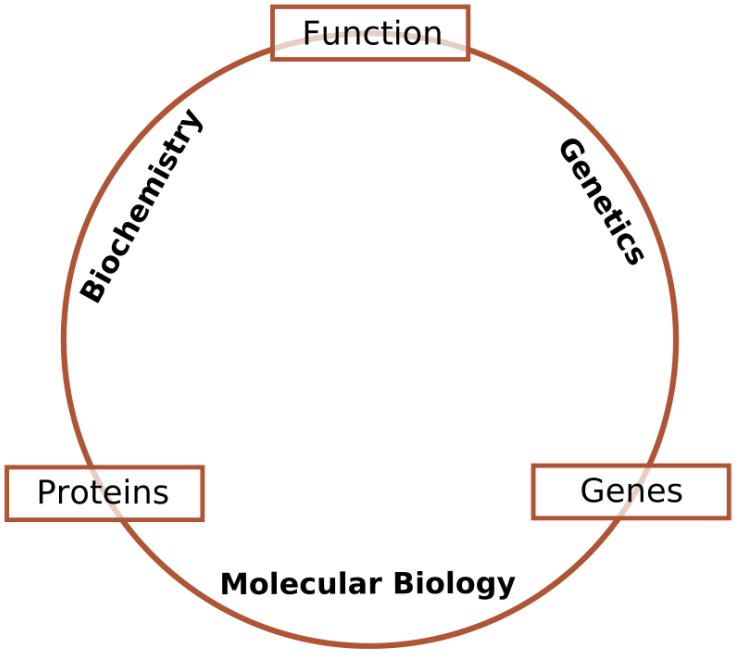
Introduction to molecular biology

Molecular biology is often separated from the field of cell biology, which concentrates on cellular structures (organelles and the like), molecular pathways within cells and cell life cycles, therefore, molecular biology is the branch of biology that concerns the molecular basis of biological activity in and between cells, including molecular synthesis, modification, mechanisms and interactions.

Molecular biology is a specialized branch of biochemistry, the study of the chemistry of molecules which are specifically connected to living processes. Of particular importance to molecular biology are the nucleic acids (DNA and RNA) and the proteins which are constructed using the genetic instructions encoded in those molecules. Other biomolecules, such as carbohydrates and lipids may also be studied for the interactions they have with nucleic acids and proteins.



Some clinical research and medical therapies arising from molecular biology are covered under gene therapy whereas the use of molecular biology or molecular cell biology in medicine is now referred to as molecular medicine. For example breast cancers that overexpress the protein for the HER2 gene.

There is evidence that both genetic disorders and environmental factors play a critical role in the human diseases for example cancer. Cancer or cancerous tumour is a disease that is caused by changes in DNA. Extensive research has shown that there are more than two

hundred type of cancerous tumors that are including lymphoma, lung cancer, breast cancer, prostate cancer colon cancer, and skin cancer. However, cigarette smoking has many a major risk factor on human health and it is causes many serious disease for example, heart attacks, strokes, and cancer diseases and lead to more than five million deaths per year over the world.

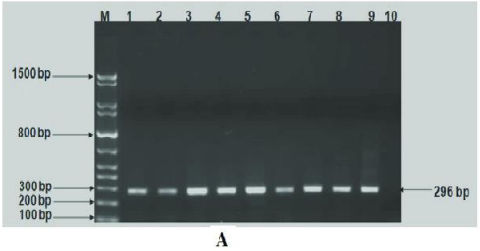
There are two types of genes that can play a critical role in cancer, tumour suppressor genes and oncogenes (See Table below). Thereby, smoking use can causes cancer disease by many of genetic mutations in these genes.

