

OBJECTIVE BOTANY

Cell & Molecular Biology

for

M.Sc. (Semester II) Paper 2

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UNIT 01

Introduction : Cell and Molecular Biology

Syllabus: Introduction of Cell and molecular biologist. Research developments, opportunities, institutions and journals.

Introduction

Cell Biology is the study of the structure, function, and behavior of cells. It encompasses the study of cell components like the nucleus, mitochondria, endoplasmic reticulum, and more, and how they work together to maintain life. Molecular Biology, on the other hand, focuses on the molecular mechanisms within cells, especially the interactions between various macromolecules such as DNA, RNA, and proteins. Together, Cell and Molecular Biology is an interdisciplinary field that explores how cellular processes work at a molecular level and how these processes contribute to cellular function, organismal development, and disease.

Key Research Developments:

1. DNA Sequencing and Genomics:

- Human Genome Project (2001): Mapping the entire human genome provided insights into genetics, inheritance, and diseases.
- Advances in Next-Generation Sequencing (NGS) technologies have

led to the ability to sequence entire genomes in a fraction of the time and cost.

2. Gene Editing:

- The discovery of the CRISPR-Cas9 system revolutionized genetic engineering. This technology allows scientists to make precise modifications to the genome, which has applications in gene therapy, agriculture, and disease modeling.

3. Stem Cell Research:

- The isolation of induced pluripotent stem cells (iPSCs) from adult cells has opened the possibility for regenerative medicine, allowing for the creation of patient-specific models for drug testing and potential tissue regeneration therapies.

4. Cancer Research:

- Molecular understanding of cancer has led to targeted therapies, such as immunotherapy and precision medicine, which specifically target cancerous cells while minimizing damage to healthy cells.

- Oncogenes and tumor suppressor genes have been studied to understand how mutations lead to cancer development.

5. Single-Cell Biology:

- Single-cell RNA sequencing has enabled researchers to understand the gene expression profiles of individual cells, helping in understanding cellular heterogeneity and tissue organization.

6. Synthetic Biology and Bioengineering:

- Synthetic biology has enabled the design and construction of new biological parts and systems, such as engineered microorganisms that can produce biofuels or pharmaceuticals.

7. Understanding Disease Mechanisms:

- Research into the molecular mechanisms behind diseases like Alzheimer's, diabetes, and cardiovascular disease has revealed potential targets for therapeutic interventions.

8. Epigenetics:

- The study of epigenetic modifications, which affect gene expression without changing the underlying DNA sequence, has provided insights into cancer, aging, and environmental impacts on health.

Cell and Molecular Biology in India

1. Genomic and Bioinformatics Research:

- India has made significant progress in genomics research, with institutions like The Centre for Cellular and Molecular Biology (CCMB) in Hyderabad and National Centre for Biological Sciences (NCBS) in Bangalore making notable contributions.

- India is also an important player in the Human Genome Project and other international genomic initiatives, including the Indian Genome Variation Consortium which aims to map genetic diversity in the Indian population.
- Advances in bioinformatics have helped to analyze vast amounts of molecular data, with Indian institutions contributing to the development of tools for genome sequencing, molecular docking, and other computational biology techniques.

2. Stem Cell Research and Regenerative Medicine:

- India has made strides in stem cell research, with institutions like All India Institute of Medical Sciences (AIIMS), National Institute of Immunology (NII), and Institute of Stem Cell Biology and Regenerative Medicine (inStem) conducting cutting-edge research on stem cell therapy, regenerative medicine, and tissue engineering.
- Researchers are exploring stem cells for treating various diseases, such as spinal cord injuries, heart disease, and diabetes, contributing to the emerging field of regenerative medicine.

3. Cancer Research:

- Indian scientists are making significant contributions to understanding the molecular mechanisms of cancer. The Tata Memorial Centre and National Cancer Institute in India focus on cancer genomics, tumor microenvironments, and developing targeted therapies.
- Several Indian biotech companies are working on developing cancer biomarkers, diagnostics, and therapeutics.

