

DEPARTMENT OF BIOCHEMISTRY
FACULTY OF ARTS, SCIENCE AND HUMANITIES
KARPAGAM ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act 1956)
Eachanari PO, Coimbatore – 641 021, India.

B.Sc., BIOCHEMISTRY

PREAMBLE

- Biochemistry is the study of chemistry and relating to, biological organisms.
- Biochemistry is sometimes viewed as a hybrid branch of organic chemistry which specializes in the chemical processes and chemical transformations that take place inside of living organisms.
- All life forms alive today are generally believed to have descend from a single proto-biotic ancestor, which could explain why all known living things naturally have similar biochemistries.
- Biochemistry essentially remains the study of the structure and functions of cellular components (such as enzymes and cellular organelles) and the processes carry out both on and by organic macromolecules - especially proteins, but also carbohydrates, lipids, nucleic acids and other biomolecules.
- Biochemistry is most simply put, the chemistry of life.

KARPAGAM ACADEMY OF HIGHER EDUCATION

Coimbatore – 641 021

DEPARTMENT OF BIOCHEMISTRY FACULTY OF ARTS, SCIENCE AND HUMANITIES UG PROGRAM (CBCS)-B.Sc., Biochemistry (2019–2020 and onwards)

Course code	Name of the course	Objective s and out comes		Instruction hours / week			Credit(s)	Maximum Marks		
		PEOs	POs	L	T	P		CIA	ESE	Total
				40	60	100				
SEMESTER – I										
19LSU101	Language -I	I	a	4	-	-	4	40	60	100
19ENU101	English	I	a	4	-	-	4	40	60	100
19BCU101	Molecules of Life	I	b	3	1	-	4	40	60	100
19BCU102	Cell biology	I	d	4	-	-	4	40	60	100
19BCU103	Chemistry-I	I	d	4	-	-	4	40	60	100
19BCU111	Molecules of Life- Practical	III	d	-	-	3	2	40	60	100
19BCU112	Cell biology – Practical	III	d	-	-	3	2	40	60	100
19BCU113	Chemistry Practical- I	III	d	-	-	4	2	40	60	100
Semester Total				19	1	10	26	320	480	800
SEMESTER – II										
19LSU 201	Language – II	I	a	4	-	-	4	40	60	100
19BCU201	Proteins	III	e	4	-	-	4	40	60	100
19BCU202	Enzymes	III	e	4	1	-	5	40	60	100
19BCU203	Chemistry-II	I	e	4	-	-	4	40	60	100
19BCU211	Proteins – Practical	III	e	-	-	3	2	40	60	100
19BCU212	Enzymes- Practical	III	e	-	-	3	2	40	60	100
19BCU213	Chemistry Practical -II	III	e	-	-	4	2	40	60	100
19AEC201	Environmental Studies	IV	h	3	-	-	3	40	60	100
Semester Total				19	1	10	26	320	480	800
SEMESTER – III										
19BCU301	Metabolism of Carbohydrates and Lipids	I	f	4			4	40	60	100
19BCU302	Metabolism of Amino acids and Nucleic acids	I	f	4			4	40	60	100
19BCU303	Membrane Biology & Bioenergetics	I	f	3	1	-	4	40	60	100
19BCU311	Metabolism of Carbohydrates and Lipids – Practical	III	c, f	-	-	4	2	40	60	100
19BCU312	Metabolism of Amino acids and Nucleic acids-Practical	III	c, f	-	-	4	2	40	60	100
19BCU313	Membrane Biology & Bioenergetics – Practical	III	c, f	-	-	4	2	40	60	100
19BCU304A	Tools and Techniques in Biochemistry	II	c, f	3	-	-	3	40	60	100
19BCU304B	Concepts in Genetics	I	c, f							
19BCU314A	Tools and Techniques in Biochemistry – Practical	III	c, f	-	-	3	1	40	60	100
19BCU314B	Concepts in Genetics - Practical	III	c, f							
Semester Total				14	1	15	22	320	480	800
SEMESTER – IV										
19BCU401	Gene Organization, Replication and Repair	I, II	g	4	-		4	40	60	100
19BCU402	Gene Expression and Regulation	I, II	g	4	-		4	40	60	100
19BCU403	Human Physiology	I, II	g	3	1	-	4	40	60	100
19BCU411	Gene Organisation, Replication and Repair-Practical	III	c, g	-	-	4	2	40	60	100

19BCU412	Gene Expression and Regulation- Practical	III	c, g	-	-	4	2	40	60	100
19BCU413	Human Physiology – Practical	III	c, g	-	-	4	2	40	60	100
19BCU404A	Bioinformatics	III	c, g	3	-	-	3	40	60	100
19BCU404B	Protein Purification Techniques		c, g							
19BCU414A	Bioinformatics – Practical	III	c, g	-	-	3	1	40	60	100
19BCU414B	Protein Purification Techniques – Practical		c, g							
Semester Total				14	1	15	22	320	480	800
SEMESTER – V										
19BCU501	Hormone: Biochemistry and Functions	V	d, e	3	1	-	4	40	60	100
19BCU502A	Clinical Biochemistry	II, III	d, e	3	-	-	3	40	60	100
19BCU502B	Biochemical Correlation of Diseases	II, III	d, e							
19BCU503A	Basic Microbiology	I	d, e	4	-	-	4	40	60	100
19BCU503B	Nutritional Biochemistry	I	i							
19BCU504A	Plant Biochemistry	V	d	4	-	-	4	40	60	100
19BCU504B	Molecular Basis of Infectious diseases	V	d, e							
19BCU511	Hormone: Biochemistry and Functions – Practical	III	j	-	-	4	2	40	60	100
19BCU512A	Clinical Biochemistry- Practical	III	j	-	-	3	1	40	60	100
19BCU512B	Biochemical Correlation of Diseases- Practical	III	j							
19BCU513A	Basic Microbiology- Practical	III	j	-	-	4	2	40	60	100
19BCU513B	Nutritional Biochemistry- Practical	III	j							
19BCU514A	Plant Biochemistry—Practical	III	j	-	-	4	2	40	60	100
19BCU514B	Molecular Basis of Infectious diseases-Practical	III	j							
Semester Total				15	-	15	22	320	480	800
SEMESTER – VI										
19BCU601	Immunology	V	i, j	3	1	-	4	40	60	100
19BCU602A	Genetic Engineering and Biotechnology	I	g	3	-	-	3	40	60	100
19BCU602B	Research Methodology	V	i, j							
19BCU603A	Drug Biochemistry	II	i, j	4	-	-	4	40	60	100
19BCU603B	Biostatistics	III	e							
19BCU611	Immunology Practical	III	i, j	-	-	4	2	40	60	100
19BCU612A	Genetic Engineering and Biotechnology- Practical	III	e	-	-	3	1	40	60	100
19BCU612B	Research Methodology – Practical	III	i, j							
19BCU613A	Drug Biochemistry- Practical	II	d	-	-	4	2	40	60	100
19BCU613B	Biostatistics-Practical	III	e							
19BCU691	Project work	IV	j	2	-	6	6	40	60	100
ECA / NCC / NSS / Sports / General interest etc							Good			
Semester Total				13	-	17	22	280	420	700
Program Total				94	4	82	140	1880	2820	4700

Ability Enhancement Courses (AEC)		
Semester	Course Code	Name of the Course
I	19LSU101	Language –I
	19ENU101	English
II	19LSU201	Language –II
	19AEC201	Environmental Studies

Generic Elective Courses (GE) /Allied Courses		
Semester	Course Code	Name of the Course
I	19BCU103	Chemistry – I
	19BCU113	Chemistry – I Practical
II	19BCU203	Chemistry – II
	19BCU213	Chemistry – II Practical

Core Courses (CC)		
Semester	Course Code	Name of the Course
I	19BCU101	Molecules of Life
	19BCU102	Cell biology
	19BCU111	Molecules of Life- Practical
	19BCU112	Cell biology – Practical
II	19BCU201	Proteins
	19BCU202	Enzymes
	19BCU211	Proteins – Practical
	19BCU212	Enzymes- Practical
III	19BCU301	Metabolism of Carbohydrates and Lipids
	19BCU302	Metabolism of Amino acids and Nucleic acids
	19BCU303	Membrane Biology & Bioenergetics
	19BCU311	Metabolism of Carbohydrates and Lipids - Practical
	19BCU312	Metabolism of Amino acids and Nucleic acids- Practical
	19BCU313	Membrane Biology & Bioenergetics - Practical
IV	19BCU401	Gene Organization, Replication and Repair
	19BCU402	Gene Expression and Regulation
	19BCU403	Human Physiology
	19BCU411	Gene Organisation, Replication and Repair- Practical
	19BCU412	Gene Expression and Regulation- Practical
	19BCU413	Human Physiology – Practical
V	19BCU501	Hormone: Biochemistry and Functions
	19BCU511	Hormone: Biochemistry and Functions - Practical
VI	19BCU601	Immunology
	19BCU611	Immunology Practical
	19BCU691	Project work

