Molecular biology

Molecular biology is the branch of biology that deals with the molecular basis of biological activity. This field overlaps with other areas of biology and chemistry, particularly genetics and biochemistry. Molecular biology chiefly concerns itself with understanding the interactions between the various systems of a cell, including the interactions between the different types of DNA, RNA, and protein biosynthesis as well as learning how these interactions are regulated.

Molecular strategies are currently being either used or sought for brain tumors, stroke, neurodegenerative diseases, vascular malformations, spinal degenerative diseases, and congenital malformations of the central nervous system.

Techniques

The application of techniques in molecular biology to human neurosurgical conditions has led to an increased understanding of disease processes that affect the brain and to novel forms of therapy that favorably modify the natural history of many of these conditions.

Molecular biology encompasses a wide range of laboratory techniques and methods that are used to study and manipulate biological molecules, such as DNA, RNA, and proteins. These techniques play a crucial role in various aspects of biological research, including genetics, genomics, cell biology, and biotechnology. Here are some commonly used molecular biology techniques:

Polymerase Chain Reaction (PCR)

Gel Electrophoresis

DNA Sequencing: DNA sequencing methods, such as Sanger sequencing and next-generation sequencing (NGS), are used to determine the nucleotide sequence of DNA molecules. NGS technologies enable the high-throughput sequencing of entire genomes, transcriptomes, or specific genomic regions.

Restriction Enzyme Digestion

Cloning

Southern Blotting

Northern Blotting

Western Blotting

Gene Expression Analysis

CRISPR-Cas9

Protein Purification

These are just a few examples of the many molecular biology techniques available to researchers. The choice of technique depends on the specific research goals and the type of biological molecules being studied. Advances in molecular biology continue to drive discoveries in genetics, genomics, and various fields of biology.

Considering that the structure of deoxyribonucleic acid was ascertained by Watson and Crick as recently as 1953, the progress that has been made to implement molecular medicine in clinical practice has been meteoric. More than 2000 patients have been treated in approved gene therapy trials throughout the world. Many of these patients have been treated for neurological diseases for which conventional medical therapies have been of limited utility. As part of this continuing series on advances in neurosurgery in the third millennium, we first reflect on the history of the nascent field of molecular biology. We then describe the powerful techniques that have evolved from knowledge in this field and have been used in many publications in Neurosurgery, particularly within the past decade. These methods include commonly used techniques such as advanced cytogenetics, differential display, microarray technology, molecular cell imaging, yeast two-hybrid assays, gene therapy, and stem cell utilization. We conclude with a description of the rapidly growing field of bioinformatics. Because the Human Genome Project will be completed within 5 years, providing a virtual blueprint of the human race, the next frontier (and perhaps our greatest challenge) will involve the development of the field of “proteomics,” in which protein structure and function are determined from the deoxyribonucleic acid blueprint. It is our conviction that neurosurgeons will continue to be at the forefront of the treatment of patients with neurological diseases using molecular strategies, by performing essential research leading to increased understanding of diseases, by conducting carefully controlled studies to test the effects of treatments on disease processes, and by directly administering (by neurosurgical, endovascular, endoscopic, or stereotactic means) the treatments to patients [1)].

Molecular biology in neurosurgery

- Cellular and Molecular Interactions in CNS Injury: The Role of Immune Cells and Inflammatory Responses in Damage and Repair
- A Refined Approach to Isolate Interneurons for High-Validity Epigenetic Studies in Human Brain Tissue
- Recent advances in molecular mechanisms of microRNAs in pathogenesis and resistance of treatment in glioblastoma
- Treating seizures in SYN1-related epilepsy: a systematic review
- Ectopic expression of GDF15 in cancer-associated fibroblasts enhances melanoma immunosuppression via the GFRAL/RET cascade
- Network-based analysis of candidate oncogenes and pathways in hepatocellular carcinoma
- Spinal Instability Neoplastic Score as a Predictor of Vertebral Fracture in Patients Undergoing Radiation Therapy for Spinal Metastases: A Single-Institution Study
- Large-scale high-density brain-wide neural recording in nonhuman primates

see Glioma biomarker.

1)

Rutka JT, Taylor M, Mainprize T, Langlois A, Ivanchuk S, Mondal S, Dirks P. Molecular biology and

neurosurgery in the third millennium. Neurosurgery. 2000 May;46(5):1034-51. Review. PubMed PMID: 10807235.