4. Biotechnology and Industrial Applications:

- The Indian biotech industry is one of the fastest-growing in the world, with Indian companies like Biocon, Dr. Reddy's Laboratories, and Cadila Pharmaceuticals investing in molecular biology-based innovations, including monoclonal antibodies, vaccines, and enzyme therapies.
- CRISPR-Cas9 gene-editing technology is being actively researched for agricultural and clinical applications, with Indian biotech firms using this technology to develop genetically modified crops and gene therapy treatments.

5. Agricultural Biotechnology:

- India is one of the global leaders in genetically modified (GM) crops, particularly in cotton. Research into GM crops like Bt cotton and Btbrinjal has helped improve agricultural productivity and pest resistance.
- Indian researchers are also working on the genetic modification of crops for better resistance to drought, pests, and diseases, as well as improving the nutritional content of staple foods like rice and wheat.

Key Molecular Biologists in India

1. Dr. Venkatraman Ramakrishnan

- **Notable Contributions:** Dr. Venkatraman Ramakrishnan was awarded the Nobel Prize in Chemistry (2009) for his pioneering work on the

structure of the ribosome. His research provided key insights into how ribosomes (the molecular machines responsible for protein synthesis) function and how antibiotics can specifically target bacterial ribosomes without affecting human ribosomes.

2. Dr. M. S. Swaminathan

- **Notable Contributions:** Dr. M. S. Swaminathan is regarded as the father of India's Green Revolution. Though primarily known for his work in agricultural sciences, his contributions in plant molecular biology and genetic modification of crops are profound.

3. Dr. Satyajit Mayor

- **Notable Contributions:** Dr. Satyajit Mayor is a cell biologist whose work has focused on lipid rafts in cell membranes. These lipid microdomains are crucial for cell signaling, membrane trafficking, and cell-cell interactions.

4. Dr. K. VijayRaghavan

- **Notable Contributions:** Dr. K. VijayRaghavan is an expert in developmental biology and genetics, particularly known for his work in *Drosophila* (fruit flies) genetics. His research has focused on the genetic regulation during the development of organisms.

5. Dr. ShubhaTole

- **Notable Contributions:** Dr. ShubhaTole is a molecular biologist and neuroscientist whose research focuses on brain development. She has made significant contributions to the molecular understanding of neurodevelopment, particularly the formation of the cerebral cortex.

6. Dr. Raghunath Chatterjee

- **Notable Contributions:** Dr. Raghunath Chatterjee is a molecular biologist known for his work on DNA damage and repair mechanisms. He studied how cells repair DNA damage, and how mutations in this process lead to diseases like cancer.

7. Dr. Rajesh Gokhale

- **Notable Contributions:** Dr. Rajesh Gokhale is known for his contributions to molecular microbiology, particularly in studying *Mycobacterium tuberculosis* and its resistance mechanisms.

8. Dr. Soumya Swaminathan

- **Notable Contributions:** Dr. Soumya Swaminathan is a renowned physician-scientist and the former Deputy Director-General for Programmes at the World Health Organization (WHO). She is an expert in tuberculosis (TB), HIV/AIDS, and maternal-child health.

9. Dr. T. S. S. R. Anjaneyulu

- **Notable Contributions:** Dr. T. S. S. R. Anjaneyulu was a pioneer in the study of enzymology and biochemical genetics. His work also extended to human genetics, where he studied genetic diseases and genetic diversity in populations.

10. Dr. R. A. Mashelkar

- **Notable Contributions:** Dr. R. A. Mashelkar is one of the leading voices in biotechnology and industrial research in India. His work in molecular genetics and pharmaceuticals helped shape India's biotech landscape.

Major Institutions in Cell and Molecular Biology

Many prominent institutions and research centers worldwide are leaders in advancing cell and molecular biology research. These institutions offer collaborative research opportunities and access to cutting-edge technology.

Notable Institutions:

1. **The National Institutes of Health (NIH), USA:** NIH is one of the world's largest biomedical research organizations, funding and conducting a vast amount of cell and molecular biology research in various health fields.
2. **Max Planck Institutes, Germany:** The Max Planck Institutes are known for their pioneering work in molecular biology, genetics, and biochemistry.
3. **Howard Hughes Medical Institute (HHMI), USA:** HHMI funds researchers and provides support for transformative biomedical research, with many molecular biologists being affiliated with HHMI.
4. **European Molecular Biology Laboratory (EMBL), Germany:** EMBL is an intergovernmental organization that conducts research in cell and molecular biology, genetics, and bioinformatics.
5. **Cold Spring Harbor Laboratory (CSHL), USA:** CSHL is renowned for its research in molecular genetics, cell biology, and cancer biology.
6. **Johns Hopkins University, USA:** Known for its biomedical research, particularly in molecular and cellular physiology, oncology, and genetics.