Skill Enhancement Courses(SEC)		
Semester	Course Code	Name of the Course
III	19BCU304A	Tools and Techniques in Biochemistry
	19BCU304B	Concepts in Genetics
III	19BCU314A	Tools and Techniques in Biochemistry - Practical
	19BCU314B	Concepts in Genetics - Practical
IV	19BCU404A	Bioinformatics
	19BCU404B	Protein Purification Techniques
IV	19BCU414A	Bioinformatics- Practical
	19BCU414B	Protein Purification Techniques- Practical
V	19BCU502A	Clinical Biochemistry
	19BCU502B	Biochemical Correlations and Diseases
V	19BCU512A	Clinical Biochemistry- Practical

	19BCU512B	Biochemical Correlations and Diseases- Practical
VI	19BCU602A	Genetic Engineering and Biotechnology
	19BCU602B	Research Methodology
VI	19BCU612A	Genetic Engineering and Biotechnology- Practical
	19BCU612B	Research Methodology - Practical

Discipline Specific Elective Courses (DSE)		
Semester	Course Code	Name of the Course
V	19BCU503A	Basic Microbiology
	19BCU503B	Nutritional Biochemistry
	19BCU504A	Plant Biochemistry
	19BCU504B	Molecular basis of infectious diseases
V	19BCU513A	Basic Microbiology- Practical
	19BCU513B	Nutritional Biochemistry- Practical
	19BCU514A	Plant Biochemistry- Practical
	19BCU514B	Molecular basis of infectious diseases practical
VI	19BCU603A	Drug Biochemistry
	19BCU603B	Biostatistics
	19BCU613A	Drug Biochemistry- Practical
	19BCU613B	Biostatistics- Practical

PROGRAMME OUTCOME (POs).

The Biochemistry graduate will be able to acquire

- a. **Critical Thinking and Language Training:** The ability to analyze information objectively and make a reasonable judgment and conclusion by evaluating data, facts, observable phenomenon, and research findings from a set of information and distinguish among priorities to solve a problem To train them to communicate science by improving their English vocabulary. Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
- b. **Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
- c. **Social Interaction:** Elicit views of others, mediate disagreements and help reach conclusions in group settings. Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
- d. **Understanding cellular function:** To equip them with basic and advanced knowledge in cell biology in order to get entry/placed in cell based research and development institution/laboratories.
- e. **Protein based skills:**To make them understand protein, enzymes and human physiology to lay solid foundation and to get through competitive examinations. To equip them to get placed in recombinant protein production industries/laboratory.
- f. **Understanding of endocrine system and metabolism:**To train them on the regulatory role of hormone on the metabolism of carbohydrates, lipids, amino acids and nucleic acid.
- g. **Molecular and Genetic understanding:**To train them on the genetic regulation of immune system and to use computational tools.
- h. **Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.
- i. **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.
- j. **Skill development:** To gain hands on experience on various biochemical experiments and to equip them to interpret the data.

PROGRAMME SPECIFIC OUTCOME (PSOs)

- k. Be able to demonstrate foundation knowledge in the areas of Biochemistry like cell biology, biomolecules, protein biochemistry, molecular biology, Pharmaceutical chemistry and hormonal biochemistry
- l. Be able to integrate knowledge learned in discipline specific courses like Microbiology, Plant Biochemistry, Nutritional biochemistry, Biostatistics, Drug Biochemistry and Biotechnology
- m. To use standard laboratory protocols in biochemistry, modern instrumentations, proper laboratory safety protocols and classical techniques to carry out experiments and also use computers in data acquisition and processing and use available software as a tool in data analysis.
- n. To understand the applications of biological sciences in genetics, biochemical correlations of diseases, Microbiology, Genetic Engineering and Biotechnology.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

- I. To give students a basic knowledge in biochemistry and to teach on ethics.
- II. To develop analytical and critical-thinking skills that allows independent exploration of biological phenomena through the scientific methods.
- III. To acquaint knowledge on modern methods of biochemical experimentation to implement for future studies.
- IV. To motivate students for social responsibilities and to educate them on ethical values in addition to inculcating environmental awareness.
- V. To enable them to execute a research objective through experimentation.

Mapping of PEOs and POs

POs	a	b	c	d	e	F	g	h	i	j	k	l	m	n
PEO I	X	X		X		X	X				X			
PEO II			X			X	X				X	X	X	X
PEO III			X	X	X		X				X	X	X	X
PEO IV								X		X				X
PEO V				X	X				X	X	X	X	X	X

19LSU101
(2019-2020)

TAMIL-1

Semester I
4H-4C

Instruction Hours / week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

பாடத்திட்டப்பொதுநோக்கம்

- கற்றல் வழி சிந்தனைத் திறனையும், கருத்து வெளிப்பாட்டுத் திறனையும், மேம்படுத்துதல்.
- ஆய்வுநோக்கைமேம்படுத்துதல்.
- இலக்கியங்கள் உணர்த்தும் வாழ்வின் நுட்பமான பகுதிகளை உணர்த்துதல்.
- மனித மனத்தினைப் பக்குவப்படுத்துதலில் இலக்கியம் தரும் பங்கினை உணர்த்துதல்.
- வளர்ந்து வரும் சமூகத்தில் அறஉணர்வு, பண்பாடு போன்றவை குறித்து அறிவூட்டல்.
- அரசுத் தேர்வுகளுக்கு மாணவர்களை ஆயத்தமாக்குதல்.

பாடத்திட்டப்பயன்விளைவு

1. இந்தியகுடியுரிமைப்பணிமுதலானபோட்டித்தேர்வுகளில், விருப்பப்பாடமாகஇடம்பெறுகின்ற, 'தமிழ்இலக்கியவரலாறு' குறித்தமுழுமையானஅறிமுகம்பெற்றிருத்தல்.
2. கல்வெட்டியல், ஓலைச்சுவடியியல்மற்றும்தொல்லியல்சார்ந்தஆவணத்தேடலுக்குரியஆய்வுமனப்பான்மையுடன், இலக்கியங்களைஅணுகுதல்.
3. தமிழின்வளர்ச்சித்துறையாகிய, 'அறிவியல்தமிழ்'; 'இணையதமிழ்' குறித்தபன்னோக்குஅணுகுமுறையிலானஆய்வுச்சிந்தனைமேம்பாடு.
4. வேலைவாய்ப்புக்குரியசுயதிறன்மேம்பாட்டுடன், படைப்பாக்கத்திறன்மேம்பாடும்பெற்றிருத்தல் .
5. சமுதாயமற்றும்வாழ்வியல்மதிப்புகளைப்பேணுவதற்குக்கருவியாகஇலக்கியங்களைநாடுகின்றமனப்பான்மைவளர்ச்சி.
6. மொழிபெயப்புத்துறைசார்ந்தவேலைவாய்புத்திறன்பெற்றிருத்தல்

தாள்கள்வரிசையும்தேர்வுச்செயல்திட்டமும்பகுதி-I தமிழ்

பருவம்	தாள்	கற்பிக்கும் நேரம்/வாரம்	தேர்வு ம ணிகள்	மதிப்பெண் அக/எழுத்து	மொத்தம்	மதிப்பீடு
இரண்டு	II	4	3	40 / 60	100	4

தமிழ் முதல் தாள்
(இளநிலை அறிவியல் பட்ட வகுப்புகளுக்குரியது)
(For I-UG Science Degree Classes)

4-H,4-C

அலகு - I : இக்கால இலக்கியம்: (10 மணிநேரம்)

- | | |
|---------------------------------|---------------------------|
| 1. மகாகவி பாரதியார் | - பரம்பொருள் வாழ்த்து . |
| 2. புரட்சிக்கவிஞன் பாரதிதாசன் | - தமிழின் இனிமை. |
| 3. கவிமணி தேசிக விநாயகம் பிள்ளை | - கோவில் வழிபாடு. |
| 4. கவிக்கோ. அப்துல் ரகுமான் | - பாருக்குள்ளே நல்ல நாடு. |
| 5. சிற்பி பாலசுப்பிரமணியன் | - காலம். |
| 6. கவிஞர் தாமரை | - தொலைந்து போனேன். |

அலகு - II : அற இலக்கியம்: (8 மணிநேரம்)

- ஒளவையார் - கொன்றை வேந்தன் (1- 50 பாடல்கள்)
அன்னையும் பிதாவும் - புலையும் கொலையும் களவும் தவிர்
- வேதநாயகம்பிள்ளை - நீதிநூல் - (5 பாடல்கள்)
சின்னவோர் பொருள், கடவுளை வருந்தி, எப்புவிகளும், வைத்தவர், ஈன்றவர்
- திருவள்ளுவர் - திருக்குறள் - பண்புடைமை, வினைத்திட்டம்
- முன்றுறையரையனார் - பழமொழி நானூறு 5 பாடல்கள்

உணற்கு இனிய, பரந்த திறலாரை, நெடியது காண்கிலாய், இனி யாரும், உரைசான்ற

அலகு - III : சிற்றிலக்கியம்: (8 மணிநேரம்)

- முக்கூடற் பள்ளு - 2 பாடல்கள் - சித்திரக் காலிவாலான் (நெல்வகைகள்)
குற்றாலத் திரிகூட மால்வரை (மீன் வகைகள்)
- நந்தி கலம்பகம் - 5 பாடல்கள் - என்னையே புகழ்ந்தேன், பதிதொறு புயல்பொழி,
இந்தப்புலியில், அடிவிளக்கும் துகில், வானுறுமதியை
- மதுரைச் சொக்கநாதர் தமிழ்விடு தூது -தமிழின் சிறப்பு
பாடியருள பத்துப்பாட்டும்-விளம்பக்கேள்.