Oncogenes	suppressors
ABL, AF4/HRX, AKT-2, ALK, ALK/NPM, AML1, AML1/MTG8, AXL, BCL-2, 3, 6, BCR/ABL, c-MYC, EGFR, ERBB-2, HER2/neu, MOS	pVHL, APC, CD95, ST5, YPEL3, ST7, and ST14, p16, BRCA2, APC

Molecular biology also plays important role in understanding formations, actions, and regulations of various parts of cells which can be used to efficiently target new drugs, diagnose disease, and understand the physiology of the cell.

Common molecular biology techniques

- Electrophoresis – a process which separates molecules such as DNA or proteins out according to their size, electrophoresis is a mainstay of molecular biology laboratories. While knowing the size of a molecule might not seem like all that much information, it can be used to identify molecules or fragments of molecules and as a check to make sure that we have the correct molecule present.



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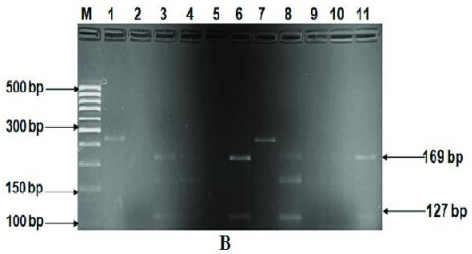

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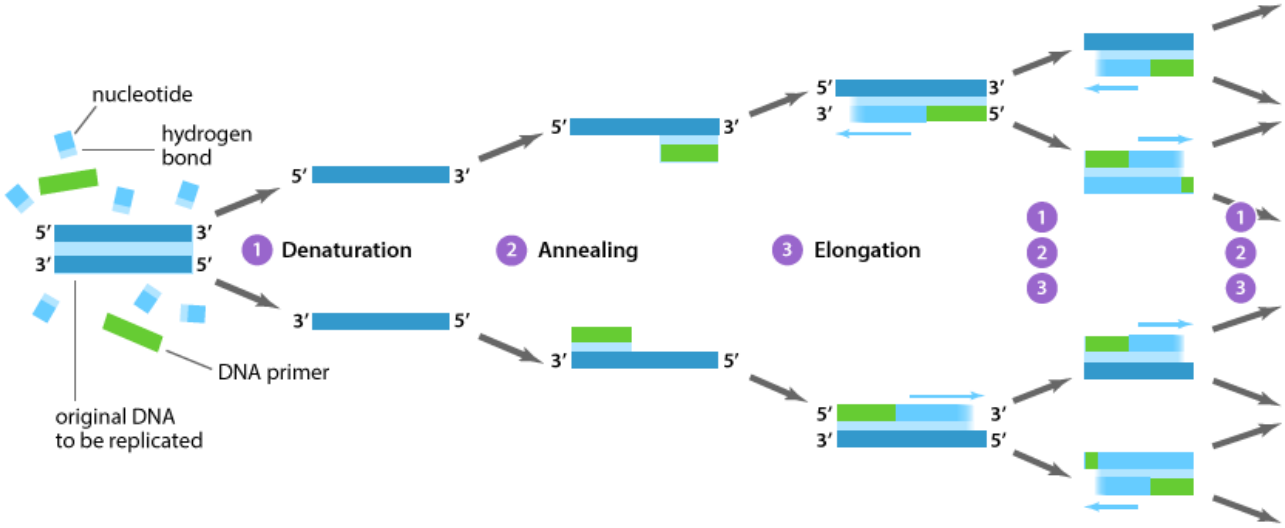
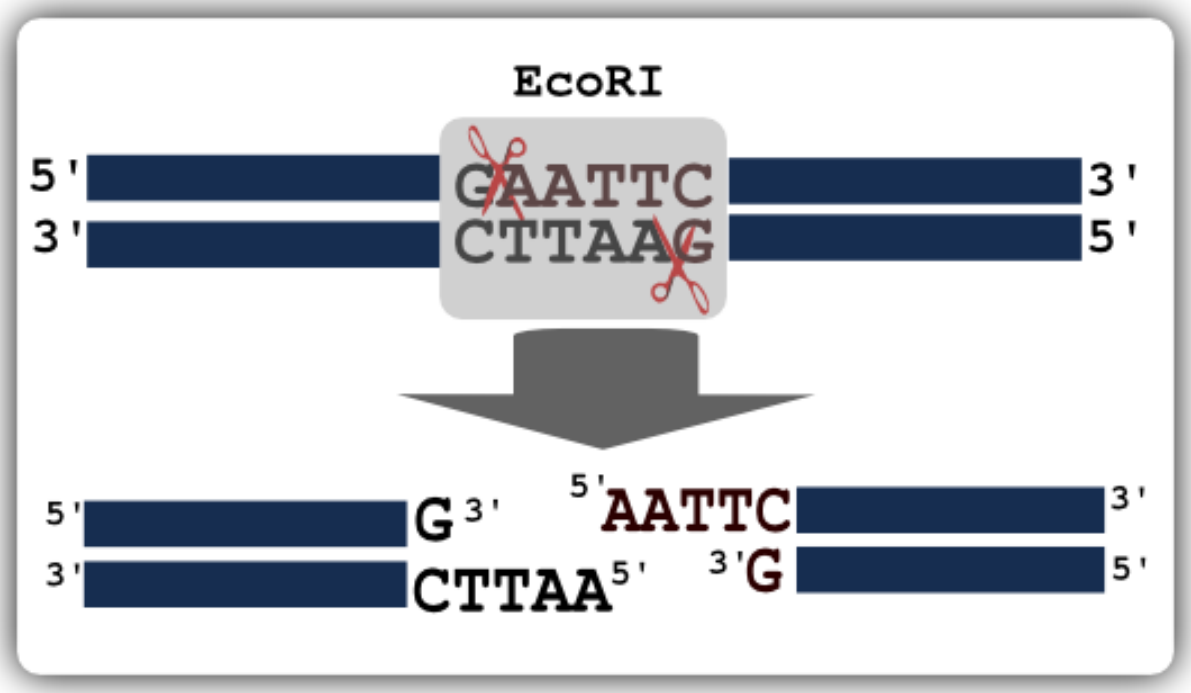
- Polymerase Chain Reaction (PCR) – a process used to amplify very small amounts of DNA to amounts which can be used in further experiments. It is used as a basic tool in molecular biology to ensure that we have sufficient DNA to carry out further techniques such as genetic modification, however it has wider practical uses such as in forensics (identification using DNA profiling) and disease diagnosis. PCR can also be used to introduce small point mutations into a gene in a process called site-directed mutagenesis.