7. **Stanford University, USA:** Stanford is a major hub for research in molecular biology, biotechnology, and gene therapy.

Prominent Institutions in India for Cell and Molecular Biology Research

India is home to several world-class research institutions that focus on cell and molecular biology, with a strong emphasis on both fundamental and applied research.

1. **Indian Institute of Science (IISc), Bangalore:** IISc is a premier research institute in India with departments dedicated to molecular biology, bioengineering, genetics, and bioinformatics.
2. **National Centre for Biological Sciences (NCBS), Bangalore:** NCBS is a leader in cellular and molecular biology research, with focus areas in genomics, disease biology, and stem cell research.
3. **Centre for Cellular and Molecular Biology (CCMB), Hyderabad:** CCMB is a major research institute under the CSIR, focusing on molecular genetics, structural biology, and biotechnology.
4. **Jawaharlal Nehru University (JNU), New Delhi:** JNU is well-known for its School of Life Sciences, which focuses on molecular genetics, cell biology, and bioinformatics.
5. **Institute of Stem Cell Biology and Regenerative Medicine (inStem), Bangalore:** inStem conducts research in stem cells, regenerative medicine, and developmental biology.
6. **All India Institute of Medical Sciences (AIIMS), New Delhi:** AIIMS is a leading

institution for research in molecular medicine, with departments dedicated to oncology, genetics, and microbiology.

7. **Indian Institute of Chemical Biology (IICB), Kolkata:** IICB focuses on molecular pharmacology, cell biology, and drug development.
8. **National Institute of Immunology (NII), New Delhi:** NII conducts research in immunology, molecular genetics, and cell signaling.
9. **Indian Council of Medical Research (ICMR):** ICMR supports research in molecular medicine, particularly focusing on diseases like tuberculosis, HIV/AIDS, and cancer.

Journals in Cell and Molecular Biology

To stay updated with the latest research, many scientists and academics publish their work in prominent journals dedicated to cell and molecular biology. Some of the leading journals in this field include:

1. **Nature Cell Biology** A premier journal publishing cutting-edge research in cell biology, including cellular mechanisms and disease models.
2. **Cell** One of the most influential journals in molecular biology, covering a wide range of topics from genetics to stem cells.
3. **Journal of Cell Biology** This journal focuses on cell structure, function, and regulation, publishing high-impact articles on cellular dynamics and interactions.
4. **Molecular Cell** Publishes significant research on molecular processes such as transcription, translation, and protein folding.

5. **Trends in Cell Biology** Focuses on the latest developments and trends in cell and molecular biology, providing review articles and perspectives.
 6. **Journal of Molecular Biology** Covers fundamental research in molecular biology, including protein function, RNA biology, and molecular genetics.
 7. **Developmental Cell** Specializes in research related to cellular processes involved in development and differentiation.
 8. **EMBO Journal** Publishes high-quality research in molecular and cellular biology, including gene regulation, protein function, and signaling pathways.
 9. **Cell Stem Cell** A leading journal in the field of stem cell biology, publishing groundbreaking research on stem cells and regenerative medicine.
 10. **Genetics** Focuses on molecular genetics and genomics, with a special emphasis on genetic mechanisms and inheritance.
- Journals and Publications in India**
- Researchers in India publish their findings in both international and national journals. Some prominent journals in the field of cell and molecular biology in India include:
1. **Indian Journal of Biochemistry and Biophysics (IJBB):** This journal publishes research on biochemistry, molecular biology, and biotechnology.
 2. **Journal of Biosciences:** A leading journal from Indian Academy of Sciences covering topics in cell biology, molecular genetics, and biochemistry.
 3. **Current Science:** A multidisciplinary scientific journal that publishes articles on cell biology, genetics, and molecular biology.
 4. **Indian Journal of Medical Research (IJMR):** IJMR is a reputed journal for medical research, including molecular medicine and cellular studies.
 5. **Biotechnology Advances:** Although an international journal, it includes significant contributions from Indian researchers in biotechnology and molecular biology.
 6. **Molecular Biology Reports:** A journal that features molecular and cellular research, including studies from Indian scientists.