அலகு - IV : சிறுகதை: (8 மணிநேரம்)

- | | |
|---------------------|-------------------|
| 1. மகாமசானம் | - புதுமைப்பித்தன் |
| 2. அப்பாவின் வேஷ்டி | - பிரபஞ்சன் |
| 3. அந்நியர்கள் | - ஆர். சூடாமணி |
| 4. இந்நாட்டுமன்னர் | - நாஞ்சில்நாடன் |

அலகு - V : மொழிப்பயிற்சி: (6 மணிநேரம்)

- பொருத்தமான தமிழ்ச் சொற்களைப் பயன்படுத்துதல்
- செய்யுள் பொருளுரை திறன்
- மொழிபெயர்ப்புப் பயிற்சிகள்
- கடிதங்கள் மற்றும் விண்ணப்பங்கள் எழுதுதல்

பாட நூல்: கற்பகச்சோலை - தமிழ் ஏடு.

கற்பகம் உயர்கல்வி கலைக்கழகத் தமிழ்த்துறை வெளியீடு.

Course Objectives

- To train students to acquire proficiency in English
- To explore different genres of literature and learning grammar
- To provide aesthetic pleasure through literature
- To inculcate moral values through literature
- To develop ethical values
- To give basic grammar knowledge

Course Outcomes (CO's)

1. Develop the knowledge of interpersonal skills
2. Establish and maintain social relationships
3. Genres of literature will give moral values of life
4. Develop communication skills in business environment
5. Communication skills will get developed
6. Develop to have language competence

UNIT - I: Prose

1. Morals in the Indian Context - Francis Nicholas Chelliah
2. How Comic Books help us to relive our Childhood - Benoit Peeters
3. Let's Do What India Needs From Us -Dr.A.P.J. Abdul Kalam

UNIT - II: Poem

1. The Stolen Boat - William Wordsworth
2. Telephone Conversation- Wole Soyinka
3. A River - A.K. Ramanujan

UNIT - III: Short stories

1. Rapunzel - Brothers Grimm
2. The Ant and The Grasshopper- W. Somerset Maugham
3. The Nightingale and the Rose - Oscar Wilde.

UNIT - IV: Drama

1. The Merchant of Venice- Act 4-Scene 1
2. The Death Trap- Saki

UNIT - V: Grammar and Composition

- Grammar:
1. Tenses
 2. Articles
 3. Auxiliaries (Primary and Modal)
 4. Tag Questions

Composition: 1. Reading to Comprehend
 2. Letter Writing
 3. Resume Writing
 4. General Essay

Prescribed Text: Reminisce, Published by the Department of English, Karpagam Academy of Higher Education.

Suggested Reading: Hewings Martin, 1999 Advanced English Grammar, Cambridge University Press.

Instruction hours/week: L: 3 T: 1 P: 0 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

Equip the students:

- To understand the properties and importance of water in biological system
- To know the biological significance of aminoacids and proteins in living systems
- To know the biological significance of lipids and fats in living systems
- To know the biological significance of carbohydrate metabolites in living systems
- To understand the functional role of nucleic acid in living systems
- To introduce the importance of vitamins in human body

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Recognize water as a universal solvent and elixir of life by knowing its importance
2. Identify the properties and classification of carbohydrates
3. Recall the role of various lipids in biomembrane including signal transduction
4. Categorize the aminoacids and know their properties
5. Differentiate the structure, properties and functions of DNA and RNA
6. List the functions and deficiency disease of fat and water soluble vitamins

Unit I: The foundations of biochemistry and water

Cellular and chemical foundations of life. Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

Unit II: Carbohydrates and glycobiology

Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non-reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates

Unit III: Lipids

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments.

Unit IV: Amino acids and Nucleic acids

Structure and classification, physical, chemical and optical properties of amino acids. Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Unit V: Vitamins

Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis.

SUGGESTED READING

1. Ambika, S, (2004). Fundamentals of Biochemistry for Medical Students, CIT Chennai.
2. Deb, C., (2011). Fundamentals of Biochemistry, 9th edition New Central Book Agency, Calcutta.
3. Jain, J.L., Jain, S and Jain, N., (2005). Fundamentals of Biochemistry, S. Chand and Company Ltd, New Delhi.
4. Nelson, D., and Cox, M. W.H. (2012) Lehninger Principles of Biochemistry (4th Ed.) New York, Freeman and Company.
5. Stryer, L., (2009). Biochemistry, W.H. Freeman and Company, New York.
6. Murray, R.K., Bender, D.A., Botham, K.M., and Kennelly, P.J., (2012). Harper's illustrated Biochemistry, 29th Edition. McGraw-Hill Medical. London.

Course Objectives

Equip the students:

- To understand the structural organization of prokaryotic cells
- To understand the structural organization of eukaryotic cells
- To understand the technical basis of membrane biology
- On the structure and functions of various sub-cellular organelle
- To understand the cytoskeletal network and extracellular matrix
- To understand the cell cycle, cell division and cell death process

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Differentiate the prokaryotic and eukaryotic cell
2. Understand the principle behind studying the cell morphology using various microscope
3. Identify the structure and functions of each organelle in cell
4. Recognise the mechanism behind the protein sorting and transport to their destinations like lysosome, mitochondria and chloroplast
5. Maintenance of cytoskeleton structure and function of micro, macro and intermediary filaments
6. Enumerate the phases of cell cycle, events in cell division and mechanism of cell death

Unit I: Introduction to cell biology

Prokaryotic (*archaea and eubacteria*) and eukaryotic cell (animal and plant cells), cells as experimental models.

Plasma membrane: Composition, Fluid mosaic model

Tools of cell biology: Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for sub-cellular fractionation.

Unit II: Structure of different cell organelles

Structure of nuclear envelope, nuclear pore complex. Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export.

ER structure. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Protein folding in ER

Peroxisomes and Zellweger syndrome.

Unit III: Protein trafficking

Organization of Golgi. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. N and O-linked glycosylation.

Lysosome. – Acid hydrolases, phagocytosis and autophagy.

Mitochondria-Structure and functions, protein import and mitochondrial assembly,

protein export from mitochondrial matrix.

Chloroplasts- Import and sorting of chloroplast proteins.

Unit IV: Cytoskeletal proteins

Structure and organization of actin filaments. Treadmilling and role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly and intracellular organization. Assembly, organization and movement of cilia and flagella.

Unit V: Cell wall and extracellular matrix

Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata.

Cell cycle, cell death and cell renewal :Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Salient features of a transformed cell.

SUGGESTED READING

1. Paul, A., (2007). Text Book of Cell and Molecular Biology, 1st edition. Books and Allied (P) Ltd, Kolkata.
2. Verma, P.S., and Agarwal, V.K., (2005). Cell Biology Molecular Biology and Genetics, VII Edition, S.Chand and company Ltd, New Delhi.
3. Shukla, R.M., (2013). A textbook of Cell Biology, Dominant Publishers and Distributors.
4. Powar, C.B., (2001). Cell Biology, 3rd edition, Himalaya Publishing House, New Delhi
5. Lodish, H., Berk, A., Kaiser, C.A., and Krieger, M., (2012). Molecular Cell Biology, 7th edition. W.H. Freeman & Company, London.
6. Garret, R. H. and Grisham, C.M., Biochemistry (2010) 4th ed., Cengage Learning (Boston), ISBN-13: 978-0-495-11464-2.
7. Cooper, G.M., and Hausman, R.E., (2013). Cell-A Molecular Approach, 6th Edition.. Sinauer Associates. USA
8. Karp, G., (2013). Cell and Molecular Biology, 7th edition. John Wiley and Sons, Inc, Hoboken, United States.
9. Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Molecular Biology of the Cell (2008) 5th ed., Garland Science (Princeton), ISBN:

Course Objectives

Equip the students:

- On the molecular orbital theory, preparation and properties of inorganic compounds
- On the theory of covalent bond, polar effects and stereochemistry of organic compounds
- About important industrial chemicals like silicones, fuel gases
- About Fertilizers and their impact on environment
- On the elements of photochemistry, chemical kinetics and chromatography
- About the dyes, chemotherapy and vitamins

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the molecular orbital theory, preparation and properties of inorganic compounds
2. Understand the theory of covalent bond, polar effects and stereochemistry of organic compounds
3. Have knowledge about important industrial chemicals like silicones, fuel gases
4. Know the classes of fertilizers and their impact on environment
5. Understand the elements of photochemistry, chemical kinetics and chromatography.
6. Understand about the dyes, chemotherapy and vitamins

UNIT-I

Chemical Bonding: Molecular orbital theory-linear combination of atomic orbitals-bonding and antibonding molecular orbitals-energy level diagram-bond order- M.O. configuration of H_2 , N_2 and F_2 molecules. Diborane: Preparation, properties and structure. $NaBH_4$: Preparation and uses. Borazole: Preparation and properties. Interhalogen compounds: ICl , BrF_3 , IF_5 - preparation, properties, uses and structure. Basic properties of iodine. Compounds of sulphur: Sodium hydrosulphite- preparation, properties, uses and structure. Peroxy acids of sulphur: Preparation, properties, uses and structure.