- Restriction Digest – the process of cutting DNA up into smaller fragments using enzymes which only act at a particular genetic sequence.



- Ligation – the process of joining two pieces of DNA together. Ligation is useful when introducing a new piece of DNA into another genome.
- Blotting – a technique used to specifically identify biomolecules following electrophoresis. The molecule of interest is indicated using either a labeled probe (a complementary strand of nucleic acid) or a labeled antibody raised against a specific protein.
- Cloning – the technique of introducing a new gene into a cell or organism. This can be used to see what effect the expression of that gene has on the organism, to turn the organism into a factory which will produce large quantities of the gene or the protein it codes for, or (within the inclusion of a label) to indicate where the products of that gene are expressed in the organism. Insertion of genetic material into a bacterium is called transformation, while insertion into a eukaryotic cell is called transfection. If a virus is used to introduce this material, the process is called transduction.

Each of these techniques is used in conjunction with other techniques to help scientists solve a particular research question. For example, following using PCR to create large quantities of a particular gene a scientist may ligate a gene for a particular protein into a plasmid vector (a short circular strand of DNA which acts as a carrier), perform a quick restriction digest and electrophoresis to ensure that the gene has been inserted properly, and then use that plasmid to transform a bacterial cell which is used to produce large quantities of the vector. After purification of the vector from the bacteria, it is then used to transfect a mammalian cell in culture. The scientist then uses protein electrophoresis and western blotting to demonstrate the expression of the gene product.