EXERCISE

1. Who is considered the father of modern cell biology?

- (a) Robert Hooke
- (b) Matthias Schleiden
- (c) Theodor Schwann
- (d) George Palade

Ans. (d) George Palade is often referred to as the father of modern cell biology for his

pioneering work on cellular structures, especially his identification of the ribosome in eukaryotic cells.

2. Who coined the term "cell" when observing cork under a microscope?

- (a) Antonie van Leeuwenhoek
- (b) Louis Pasteur
- (c) Robert Hooke
- (d) Charles Darwin

Ans. (c) Robert Hooke coined the term "cell" in 1665 after observing the microscopic structure of cork and noticing small box-like structures, which he termed "cells."

3. The cell theory was proposed by which two scientists?

- (a) Hooke and Leeuwenhoek
- (b) Schleiden and Schwann
- (c) Pasteur and Darwin
- (d) Darwin and Mendel

Ans. (b) The cell theory, stating that all living organisms are composed of cells and that the cell is the basic unit of life, was formulated by Matthias Schleiden (plants) and Theodor Schwann (animals).

4. Which discovery is attributed to Antonie van Leeuwenhoek?

- (a) The discovery of the nucleus
- (b) The discovery of microorganisms
- (c) The development of the cell theory
- (d) The discovery of the cell membrane

Ans. (b) Antonie van Leeuwenhoek is credited with the discovery of microorganisms, including bacteria, by using a microscope he built himself.

5. What is the primary function of ribosomes in a cell?

- (a) Protein synthesis
- (b) DNA replication
- (c) Energy production
- (d) Waste removal

Ans. (a) Ribosomes are responsible for synthesizing proteins by translating mRNA into amino acid sequences.

6. Which of the following structures is found in plant cells but not in animal cells?

- (a) Nucleus
- (b) Mitochondria
- (c) Chloroplast
- (d) Ribosomes

Ans. (c) Chloroplasts are found in plant cells and are responsible for photosynthesis. They are absent in animal cells.

7. Which scientist is known for his discovery of the structure of DNA?

- (a) Charles Darwin
- (b) Watson and Crick
- (c) Gregor Mendel
- (d) Louis Pasteur

Ans. (b) James Watson and Francis Crick are credited with discovering the double-helix structure of DNA in 1953.

8. The primary structure of a protein refers to:

- (a) The folding of the protein into alpha helices and beta sheets
- (b) The sequence of amino acids
- (c) The overall three-dimensional shape of the protein
- (d) The interaction between subunits in a multi-subunit protein

Ans. (b) The primary structure of a protein is simply the linear sequence of amino acids that make up the protein.

9. Which organelle is known as the powerhouse of the cell?

- (a) Nucleus
- (b) Mitochondria
- (c) Golgi apparatus
- (d) Endoplasmic reticulum

Ans. (b) Mitochondria are the powerhouses of the cell, generating energy in the form of ATP through cellular respiration.

10. Who first observed the nucleus in a cell?

- (a) Robert Hooke
- (b) Antonie van Leeuwenhoek
- (c) Felix Dujardin
- (d) Thomas Huxley

Ans. (a) Robert Hooke was the first to describe the nucleus, observing it in plant cells under a microscope in the 17th century.

11. The process of DNA replication is semi-conservative. This means:

- (a) Both strands of the DNA molecule are conserved
- (b) The new DNA molecules consist of one old strand and one new strand
- (c) The entire DNA molecule is synthesized from scratch
- (d) Each DNA molecule is composed of two new strands

Ans. (b) Semi-conservative replication means that each newly formed DNA molecule consists of one strand from the original DNA molecule and one newly synthesized strand.