UNIT- II

Covalent Bond and Stereoisomerism: Covalent Bond: Orbital overlap, hybridization and geometry of CH_4 , C_2H_4 and C_2H_2 . Polar effects: Inductive effect-electromeric effect-mesomeric effect- steric effect- hyperconjugation. **Stereoisomerism:** Elements of symmetry-polarised light and optical activity-isomerism in tartaric acid-racemisation-resolution- geometrical isomerism of maleic and fumaric acids-keto-enol tautomerism of acetoacetic esters.

UNIT-III

Industrial Chemistry: Silicones: Synthesis, properties and uses. Fuels gases: Natural gas-water gas-semi water gas-carbureted water gas-producer gas- oil gas (Manufacturing details not required). Fertilizers: NPK fertilizer-ammonium sulphate-urea-superphosphate of lime-triple superphosphate- potassium nitrate-ammonium nitrate. Pollution: Water, air and soil pollution-sources and remedies-acid rain-ozone hole-greenhouse effect.

UNIT-IV

Elements of Photochemistry, Chemical Kinetics and Chromatography: Elements of Photochemistry: Photochemical laws-Beer Lambert's law-Grothuss-Draper law-Stark-Einstein law (statement only). **Chemical Kinetics:** Rate-order-molecularity-pseudo first order reactions-zero order reactions-determination of order of reaction-measurement of order and rates of reactions-effect of temperature on reaction rate-energy of activation. **Chromatography:** Principles and applications of Column, Paper and Thin Layer Chromatography.

UNIT- V

Dyes, Chemotherapy and Vitamins: Dyes: Terms used chromophore, auxochrome, bathochromic shift and hypsochromic shift- classification of dyes– based on chemical structure and application-one example each for azo, triphenylmethane, vat and mordant dyes- preparation.

Chemotherapy: Preparation, uses and mechanism of action sulpha drugs- preparation and uses of prontosil, sulphadiazine and sulphafurazole-structure and uses of penicillins and Chloromycetin. **Vitamins:** Diseases caused by the deficiency of vitamins A, B₁, B₂, C and D-sources of these vitamins.

SUGGESTED READING:

1. Thangamani, A. (2018). *Text Book on Allied Chemistry* (1st Edition). Coimbatore: Karpagam Publication.
2. Puri, B.R., Sharma, L. R., & Kalia, K. C. (2017). *Principles of Inorganic Chemistry* (33rd Edition). Jalandar: Vishal Publishing Company.
3. Bahl, A., & Bahl, B.S. (2015). *A Textbook of Organic Chemistry* (21st Revised Edition). New Delhi: S.Chand& Company Pvt. Ltd.
4. Puri, B. R., Sharma, L. R. & Pathania, M. S. (2014). *Elements of Physical Chemistry* (46th Edition). Jalandhar: Vishal Publishing Company.
5. Gopalan, R., & Sundaram, S. (2013). *Allied Chemistry* (III Edition). New Delhi: Sultan Chand & Sons.

Instruction hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

To impart hands-on training:

- To know the safety measures to be followed in laboratory
- To prepare molar, normal and ppm solutions
- On buffer preparation
- To separate the biomolecules using chromatography techniques
- To identify the biomolecules qualitatively
- To quantify the biomolecules using colorimetry

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Gain knowledge on lab safety
2. Prepare reagents and solutions
3. Understand the basis of buffer preparation
4. Understand the principle and working procedure behind chromatographic separations
5. Understand the principle and working procedure behind staining techniques
6. Understand the principle and working procedure behind colorimetric techniques

Experiments

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
6. Separation of amino acids/ sugars/ bases by thin layer chromatography.
7. Estimation of vitamin C.
8. Estimation of vitamin E.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., W.H. Freeman., Lehninger: Principles of Biochemistry (2013) 6th ed., and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Devlin, T.M., (2011) Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
3. Jayaraman, J. (2007). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.
4. Sadasivam, S., and Manickam, A., (2009). Biochemical Methods, New Age International Publishers, New Delhi.

Instruction hours/week: L:0 T:0 P:4**Marks: Internal: 40 External: 60 Total: 100**
End Semester Exam: 3 Hours

Course Objectives

To impart hands-on training:

- On different parts of light microscopy
- On how to visualize the cells
- On phase contrast microscopy
- On how to identify different stages of mitosis and meiosis
- On staining techniques to identify the cell types
- On how to count the cells using hemocytometer

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Identify the spotters of light microscopy
2. Be able to visualize the cells
3. Use the phase contrast microscopy at appropriate magnifications
4. Identify the cells using staining techniques
5. Interpret various stages of cell division
6. Count the cells manually using hemocytometer

Experiments

1. Preparation of onion root squash and observation of cell
2. Visualization of animal and plant cell by methylene blue staining
3. Identification of different stages of mitosis in onion root tip.
4. Identification of different stages of meiosis in grasshopper testis.
5. Cell size determination using ocular stage micrometer
6. Micrographs of different cell components (dry lab).
7. Sub-cellular fractionation.
8. Visualization of nuclear fraction by acetocarmine stain.
9. Staining and visualization of mitochondria by Janus green stain.

SUGGESTED READING

1. Cooper, G.M. and Hausman, R.E., (2009). The Cell: A Molecular Approach 5th ed., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
2. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J., (2012) Molecular Cell Biology 7th ed., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10: 1-4641-0981-8.
3. Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., (2008) Molecular Biology of the Cell 5th ed., Garland Science (Princeton), ISBN:

Course Objectives

To impart hands-on training on:

- Preliminary tests for identification of an organic compound
- Detection of elements
- Identification of aromatic or aliphatic compound
- Different functional groups and its nature
- Confirmatory test for aldehydes, ketones, amines and amides
- Confirmatory test for carbohydrates, phenol, acids, esters and nitro compounds

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Perform preliminary tests for identification of an organic compound
2. Perform and detect the elements present in the given compound
3. Identify and differentiate between aromatic and aliphatic compound
4. Identify different functional groups and its nature
5. Perform confirmatory test for aldehydes, ketones, amines and amides
6. Perform confirmatory test for carbohydrates, phenol, acids, esters and nitro compounds

Systematic analysis of an organic compound

- Preliminary tests
- Detection of elements present
- Aromatic or aliphatic
- Saturated or unsaturated
- Nature of the functional group,
- Confirmatory tests– aldehydes, ketones, amines, amides, diamide, carbohydrates, phenols, acids, esters & nitro compounds.

Note: Each student should analyze minimum 6 compounds.

SUGGESTED READING

1. Thomas, A.O. (2012). *Practical Chemistry for B.Sc. Main Students*. Cannanore: Kerala, Scientific Book Centre.
2. Ramasamy, R. (2011). *Allied Chemistry Practical Book*. Karur: Priya Publications.
3. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2015). *Basic Principles of Practical Chemistry* (2nd ed.). New Delhi: S. Chand Publications.

பாடத்திட்டப்பொதுநோக்கம்

- கற்றல் வழி சிந்தனைத் திறனையும், கருத்து வெளிப்பாட்டுத் திறனையும், மேம்படுத்துதல்.
- ஆய்வுநோக்கைமேம்படுத்துதல்.
- இலக்கியங்கள் உணர்த்தும் வாழ்வின் நுட்பமான பகுதிகளை உணர்த்துதல்.
- மனித மனத்தினைப் பக்குவப்படுத்துதலில் இலக்கியம் தரும் பங்கினை உணர்த்துதல்.
- வளர்ந்து வரும் சமூகத்தில் அறஉணர்வு, பண்பாடு போன்றவை குறித்து அறிவூட்டல்.
- அரசுத் தேர்வுகளுக்கு மாணவர்களை ஆயத்தமாக்குதல்.

