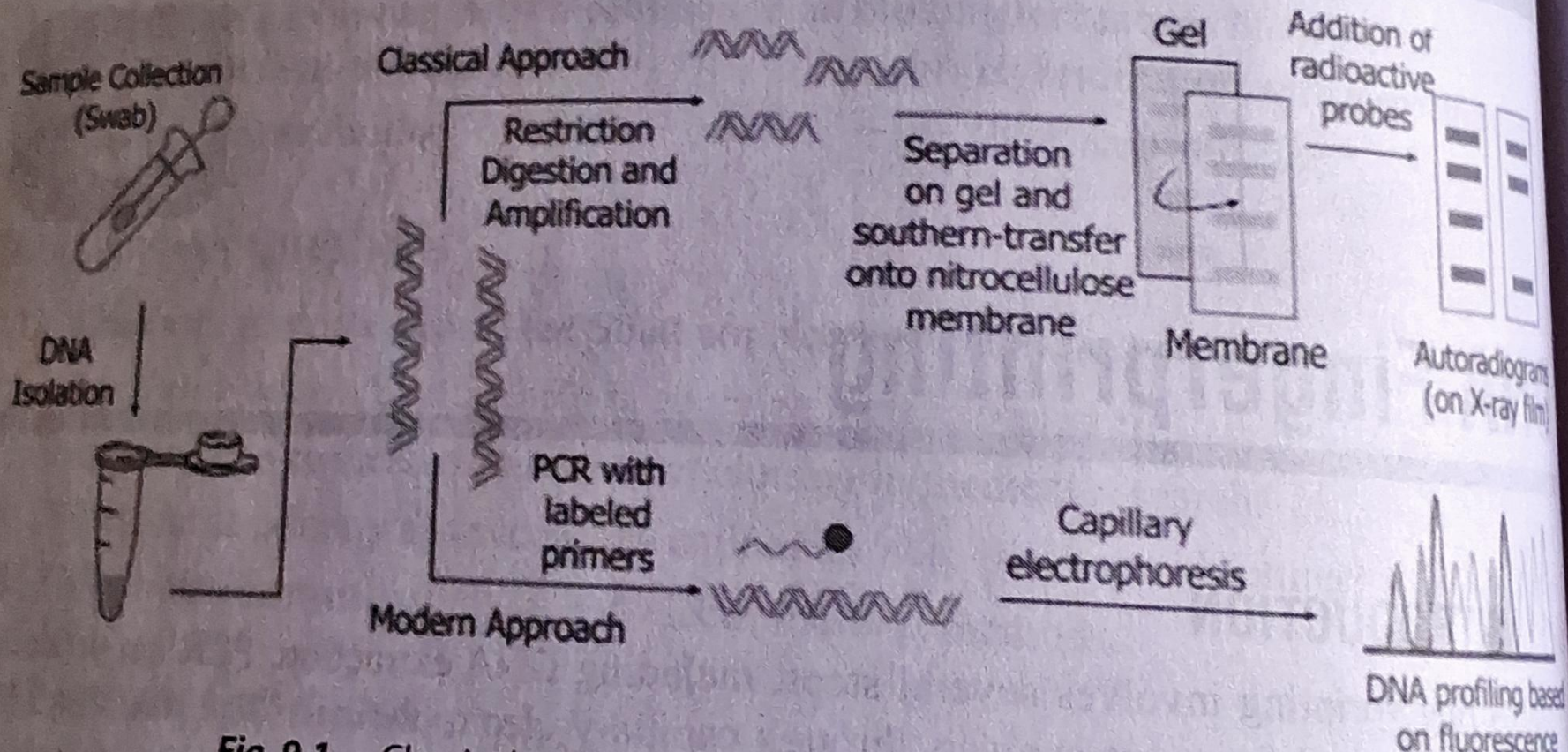

Fig. 9.1. *Classical and Modern*