12. The process by which a cell engulfs and takes in large particles is called:

- (a) Phagocytosis
- (b) Pinocytosis
- (c) Exocytosis
- (d) Receptor-mediated endocytosis

Ans. (a) Phagocytosis is a process in which a cell engulfs large particles, such as pathogens or debris, by wrapping its membrane around them and ingesting them.

13. What is the primary function of the smooth endoplasmic reticulum (ER)?

- (a) Protein synthesis
- (b) Lipid synthesis and detoxification
- (c) DNA replication
- (d) ATP production

Ans. (b) The smooth ER is involved in lipid synthesis, metabolism of carbohydrates, and detoxification of drugs and poisons.

14. Which of the following is NOT a component of the cell membrane?

- (a) Phospholipids (b) Proteins
- (c) Cholesterol (d) RNA

Ans. (d) The cell membrane is composed of phospholipids, proteins, and cholesterol. RNA is not a structural component of the membrane.

15. Which of the following discoveries contributed to the understanding of the cell membrane's fluidity?

- (a) The discovery of ribosomes
- (b) The Singer-Nicolson fluid mosaic model
- (c) The theory of endosymbiosis
- (d) The discovery of mitochondria

Ans. (b) The fluid mosaic model proposed by Singer and Nicolson in 1972 describes the cell membrane as a dynamic structure with proteins floating in or on a fluid lipid bilayer.

16. The central dogma of molecular biology describes the flow of genetic information. Which of the following is the correct order?

- (a) DNA mRNA Protein tRNA
- (b) DNA Protein mRNA tRNA
- (c) DNA mRNA Protein
- (d) mRNA DNA Protein

Ans. (c) According to the central dogma, genetic information flows from DNA to mRNA in transcription, and then from mRNA to protein in translation.

17. The first human genome sequencing project was completed by:

- (a) The Human Genome Project
- (b) The HapMap Project
- (c) The ENCODE Project
- (d) The NIH

Ans. (a) The Human Genome Project, completed in 2003, mapped the entire human genome, identifying the sequences of the approximately 20,000-25,000 genes.

18. Who proposed the idea of 'genes' as discrete units of heredity?

- (a) Charles Darwin (b) Gregor Mendel
- (c) Thomas Morgan
- (d) Rosalind Franklin

Ans. (b) Gregor Mendel is known as the father of modern genetics, and he proposed that genes are discrete units that determine inheritance patterns in organisms.

19. What is the function of the Golgi apparatus?

- (a) Synthesizing ribosomal RNA
- (b) Modifying, sorting, and packaging proteins
- (c) Generating ATP
- (d) Synthesizing lipids

Ans. (b) The Golgi apparatus processes, modifies, sorts, and packages proteins for secretion or delivery to other parts of the cell.

20. Which of the following is NOT a part of the endomembrane system?

- (a) Nucleus
- (b) Mitochondria
- (c) Golgi apparatus
- (d) Endoplasmic reticulum

Ans. (b) The endomembrane system includes the nuclear envelope, endoplasmic reticulum, Golgi apparatus, lysosomes, and vacuoles, but not mitochondria.

21. The headquarters of the National Centre for Cell Science (NCCS) is located in:

- (a) Bangalore (b) Pune
- (c) Hyderabad (d) Delhi

Ans. (b) The National Centre for Cell Science (NCCS) is based in Pune and focuses on cell biology, stem cell research, and disease studies.

22. The Indian Institute of Science (IISc), a major research institution for molecular biology, is located in:

- (a) Mumbai (b) Bangalore
- (c) Chennai (d) New Delhi

Ans. (b) IISc, located in Bangalore, is one of India's premier institutes for research in molecular biology, biotechnology, and various other fields.

23. The Institute of Genomics and Integrative Biology (IGIB) is headquartered in:

- (a) Mumbai (b) Pune
- (c) New Delhi (d) Hyderabad

Ans. (c) IGIB, based in New Delhi, focuses on genomics and molecular biology research to understand diseases and develop therapeutic approaches.

24. The National Institute of Immunology (NII), known for its work in immunology and molecular biology, is located in:

- (a) Bangalore (b) Hyderabad
- (c) Pune (d) New Delhi

Ans. (d) The National Institute of Immunology (NII) is located in New Delhi and specializes in immunology, molecular biology, and biotechnology.