பாடத்திட்டப்பயன்விளைவு

1. இந்தியகுடியுரிமைப்பணிமுதலானபோட்டித்தேர்வுகளில், விருப்பப்பாடமாகஇடம்பெறுகின்ற, 'தமிழ்இலக்கியவரலாறு' குறித்தமுழுமையானஅறிமுகம்பெற்றிருத்தல்.
2. கல்வெட்டியல், ஓலைச்சுவடியியல்மற்றும்தொல்லியல்சார்ந்தஆவணத்தேடலுக்குரியஆய்வுமனப்பான்மையுடன், இலக்கியங்களைஅணுகுதல்.
3. தமிழின்வளர்ச்சித்துறையாகிய, 'அறிவியல்தமிழ்' ; 'இணையதமிழ்' குறித்தபன்னோக்குஅணுகுமுறையிலானஆய்வுச்சிந்தனைமேம்பாடு.
4. வேலைவாய்ப்புக்குரியசுயதிறன்மேம்பாட்டுடன், படைப்பாக்கத்திறன்மேம்பாடும்பெற்றிருத்தல் .
5. சமுதாயமற்றும்வாழ்வியல்மதிப்புகளைப்பேணுவதற்குக்கருவியாகஇலக்கியங்களைநாடுகின்றமனப்பான்மைவளர்ச்சி.
6. மொழிபெயப்புத்துறைசார்ந்தவேலைவாய்புத்திறன்பெற்றிருத்தல்

தாள்கள்வரிசையும்தேர்வுச்செயல்திட்டமும்பகுதி-I தமிழ்

பருவம்	தாள்	கற்பிக்கும் நேரம்/வாரம்	தேர்வு ம ணிகள்	மதிப்பெண் அக/எழுத்து	மொத்தம்	மதிப்பீடு
இரண்டு	II	4	3	40 / 60	100	4

(இளநிலைஅறிவியல்பட்டவகுப்புகளுக்குரியது)
(For I-UG Science DegreeClasses)

அலகு – I :பக்திலக்கியம்

(7 மணிநேரம்)

சைவ, வைணவஇலக்கியங்கள் -தோற்றம் ,வளர்ச்சி, வரலாறு.

1. சைவம்- (15பாடல்கள்)பெரியபுராணம் - திருமூலநாயனார்புராணம் -
அந்திஇளம்பிறைக்கண்ணி, மற்றும்அவர்தாம்அணிமா,
காவிரிநீர்பெருந்தீர்த்தம், அந்நிலைமைத்தானத்தை,
அந்தணர்தம்சாத்தனார், மற்றும்அதன்தன்உடம்பினை,
இவன்உயிர்பெற்றெழில், பாய்த்தியபின்திருமூலராய்,
வெய்யசுடர்கதிரவனும், அங்கவளும், பித்துஉற்றமையல்அன்று,
இந்தநிலைமையில், ஆவடுதண்துறை, ஊன்உடம்பில்,
முன்னியஅப்பொருள்.

2. வைணவம் - ஆண்டாள்நாச்சியார்திருப்பாவை: (11
பாடல்கள்):மார்கழித்திங்கள், வையத்து வாழ்வீர்காள், ஓங்கிலகளந்த,
ஆழிமழைக்கண்ணா, மாயனைமன்னுவடமதுரை, சிற்றம்சிறுகாலே,
ஒருத்திமகனாய், மாலைமணிவண்ணா, கூடாரைவெல்லும்,
கறவைகள்பின்சென்று, வங்கக்கடல்கடைந்த.

அலகு – II :சங்கஇலக்கியம்

(14 மணிநேரம்)

சங்கஇலக்கியங்கள் -அறிமுகம்

அ).எட்டுத்தொகை

நற்றிணை:கொண்டல்மாமழை - குறிஞ்சி - தலைவன் - 140

குறுந்தொகை : வாரார்ஆயினும், வரினும் -முல்லை- தலைவி - 110

ஐங்குறுநூறு :மருதம் -தோழி -வேட்கைப்பத்து: வாழிஆதன்வாழிஅவனி - 6

பதிற்றுப்பத்து: சிதைந்ததுமன்ற - 27

பரிபாடல்: பரிபாடல்திரட்டு-வையை -10: மலைவரைமாலை-கரைநண்ணி 10:1-25, ஆங்கஅணிநிலைமாடத்து-நீகானும்போன்ம் 10: 41-55, இலம்படுபுலவர்-ஏத்தினர்தொழுவே 10: 126-130.

கலித்தொகை:பாலைக்கலி-செவிலி - எறித்தரு கதிர்தாங்கி-9

அகநானூறு:அன்னைஅறியினும்அறிக - தோழி - நெய்தல் - 110

புறநானூறு :யாதும்ஊரேயாவருங்கேளிர் -பொதுவியல்- 192

ஆ).பத்துப்பாட்டு: நெடுநல்வாடை - கார்காலச்சிறப்பு : வையகம்பனிப்ப -1-70

அலகு - III :காப்பியம்

(6 மணிநேரம்)

(அ). சிலப்பதிகாரம்:

மங்கலவாழ்த்துப்பாடல்: (21-29)- நாகநீர்நகரொடு-கண்ணகிஎன்பாண்மன்னோ

வழக்குரைகாதை, (48-56) - நீர்வார்கண்ணை-புகாரென்பதியே .

வஞ்சினமாலை: (5-34) - வன்னிமரமும் – பிறந்தபதிப்பிறந்தேன்.

நடுகற்காதை: (207-234) - அருத்திறலரசர் – மன்னவரேறென்.,

வாழ்த்துக்காதை: (9) - என்னையிஃதென்னே – மீவிசும்பிற்நோன்றுமால்.

(ஆ). மணிமேகலை:

பசியின்கொடுமை: பாத்திரம்பெற்றகாதை:

‘போதிநீழல்’ - ‘பெருகியதன்றோ’ , ‘ஆற்றுநர்க்களிப்போர்’ -
‘நல்லறம்கண்டனை’ (73-98).

சிறைக்கோட்டம்அறக்கோட்டமாக்கியகாதை:மாவண்கிள்ளிக்குகாவலன்உரைத்த
வை:

‘பைஞ்சேறுமெழுகாப்பசும்பொன்மண்டபத்து -

அரவோர்க்காக்கினன்அரசாள்வேந்தன்’ (116-163).

அலகு – IV :கட்டுரைகள்

(8 மணிநேரம்)

1. தமிழிசைஇயக்கம் – பேரா. க. வெள்ளைவாரணர்
2. தனிப்பாடல்கள் - பேரா. வ. சுப. மாணிக்கனார்
3. கலைச்சிறப்பு - முத்தமிழ்க்காவலர்கி.ஆ.பெ. விசுவநாதம்
4. காளத்திவேடனும்கங்கைவேடனும் –
சொல்லின்செல்வார்ரா.பி.சேதுப்பிள்ளை
5. ஏட்டில்இல்லாதஇலக்கியம் – ஒளவைதுரைசாமி

அலகு- V :மொழிப்பயிற்சி

(5 மணிநேரம்)

(பேச்சுப்பயிற்சி&படைப்பாக்கப்பயிற்சி)

படைப்பிலக்கியப் பயிற்சிகள் (கதை, கவிதை, கட்டுரை, உரைநடைஎழுதுதல்,
நேர்காணல்)மொழிபெயர்ப்பு

பாடநூல்:கற்பகச்சோலை – தமிழ்எடு.

கற்பகம்உயர்கல்விகலைக்கழகத்தமிழ்த்துறைவெளியீடு.

Course Objectives

Equip the students:

- To build their understanding on proteins
- On different molecular techniques used for separation of proteins
- On different molecular techniques used for characterization of proteins
- To study the three dimensional structure of proteins using computational tools
- To enrich the biological significance of proteins
- To identify appropriate technique to use during their project work

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Build on their understanding of proteins
2. Use different molecular techniques used for separation of proteins
3. Use different molecular techniques used for characterization of proteins
4. Understand the three dimensional structure of proteins using computational tools
5. Identify the biological significance of proteins
6. Use appropriate technique during their project work

Unit I: Introduction, Extraction and Separation of Proteins

Introduction - Amino acids and their properties - hydrophobic, polar and charged amino acids. Biologically important peptides - hormones, antibiotics and growth factors. Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function. Extraction of proteins for downstream processing - Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation. Separation techniques - Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization.

Unit II: Purification and Characterization of proteins

Chromatographic Techniques - Ion-exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC (Normal and Reverse phase) and FPLC. Characterization of proteins - Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis.

Unit III: Structural Organization and Analysis of proteins

Organization of protein structure into primary, secondary, tertiary and quaternary structures. N-terminal and C-terminal amino acid analysis. Sequencing techniques - Edman degradation. Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Mass spectrometric analysis, tandem MS. Solid phase peptide synthesis.

Unit IV: Three dimensional structures of protein and Protein Structure Database

Nature of stabilizing bonds - covalent and non-covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran map. Techniques used in studying 3-D structures - X-ray diffraction and NMR. Motifs and domains. Tertiary and quaternary structures. Structures of myoglobin and haemoglobin. Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases –Alzheimer's and Prion based. Protein sequence and structure databases (PDB). Use of sequence and domain information. Viewing protein structures using *in silico* tools.

