Bot. Sp-06 BIOCHEMISTRY OF NUCLEIC ACIDS Credit Hours 3(2+1)

THEORY

Introduction of the Course:

The course is organized to provide knowledge of how nucleotides are synthesized and degraded in cells. An understanding of structure-function relationships for nucleic acids and chromatin. Knowledge of the enzymatic basis of replication of and error correction in the genome. An understanding of how genes are read and how the transcribed RNA is processed, and how genes are regulated through a coordinated collaboration between proteins and nucleic acid sequences.

Course Objectives:

The course is designed:

1. To enable the students to understand the different composition and roles of nucleic acids in the cell and their interactions with each other and with agents that cause DNA damage.
2. To enable the students to describe in detail the protein components of the nucleosome and key modifications to nucleosome components and understand the interactions between the DNA double helix and the nucleosome.
3. The students will be able to describe how gene expression is regulated at the transcriptional and post-transcriptional level.
4. To Learn about the structure of RNA, the flow of genetic information, and the transcription of DNA to form RNA.

Course Contents:

1. Nucleic Acids

1.1. DNA as a carrier of genetic information.
1.2. Double-helical structure of DNA.
1.3. Forces stabilizing nucleic acid structures and super-coiled DNA.
1.4. Nucleic acid fractionation, sequencing.
1.5. Chemical synthesis of oligonucleotides.
1.6. DNA polymerases, DNA replication-general aspects and enzymes involved and mechanism of replication.
1.7. DNA repair and methylation.

2. Transcription and Translation

2.1 RNAs and their role in protein synthesis.
2.2 RNA polymerases and transcription.
2.3 Regulation of transcription in prokaryotes and post transcriptional processing.
2.4 The genetic code and its properties.
2.5 Structure of transfer RNA.
2.6 Ribosomes, its type and role in translational process.
2.7 Protein synthesis inhibitors and control of eukaryotic translation.
2.8 Post translational modifications and protein degradation.
2.9 Non-ribosomal polypeptide synthesis, structure and genomic organization.
2.10 Regulation of eukaryotic gene expression.
2.11 Cell differentiation, oncogenes and cancer.

3. Regulation of Gene Activity in Prokaryotes and Eukaryotes:

4.1 Principles of gene regulation.
4.2 The *E. coli* Lactose system and the Operon model, the Tryptophan Operon.
4.3 A biosynthetic system autoregulation.
4.4 Feedback inhibition.

4.5 Gene families, gene dosage and gene amplification.
4.6 Regulation of transcription; regulation of processing.
4.7 Hypersensitive sites and upstream regulatory sites.
4.8 Translational control; multiple proteins from a single segment of DNA.
4.9 Gene rearrangement: joining coding sequences in the immune system.

4. Recombinant DNA and Genetic Engineering:

4.1. An outline of DNA cloning experiment.
4.2. Cloning vectors including Plasmids, Bacteriophages, Cosmids, YAC, Shuttle and Expression vectors.
4.3. Gene splicing in Eukaryotes and Prokaryotes.
4.4. Genomic libraries and screening methods for gene libraries.
4.5. DNA cloning methods, tumor inducing (TI) plasmids.
4.6. Southern and Northern blotting; Chromosome walking; Site specific mutagenesis.
4.7. Potentials of recombinant DNA technology.
4.8. PCR and production of proteins.
4.9. Tissue culture techniques; transgenic organisms and gene therapies.
4.10. Restriction fragment length polymorphism and disease detection e.g., cystic fibrosis.
4.11. Human genome project and social considerations.

Practicals:

1. Measurement of DNA and RNA is leaf (Perchloric acid methods)
2. Extraction and estimation of RNA from seedling tissues (Phenol method)
3. Extraction and estimation of DNA from leaf tissue (CDTA – NaCl method)
4. Fractionation of nucleic acid by column chromatography.
5. Estimation of soluble proteins by Lowry methods.
6. Separation of seeds proteins by gel electrophoresis.

Teaching-Learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Learning Outcome:

1. This course can help the students to identify major structural feature that distinguish DNA and RNA.
2. After completion of this course, students will be able to describe nucleic acid structure, its function in detail.
3. The students can describe easily how the genetic information is transferred from DNA to synthesis of protein.
4. They are expected to use this information for further advancement in recombinant DNA Technology.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

Recommended Readings.

1. Abdes, R. H., Frey, P. A. and Jencks W. P. (2004). *Biochemistry*, Jones and Bartlet, London.
2. Buchanan B. B, Gruissem W and Jones R. L. (2015). *Biochemistry and Molecular Biology of Plants*. John Wiley and Sons.
3. Bowsher, C., Steer, M., Tobin, A. (2008). *Plant Biochemistry*. - Garland Science, Taylor and Francis Group, New York.
4. Campbell, M. K. and F. Shawn. (2008). *Biochemistry* 6th Edition.
5. Chesworth, J. M., Strichbury T. and Scaife J. R. (1998). *An introduction to agricultural biochemistry*. Chapman and Hall, London.
6. Conn E. E. and Stumpf, P. K. (2009). *Outlines of Biochemistry*, John Wiley and Sons Inc. New York.
7. Dey, P. M. and Harborne, J. B. (1997). *Plant Biochemistry*. Harcourt Asia PTE Ltd. Singapore.
8. Goodwin T. W. and Mercer, E. I. (1997). *Introduction to Plant Biochemistry*. Pergamon Press, Oxford.
9. Heldt, H. W. 2008. *Plant Biochemistry*. 3rd Edition, Academic Press, U. K.
10. Lea, P. J. and Leegood, R. C. (1993). *Plant Biochemistry and Molecular Biology*. Wiley and Sons, New York.
11. Nelson, D. L and Cox M. M. (2017). *Lehninger Principles of Biochemistry*. 7th edition. W. H. Freeman and Company. New York.
12. Mckee, T. and Mckee, J. R. (1999). *Biochemistry – An Introduction*. WCB/McGraw-Hill, New York, Boston, USA.
13. Voet, D. Voet J. G. and Pratt, C. W. (2016). *Fundamentals of Biochemistry*: Life at the Molecular level, 5th Edition. John Wiley and Sons, New York.
14. Zubay G. 2003. Biochemistry, MacMillan Publishing Co., New York.

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