25. The National Institute of Plant Genome Research (NIPGR) is located in:

- (a) Bangalore (b) Pune
- (c) New Delhi (d) Chennai

Ans. (c) NIPGR, based in New Delhi, focuses on plant genome research, crop improvement, and biotechnology.

26. The Centre for Cellular and Molecular Biology (CCMB) is headquartered in:

- (a) Mumbai (b) Hyderabad
(c) Chennai (d) Pune

Ans. (b) CCMB is located in Hyderabad and focuses on research in molecular biology, cellular biology, and genomics.

27. The Bose Institute in Kolkata, known for its research in molecular and cell biology, is headquartered in:

- (a) Mumbai (b) Kolkata
(c) Bangalore (d) New Delhi

Ans. (b) The Bose Institute in Kolkata is a leading research institute in molecular biology, including cell biology and biotechnology.

28. The National Institute of Biomedical Genomics (NIBMG) is located in:

- (a) Pune (b) Kolkata
(c) Mumbai (d) Kalyani

Ans. (d) NIBMG, located in Kalyani, West Bengal, focuses on genomics research and precision medicine.

29. The Tata Institute for Fundamental Research (TIFR), known for its contribution to molecular and cell biology research, is located in:

- (a) Hyderabad (b) Chennai
(c) Mumbai (d) New Delhi

Ans. (c) TIFR is located in Mumbai and conducts cutting-edge research in molecular biology, cancer biology, and related fields.

30. The Rajiv Gandhi Centre for Biotechnology (RGCB) is headquartered in:

- (a) Chennai (b) New Delhi
(c) Thiruvananthapuram
(d) Kolkata

Ans. (c) RGCB, located in Thiruvananthapuram, focuses on biotechnology, molecular biology, and medical research.

31. The Institute for Stem Cell Biology and Regenerative Medicine (inStem) is based in:

- (a) Pune (b) Hyderabad
(c) Bangalore (d) Chennai

Ans. (c) inStem, located in Bangalore, conducts research on stem cells and regenerative medicine.

32. The Indian Institute of Chemical Biology (IICB) is located in:

- (a) Hyderabad (b) Kolkata
(c) Pune (d) Mumbai

Ans. (b) IICB, located in Kolkata, is renowned for its research in chemical biology, drug discovery, and molecular biology.

33. The National Institute of Virology (NIV) is located in:

- (a) New Delhi (b) Bangalore
(c) Pune (d) Chennai

Ans. (c) NIV, located in Pune, specializes in virology research, including molecular studies on viruses and viral diseases.

34. The SatyendraNath Bose National Centre for Basic Sciences (SNBNCBS) is located in:

- (a) Kolkata
(b) Chennai
(c) Hyderabad
(d) Bangalore

Ans. (a) The SNBNCBS, located in Kolkata, is focused on fundamental research, including molecular biology and biophysics.

35. The Central Drug Research Institute (CDRI) in Lucknow is focused on:

- (a) Plant genetics
- (b) Cancer research
- (c) Drug discovery and biotechnology
- (d) Genetic engineering

Ans. (c) CDRI, located in Lucknow, specializes in drug discovery, molecular pharmacology, and biotechnology research.

36. The Indian Institute of Technology (IIT) in Delhi is home to a department dedicated to which field of molecular biology?

- (a) Immunology
- (b) Computational biology
- (c) Cancer research
- (d) Structural biology

Ans. (b) IIT Delhi has a department dedicated to computational biology, focusing on bioinformatics, systems biology, and related fields.

37. The Molecular and Cellular Biology Unit at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) is located in:

- (a) New Delhi
- (b) Bangalore
- (c) Chennai
- (d) Hyderabad

Ans. (b) JNCASR, located in Bangalore, conducts research in molecular and cellular biology, biotechnology, and other interdisciplinary fields.

38. The National Institute for Research in Reproductive Health (NIRRH) is based in:

- (a) Kolkata
- (b) Mumbai
- (c) New Delhi
- (d) Pune

Ans. (b) NIRRH, located in Mumbai, focuses on reproductive health, molecular biology, and related biomedical research.