Unit V: Specialized Proteins and its Applications

Myoglobin and haemoglobin - Oxygen binding curves, influence of 2,3-BPG, CO₂ and Cl⁻ Hill plot. Cooperativity between subunits and models to explain the phenomena – concerted and sequential models. Haemoglobin disorders. Antibodies - Antibody structure and binding to antigens. Actin-myosin motors - ATP activated actin - myosin contractions. Membrane Proteins - Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains. Significance of membrane proteins - bacteriorhodopsin.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.
2. Sheehan, D., (2009). Physical Biochemistry 2nd ed., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
3. Cooper, T.G., (2011). The Tools of Biochemistry Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

Course Objectives

Equip the students:

- To understand the basic concepts of enzymes
- To study the kinetics of enzyme catalysed reactions
- To learn the mechanism of action of enzymes and enzyme inhibition concepts
- To understand various modes of enzyme regulation
- To learn the application of enzymes in health
- To learn the application of enzymes in diseases

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the basic concepts on enzymes
2. Relate the initial velocity and substrate concentration of enzymes and be able to understand the kinetics of inhibition reactions
3. Understand the basis of enzyme inhibitor drugs
4. Be able to understand the regulation pattern of various enzymes
5. Relate the regulation pattern of enzymes for its application in health and diseases
6. Understand the application of enzymes as marker in various disease conditions

Unit I: Introduction to enzymes and enzyme catalysis

Introduction - Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes. Features of enzyme catalysis- Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

Unit II: Enzyme kinetics

Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. K_m and V_{max} , K_{cat} and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme. Bisubstrate reactions - Types of bi bi reactions (sequential – ordered and random, ping pong reactions). Differentiating bi substrate mechanisms (diagnostic plots, isotope exchange).

Unit III: Mechanism of action of enzymes and Enzyme inhibition

Mechanism of action of enzymes - General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues. Enzyme Inhibition -

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors.

Unit IV: Regulation of enzyme activity

Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbamoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage-zymogen. Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit V: Coenzymes

Coenzymes in enzyme catalysed reactions and Applications of enzymes. Structure and Functions of TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid. Applications of enzymes - Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes – Preparation techniques and its applications.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.
2. Donald, V. and Judith G.V., (2011). Biochemistry 4th ed., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.
3. Nicholas C.P., and Lewis S., (1999). Fundamentals of Enzymology 3rd ed., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

Course Objectives

Equip the students:

- To be conversant with the extraction of metals
- About coordination chemistry
- On the preparation, properties, uses and structure of naphthalene and heterocyclic compounds
- To acquire knowledge on electrochemistry, biological functions of amino acids and proteins
- To acquire knowledge on thermodynamic laws, entropy, enthalpy change and the principles of electroplating.
- To acquire knowledge on aromatic and heterocyclic compounds

Course Outcomes (CO's)

After successful completion of the course, the student will understand:

1. The metallurgy of metals and the theories of coordination compounds and
2. The industrial importance of EDTA, haemoglobin and chlorophyll.
3. The concept of aromaticity and preparation of aromatic compounds including heterocyclic compounds.
4. The preparation, classifications and properties of amino acids, proteins and carbohydrates.
5. The concepts of first and second laws of thermodynamics
6. The fundamentals of electrochemistry

Unit-I

Metals and Coordination Chemistry: Metals: General methods of extraction of metals-methods of ore dressing-types of furnaces-reduction methods-electrical methods-types of refining-Van Arkel process-Zone refining. **Coordination Chemistry:** Nomenclature-theories of Werner, Sidgwick and Pauling-chelation and its industrial importance-EDTA-haemoglobin-chlorophyll-applications in qualitative and quantitative analysis.

Unit-II**Aromatic Compounds and Heterocyclic Compounds:**

Aromatic Compounds: Aromaticity-Huckel's ($4n+2$) rule- aromatic electrophilic substitution in benzene- mechanism of nitration, halogenation, alkylation, acylation and sulphonation. Naphthalene: Isolation, preparation, properties and structure. **Heterocyclic Compounds:** Preparation and properties of pyrrole, furan, thiophene and pyridine.

Unit-III

Amino acids, Proteins and Carbohydrates: Amino acids: Classification, preparation and properties. Peptides-preparation of peptides (Bergmann method only). **Proteins:** Classification, properties, biological functions and structure. **Carbohydrates:**

Classification, preparation and properties of glucose and fructose- discussion of open chain and ring structures of glucose and fructose-glucose-fructose interconversion.

Unit-IV

Energetics: Type of systems-processes and their types - isothermal, adiabatic, reversible, irreversible and spontaneous processes-statement of first law of thermodynamics-need for the second law of thermodynamics-heat engine-Carnot cycle-efficiency-Carnot theorem-thermodynamics scale of temperature-Joule-Thomson effect-Enthalpy- Entropy and its significance-Free energy change.

Unit-V

Electrochemistry: Kohlrausch law-conductometric titrations-hydrolysis of salts-galvanic cells-E.M.F.-standard electrode potentials-reference electrodes-electrochemical series and its applications-buffer solution-buffer solution in the biological systems-pH and its determination-principles of electroplating.

SUGGESTED READING

1. Veeraiyan, V., & Vasudevan, A.N.S. (2012). *Text Book of Allied Chemistry*(II Edition). Chennai: Highmount Publishing House.
2. Puri, B.R., Sharma, L. R., & Kalia, K. C. (2017). *Principles of Inorganic Chemistry* (33rd Edition). Jalandar: Vishal Publishing Company.
3. Bahl, A., & Bahl, B.S. (2015). *A Textbook of Organic Chemistry* (21st Revised Edition). New Delhi: S.Chand& Company Pvt. Ltd.
4. Puri, B. R., Sharma, L. R. &Pathania, M. S. (2014). *Elements ofPhysical Chemistry* (46th Edition). Jalandhar: Vishal Publishing Company.
5. Gopalan, R., & Sundaram, S. (2013). *Allied Chemistry* (III Edition). New Delhi: Sultan Chand & Sons.

Instruction hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

To impart hands-on training:

- Qualitative analysis of proteins
- Quantitative analysis of proteins
- Determination of isoelectric point of proteins
- Separation of proteins using chemical methods
- Electrophoretic separation of proteins using SDS-PAGE
- Immune based separation of proteins

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Perform qualitative analysis of proteins
2. Quantify the amount of protein in the given sample
3. Determine isoelectric point of given protein
4. Separate the protein using ammonium sulphate method
5. Perform SDS-PAGE for separation of proteins
6. Perform affinity chromatography

Experiments

1. Estimation of proteins using UV absorbance and Biuret method.
2. Microassay of proteins using Lowry/Bradford method.
3. Isoelectric pH of casein.
4. Ammonium sulphate fractionation of serum proteins.
5. Separation of albumin from serum using affinity chromatography.
6. SDS-PAGE analysis of proteins.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.
2. Sheehan, D., (2009). Physical Biochemistry 2nd ed., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
3. Cooper, T.G., (2011). The Tools of Biochemistry Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

Instruction hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

To impart hands-on training:

- To know the sources of enzymes and study the extraction and partial purification of enzymes
- To standardize the optimum pH required for the maximum activity of a given enzyme
- To standardize the optimum substrate concentration required for the maximum activity of a given enzyme
- To standardize the optimum temperature required for the maximum activity of a given enzyme
- To analyse the inhibition pattern by various competitive inhibitors for the enzyme acid phosphatase purified from germinated mung bean
- To assay the activity of Lactate dehydrogenase and glucose – 6 – phosphate dehydrogenase enzymes as diagnostic markers

Course outcome (CO's)

After successful completion of the course, the student will:

1. Identify the source of enzymes and study the extraction and partial purification of enzymes
2. Identify the optimum pH required for the maximum activity of a given enzyme
3. Identify optimum substrate concentration required for the maximum activity of a given enzyme
4. Identify the optimum temperature required for the maximum activity of a given enzyme
5. Analyse the inhibition pattern by various competitive inhibitors for the enzyme acid phosphatase purified from germinated mung bean
6. Assay the activity of Lactate dehydrogenase and glucose – 6 – phosphate dehydrogenase enzymes

Experiments

1. Partial purification of acid phosphatase from germinating mung bean.
2. Assay of enzyme activity and specific activity, e.g. acid phosphatase.
3. Effect of pH on enzyme activity
4. Determination of K_m and V_{max} using Lineweaver-Burk graph.
5. Enzyme inhibition - calculation of K_i for competitive inhibition.
6. Continuous assay of lactate dehydrogenase.
7. Assay of glucose-6-phosphate dehydrogenase.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed.,
W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 /
ISBN:10:1-4292-3414-8.
2. Donald, V., and Judith G.V., (2011). Biochemistry 4th ed., John Wiley & Sons
Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.
3. Nicholas C.P. and Lewis S., (1999). Fundamentals of Enzymology 3rd ed.,
Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

Course Objectives

To impart hands-on training on:

- Estimation of sodium carbonate and sodium hydroxide
- Estimation of sulphuric acid
- Estimation of potassium permanganate
- Estimation of ferrous sulphate using permanganometry
- Estimation of oxalic acid using permanganometry
- Estimation of calcium using permanganometry

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Estimate sodium carbonate and sodium hydroxide using standards
2. Estimate sulphuric acid using standard oxalic acid
3. Estimate potassium permanganate by alkalimetry method
4. Estimate ferrous sulphate using standard Mohr's salt
5. Estimate oxalic acid using standard ferrous sulphate
6. Estimate calcium using direct method

Experiments**Volumetric analysis****A. Acidimetry & Alkalimetry**

1. Estimation of sodium carbonate using standard sodium hydroxide.
2. Estimation of sodium hydroxide using standard sodium carbonate.
3. Estimation of sulphuric acid using standard oxalic acid.
4. Estimation of potassium permanganate using standard potassium permanganate.

B. Permanganometry

1. Estimation of ferrous sulphate using standard Mohr's salt.
2. Estimation of oxalic acid using standard ferrous sulphate.
3. Estimation of calcium-direct method.

SUGGESTED READING

1. Thomas, A.O. (2012). *Practical Chemistry for B.Sc. Main Students*. Cannanore: Kerala, Scientific Book Centre.
2. Ramasamy, R. (2011). *Allied Chemistry Practical Book*. Karur: Priya Publications.
3. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu A. R. (2015). *Basic Principles of Practical Chemistry* (2nd edition). New Delhi: S. Chand Publications.

Course Objectives

Equip the students:

- To understand the concepts and components of ecosystem
- To understand the significance of eco components and measures to maintain ecosystem
- To teach the ethical and legal perspectives on ecosystem management
- To understand the undesired effects of environmental pollution
- To device a strategy to avoid environmental pollution
- To understand the concept of conservation

Course Outcomes (COs)

1. Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Understand the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
6. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
7. Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.

Unit I – INTRODUCTION - ENVIRONMENTAL STUDIES & ECOSYSTEMS

Environment Definition, Scope and importance; Ecosystem, Structure and functions of ecosystem. Energy flow, Food chains and food webs, Ecological succession. Classification of ecosystem. Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Unit II - NATURAL RESOURCES - RENEWABLE AND NON-RENEWABLE RESOURCES

Natural resources - Renewable and Non – Renewable resources. Land resources and land use change, Land degradation, soil erosion and desertification. Forest resources - Deforestation: Causes and impacts due to mining, dam building on environment, forests,

biodiversity and tribal populations. Water resources- Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water. Use of alternate energy sources, growing energy needs, case studies. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Unit III - BIODIVERSITY AND ITS CONSERVATION

Levels of biological diversity - genetic, species and ecosystem diversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. Bio-geographical classification of India. Biodiversity patterns (global, National and local levels). Hot-spots of biodiversity. India as a mega-diversity nation. Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Unit IV - ENVIRONMENTAL POLLUTION

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution. Nuclear hazards and human health risks. Solid waste management and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Case studies.

Unit V - SOCIAL ISSUES AND THE ENVIRONMENT

Concept of sustainability and sustainable development. Water conservation - Rain water harvesting, watershed management. Climate change, global warming, ozone layer depletion, acid rain and its impacts on human communities and agriculture. Environment Laws (Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act). International agreements (Montreal and Kyoto protocols). Resettlement and rehabilitation of project affected persons. Disaster management (floods, earthquake, cyclones and landslides). Environmental Movements (Chipko, Silent valley, Bishnois of Rajasthan). Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). Human population growth: Impacts on environment, human health and welfare.

SUGGESTED READING

1. Anonymous. 2004. A text book for Environmental Studies, University Grants Commission and Bharat Vidapeeth Institute of Environmental Education Research, New Delhi.
2. Anubha Kaushik., and Kaushik, C.P. 2004. Perspectives in Environmental Studies. New Age International Pvt. Ltd. Publications, New Delhi.
3. Arvind Kumar. 2004. A Textbook of Environmental Science. APH Publishing Corporation, New Delhi.

4. Daniel, B. Botkin., and Edward, A. Keller. 1995. Environmental Science John Wiley and Sons, Inc., New York.
5. Mishra, D.D. 2010. Fundamental Concepts in Environmental Studies. S.Chand&CompanyPvt. Ltd., New Delhi.
6. Odum,E.P., Odum, H.T. and Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.
7. Rajagopalan, R. 2016.Environmental Studies: From Crisis to Cure, Oxford University Press.
8. Sing, J.S., Sing. S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Publishing Company, New Delhi.
9. Singh, M.P., Singh, B.S., and Soma, S. Dey. 2004. Conservation of Biodiversity and Natural Resources.Daya Publishing House, New Delhi.
10. Tripathy. S.N., and Sunakar Panda. (2004). Fundamentals of Environmental Studies (2nd ed.). Vrianda Publications Private Ltd, New Delhi.
11. Verma, P.S., and Agarwal V.K. 2001. Environmental Biology (Principles of Ecology).S.Chand and Company Ltd, New Delhi.
12. Uberoi, N.K. 2005. Environmental Studies. Excel Books Publications, New Delhi.

Instruction hours/week: L: 4 T:0 P:0 Marks:Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

Equip the students:

- An overview on various metabolic pathways in human
- An overview on various metabolic pathways in plants
- To understand the pathways related with energy production through catabolism of carbohydrates and lipids
- To understand the pathways related with energy production through anabolism of carbohydrates and lipids
- To recognize the metabolic pathways that involve with the synthesis of macromolecule
- To know the biomolecule homeostasis mechanism

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Students are able to understand the breakdown of macromolecules like carbohydrate and lipids
2. Recognise the energy production pathways like glycolysis, glycogeneolysis and TCA cycle
3. Interpret the central role of TCA cycle in energy metabolism
4. Relate the calvin cycle with the synthesis of starch and sucrose and integration of carbohydrate metabolism in plant
5. Understand the energy requirement and energy balance through glucose homeostasis
6. Relate the interdependence of metabolic pathways

Unit I: Basic design of metabolism

Autotrophs, heterotrophs, metabolic pathways, catabolism, anabolism, ATP as energy currency, reducing power of the cell.

Glycolysis: Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia.

Gluconeogenesis and pentose phosphate pathway: Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance.

Unit II: Glycogenesis & TCA

Glycogenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases.

Citric acid cycle: Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways.

Unit III: Synthesis of carbohydrates

Calvin cycle, regulation of Calvin cycle, regulated synthesis of starch and sucrose, photorespiration, C₄ and CAM pathways, synthesis of cell wall polysaccharides, integration of carbohydrate metabolism in plant cell.

Unit IV: Fatty acid oxidation

Digestion, mobilisation and transport of cholesterol and triacyl glycerols, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis.

Fatty acid synthesis : Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation.

Unit V: Biosynthesis of Eicosanoids, cholesterol, steroids and isoprenoids

Synthesis of prostaglandins, leukotrienes and thromboxanes. Synthesis of cholesterol, regulation of cholesterol synthesis. Synthesis of steroids and isoprenoids.

Biosynthesis of membrane lipids

Synthesis of membrane phospholipids in prokaryotes and eukaryotes, respiratory distress syndrome, biosynthesis of triacylglycerol, biosynthesis of plasmalogens, sphingolipids and glycolipids, lipid storage diseases.

Starve-feed cycle

Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis, five phases of glucose homeostasis.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.
3. Berg, J.M., Tymoczko, J.L. and Stryer L., (2012). Biochemistry 7th ed., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

Instruction hours/week: L: 4 T:0 P:0 Marks:Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

Equip the students:

- To understand the structure and functions of amino acids
- To understand the structure and functions of nucleic acids
- To understand the basis of diseases associated with amino acid catabolism
- To understand the basis of diseases associated with nucleic acid catabolism
- To understand the interconnection between amino acids and nucleic acids and central dogma concept
- To understand the biosynthesis of amino acids and nucleic acids

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Identify basic structures, names, and properties of nucleic acids
2. Demonstrate overview of amino acid metabolism and catabolism of amino acids
3. Understand the chemical logic of metabolic pathways
4. Recognize and understand basic mechanisms of pathway regulation
5. Understand the central dogma concept
6. Understand the basis of amino acid and nucleic acid disorders

Unit I: Overview of amino acid metabolism

Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkor and Marasmus. Nitrogen balance, transamination, role of pyridoxal phosphate, glucose-alanine cycle, Krebs's bicycle, urea cycle and inherited defects of urea cycle.

Catabolism of amino acids: Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units.

Unit II: Catabolism of amino acids

Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic acidemia (MMA), homocystinuria and Hartnup's disease.

Biosynthesis of amino acids

Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation.