39. The Institute of Cytology and Genetics (ICG) is located in:

- (a) Hyderabad
- (b) Kolkata
- (c) Pune
- (d) Bangalore

Ans. (a) ICG in Hyderabad focuses on genetics and cytology, with research in molecular biology, cell biology, and genetic disorders.

40. The Birla Institute of Scientific Research (BISR) is located in:

- (a) New Delhi
- (b) Mumbai
- (c) Hyderabad
- (d) Jaipur

Ans. (d) BISR, located in Jaipur, focuses on scientific research in molecular biology, genetics, and biotechnology.

41. Which of the following recent advancements was made in CRISPR technology?

- (a) Efficient gene editing in plants only
- (b) CRISPR interference to turn genes off
- (c) CRISPR-Cas9 for human gene therapy in clinical trials
- (d) Only applicable for bacterial gene editing

Ans. (c) Recent advancements in CRISPR technology have enabled its use in human gene therapy, with ongoing clinical trials aiming to treat genetic diseases by editing human DNA.

42. The Indian Institute of Science (IISc) in Bangalore is known for its contributions to which of the following areas of research?

- (a) Climate change
- (b) Plant biotechnology
- (c) Cell and molecular biology
- (d) All of the above

Ans. (d) Explanation: IISc has been at the forefront of research in various fields including cell and molecular biology, plant biotechnology, and climate change studies.

43. What is the main focus of the National Centre for Cell Science (NCCS) in Pune?

- (a) Genetic engineering in animals
- (b) Research on human stem cells and cell biology
- (c) Research in quantum biology
- (d) Research in human microbiome

Ans. (b) NCCS in Pune focuses on research related to cell biology, human stem cells, and their applications in disease treatment and regenerative medicine.

44. Which breakthrough research was recently achieved at the National Institute of Immunology (NII) in India?

- (a) Development of a universal flu vaccine
- (b) Identification of biomarkers for early cancer detection
- (c) Discovery of a new anti-bacterial compound
- (d) Discovery of gene mutations linked to Alzheimer's disease

Ans. (b) NII has made significant advancements in cancer research, particularly in identifying biomarkers that can enable early diagnosis of cancer.

45. What is the primary focus of the Institute of Genomics and Integrative Biology (IGIB) in New Delhi?

- (a) Application of AI in genomics
- (b) Human genetic variation and disease research
- (c) Protein folding studies
- (d) Gene editing for crop improvement

Ans. (b) IGIB focuses on human genetic research, understanding the molecular

mechanisms of diseases, and developing targeted therapies based on genetic information.

46. Which of the following recent techniques is used to study the interactome of proteins in a cell?

- (a) RNA-sequencing
- (b) CRISPR interference
- (c) Yeast two-hybrid system
- (d) Flow cytometry

Ans. (c) The yeast two-hybrid system is commonly used to study protein-protein interactions (interactome) in cells, allowing researchers to map complex cellular networks.

47. The Centre for Cellular and Molecular Biology (CCMB) in Hyderabad is known for its work in:

- (a) Renewable energy research
- (b) Gene cloning and DNA sequencing
- (c) Climate change modeling
- (d) Space biology

Ans. (b) CCMB has been a leader in research on genetic engineering, gene cloning, and DNA sequencing, contributing significantly to molecular biology and biotechnology.

48. Which Indian research institute is known for its recent contribution to developing a COVID-19 vaccine?

- (a) National Institute of Virology (NIV), Pune
- (b) Tata Institute of Fundamental Research (TIFR)
- (c) Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)
- (d) Indian Institute of Technology (IIT), Delhi

Ans. (a) NIV, Pune, played a key role in the development of COVID-19 vaccines, especially through research related to the SARS-CoV-2 virus and its variants.

49. What is the main focus of research at the National Institute of Plant Genome Research (NIPGR)?

- (a) Bioengineering of medicinal plants
- (b) Genome sequencing of crops and plants
- (c) Plant-based biofuels
- (d) Plant microbiome research

Ans. (b) NIPGR focuses on the sequencing and mapping of plant genomes to improve crop yield, resistance to diseases, and overall agricultural productivity.

50. Which recent advancement in molecular biology focuses on the study of epigenetic modifications?

- (a) Genome-wide association studies (GWAS)
- (b) CRISPR-based epigenome editing
- (c) Next-generation sequencing (NGS)
- (d) All of the above

Ans. (d) Recent advancements in molecular biology have highlighted the role of epigenetic modifications in gene expression and disease, and techniques like CRISPR epigenome editing and NGS have been key to understanding epigenetics.

51. The Indian Institute of Chemical Biology (IICB) in Kolkata specializes in:

- (a) Human genome mapping
- (b) Drug discovery and molecular pharmacology
- (c) Agricultural biotechnology
- (d) Microbial engineering

Ans. (b) IICB specializes in drug discovery, molecular pharmacology, and cancer research, and has contributed significantly to biomedicine.

52. Which of the following molecular techniques is used to visualize gene expression patterns in tissues?

- (a) FISH (Fluorescence In Situ Hybridization)

- (b) PCR
- (c) Electrophoresis
- (d) Southern blotting

Ans. FISH is used to visualize the location of specific gene sequences in tissues, enabling the study of gene expression patterns in situ.

53. Recent research on aging in cells has focused on which of the following molecular mechanisms?

- (a) Telomere shortening and DNA repair
- (b) Mitochondrial dysfunction and oxidative stress
- (c) Protein aggregation and misfolding
- (d) All of the above

Ans. (d) Recent research on aging has focused on telomere shortening, mitochondrial dysfunction, oxidative stress, and protein aggregation as key mechanisms driving cellular aging.

54. Which of the following is a key focus of research in the Rajiv Gandhi Centre for Biotechnology(RGCB),Thiruvananthapuram?

- (a) Plant-based vaccines
- (b) Cancer genomics and stem cell research
- (c) Microbial bioremediation
- (d) Plant biochemistry

Ans. (b) RGCB focuses on cancer genomics, stem cell biology, and molecular oncology, aiming to improve diagnostic and therapeutic approaches for cancer.

55. Which recent development has been made in synthetic biology in India?

- (a) Development of engineered bacteria for waste disposal
- (b) Creation of artificial life forms
- (c) Genetically modified crops for drought resistance
- (d) All of the above

Ans. (d) India has made significant advancements in synthetic biology, including the development of engineered bacteria, artificial life forms, and genetically modified crops with enhanced resistance.

56. The Bose Institute in Kolkata is known for research in:

- (a) Environmental genomics
- (b) Neuroscience and cancer biology
- (c) Agricultural biotechnology
- (d) Molecular and cellular biology

Ans. (d) The Bose Institute focuses on molecular and cellular biology, particularly in understanding cellular processes, disease mechanisms, and biotechnology.

57. The National Institute of Biomedical Genomics (NIBMG) focuses primarily on:

- (a) Agricultural genomics
- (b) Human genomics and precision medicine
- (c) Drug resistance in bacteria
- (d) Environmental genomics

Ans. (b) NIBMG specializes in human genomics, studying the genetic basis of diseases, and developing precision medicine approaches tailored to genetic information.

58. What is the focus of research at the Institute for Stem Cell Biology and Regenerative Medicine (inStem) in Bangalore?

- (a) Stem cell therapies for neurological diseases
- (b) Regenerative medicine using pluripotent stem cells

- (c) Stem cell-based cancer therapies
- (d) All of the above

Ans. (d) inStem focuses on the development of stem cell-based therapies for neurological diseases, regenerative medicine, and cancer treatments.

59. Which of the following is a significant contribution of the Tata Institute for Fundamental Research (TIFR) in the field of molecular biology?

- (a) Development of genome sequencing technologies
- (b) Understanding the molecular mechanisms of neurodegenerative diseases
- (c) Research on synthetic biology for energy production
- (d) All of the above

Ans. (b) TIFR is known for its research in molecular biology, particularly in understanding the molecular basis of neurodegenerative diseases like Alzheimer's.

60. What is the role of Biotechnology Industry Research Assistance Council (BIRAC) in India?

- (a) Providing financial assistance for biotech startups
- (b) Encouraging research in agriculture
- (c) Promoting pharmaceutical and healthcare technologies
- (d) All of the above

Ans. (d) BIRAC provides funding and assistance to biotech startups in India, with a focus on agriculture, healthcare, and pharmaceutical technologies.