Unit III: Precursor functions of amino acids

Biosynthesis of creatine and creatinine, polyamines (putrescine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

Unit IV: Biosynthesis of purine and pyrimidine nucleotides

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways.
Deoxyribonucleotides and synthesis of nucleotide triphosphate
Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

Unit V: Degradation of purine and pyrimidine nucleotides

Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

Integration of metabolism

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962.
2. Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.
3. Berg, J.M., Tymoczko, J.L. and Stryer L., (2012). Biochemistry 7th ed., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

Course Objectives

Equip the students:

- To understand the basis of membrane proteins (intrinsic and extrinsic)
- To understand the basis of membrane lipids (phospholipids and glycolipids)
- To understand the basis of membrane carbohydrates
- To understand the basis of membrane model system for drug delivery
- To understand the transport of biomolecules across membranes
- To understand the role of membrane components on energy production

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the basis of membrane proteins (intrinsic and extrinsic)
2. Understand the basis of membrane lipids (phospholipids and glycolipids)
3. Understand the basis of membrane carbohydrates
4. Understand the basis of membrane model system for drug delivery
5. Understand the transport of biomolecules across membranes
6. Understand the role of membrane components on energy production.

Unit I: Biomembranes, membrane structures and membrane dynamics

Composition of biomembranes- prokaryotic, eukaryotic, neuronal and sub-cellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planar bilayer and liposomes as model membrane systems. Polymorphic structures of amphiphilic molecules in aqueous solutions- micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture. Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.

Unit II: Membrane transports

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport- glucose transporter, anion transporter and porins. Primary active transporters- P type ATPases, V type ATPases, F type ATPases. Secondary active transporters- lactose permease, Na⁺-glucose symporter. ABC family of transporters- MDR, CFTR. Group translocation. Ion channels- voltage-gated ion channels (Na⁺/K⁺ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

Unit III: Vesicular transport, membrane fusion and bioenergetics

Types of vesicle transport and their function- clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin. Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

Unit IV: Oxidative phosphorylation

Mitochondria. Electron transport chain- its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F₁ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants.

Unit V: Photophosphorylation

General features of photophosphorylation, historical background, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Bacterial photophosphorylation in purple bacteria, Green sulfur bacteria and *Halobacterium salinarum*. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides. Cyclic photophosphorylation and its significance. Photo inhibition. Evolution of oxygenic photosynthesis.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., W.H. Freeman., Lehninger: Principles of Biochemistry (2013) 6th ed., and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., Molecular Cell Biology (2013) 7th ed., W.H. Freeman & Company (New York), ISBN:13: 978-1-4641-0981-2.
3. Garret, R. H. and Grisham, C.M., Biochemistry (2010) 4th ed., Cengage Learning (Boston), ISBN-13: 978-0-495-11464-2.
4. Voet, D.J., Voet, J.G. and Pratt, C.W., (2008) Principles of Biochemistry 3rd ed., John Wiley & Sons, Inc. (New York), ISBN:13: 978

**19BCU311 METABOLISM OF CARBOHYDRATES AND LIPIDS 4H-2C
PRACTICAL****Instruction hours/week: L:0 T:0 P:4 Marks:Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training:

- On different qualitative methods to estimate glucose
- On different quantitative methods to estimate glucose
- On fermentation techniques
- On isolation methods for lipids
- To understand the quantitative analysis of enzymes involved in carbohydrate metabolism
- To understand the quantitative analysis of enzymes involved in lipid metabolism

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Use different qualitative methods to estimate glucose
2. Use different quantitative methods to estimate glucose
3. Perform fermentation techniques
4. Understand the quantitative analysis of enzymes involved in carbohydrate metabolism
5. Isolate lipid from the given sample
6. Estimate enzymes involved in lipid metabolism

Experiments

1. Estimation of blood glucose.
2. Sugar fermentation of microorganisms.
3. Isolation of lecithin, identification by TLC, and its estimation.
4. Isolation of cholesterol from egg yolk and its estimation.
5. Qw
6. qw
7. Assay of salivary amylase.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1- 4641-0962-1.
2. Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.
3. Berg, J.M., Tymoczko, J.L. and Stryer L., (2012). Biochemistry 7th ed., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

**19BCU312 METABOLISM OF AMINO ACIDS AND NUCLEIC ACIDS 4H-2C
PRACTICAL****Instruction hours/week: L:0 T:0 P:4 Marks:Internal: 40 External: 60 Total: 100****End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training:

- To assay clinically relevant transaminases
- To assess the levels of urea, uric acid and creatinine in urine sample using qualitative methods
- To assess the levels of urea, uric acid and creatinine in urine sample using quantitative methods
- To interpret the results on amino acids and nucleic acids in clinical cases
- To introduce case studies related to amino acid disorders
- To introduce case studies related to nucleic acid disorders

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Assay clinically relevant transaminases
2. Assess the levels of urea, uric acid and creatinine in urine sample using qualitative methods
3. Assess the levels of urea, uric acid and creatinine in urine sample using quantitative methods
4. Interpret the results on amino acids and nucleic acids in clinical cases
5. Understand case studies related to amino acid disorders
6. Understand case studies related to nucleic acid disorders

Experiments

1. Assay of serum transaminases – SGOT
2. Assay of serum transaminases – SGPT.
3. Estimation of serum urea.
4. Estimation of serum uric acid.
5. Estimation of serum creatinine.
6. Estimation of serum Bilirubin.
7. Case studies.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4 / BRV ISBN: 978-0-470-60152-5.

Course Objectives

To impart hands-on training:

- To analyze the composition of lipids in animal cell (RBC)
- To analyze the composition of lipids in plant cell
- On CMC determination and its significance
- To separate the photosynthetic pigments using TLC
- On techniques related to isolation of membrane bound enzymes
- On techniques related to quantification of membrane bound enzymes

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Analyze the composition of lipids in animal cell (RBC)
2. Analyze the composition of lipids in plant cell
3. Determine CMC for the given sample
4. Separate the photosynthetic pigments using TLC
5. Isolate membrane bound enzymes
6. Perform quantification of membrane bound enzymes

Experiments

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. RBC ghost cell preparation and to study the effect of detergents on membranes.
4. Separation of photosynthetic pigments by TLC.
5. Isolation of mitochondria from liver and assay of marker enzyme SDH.
6. Study photosynthetic O₂ evolution in hydrilla plant.
7. Isolation of chloroplast from spinach leaves, estimation of chlorophyll.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013) Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., (2013). Molecular Cell Biology 7th ed., W.H. Freeman & Company (New York), ISBN:13: 978-1-4641-0981-2.
3. Garret, R. H. and Grisham, (2010). Biochemistry 4th ed., C.M., Cengage Learning (Boston), ISBN-13: 978-0-495-11464-2.
4. Voet, D.J., Voet, J.G. and Pratt, C.W., (2008). Principles of Biochemistry 3rd ed., John Wiley & Sons, Inc. (New York), ISBN:13: 978.

Course Objectives

Equip the students:

- On maintenance of safety documents
- On the preparation of SOPs
- On the detection of radioisotopes
- Interpretation of virtual lab experiment
- Different methods of centrifugation (differential/density gradient)
- Determination of pKa for biological buffers using Henderson-Hasselbach equation

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Maintain safety documents
2. Prepare SOPs
3. Detect radioisotopes
4. Interpret virtual lab experiments
5. Use different methods of centrifugation (differential/density gradient)
6. Determine pKa for biological buffers using Henderson-Hasselbach equation in a given situation

Unit I: Biochemical reagents and solutions

Good laboratory practices: Quality concepts, personal protective equipment. General safety-biological safety, chemical safety and fire safety. Principles of GLP: Test Facility Organization and Personnel, Test Systems, Test and Reference Items, Standard Operating Procedures. Preparation and storage of solutions. Concepts of solution concentration (molarity, molality, normality) and storing solutions. Proper techniques on the use of a pipette, volumetric flask. Use, calibration and maintenance of micropipette.

Unit II: Buffers

Concept of a buffer, buffers solutions, pH indicator, Henderson-Hasselbach equation, working of a pH meter. Measurement of pH – glass electrode, pH scale.

Colorimetry: Colour and absorption spectra. Beer Lamberts – deviation from Beer's law. Working of single cell photoelectric colorimeter. Measurement of extinction. Calibration curve.

Unit III: Spectrophotometric techniques

Principle, instrumentation and applications of UV-visible and fluorescence, FT-IR, NIR, Nuclear Magnetic Resonance (NMR) spectroscopy. Spectroscopy in clinical diagnosis, Raman spectra in clinical diagnosis.

Centrifugation techniques: Principles and techniques of preparative and analytical centrifuge.

Unit IV: Radioactive Isotopes

Radioactive decay, units of radioactivity, detection and measurement of radioactivity – GM counter, Scintillation counter, Autoradiography, biochemical applications of radioisotopes.

Unit V: Virtual labs

Objectives, salient features, the role of Virtual Laboratories in Science Education. Introduction and importance of virtual labs in Biochemistry. Virtual lab for immunological techniques.

SUGGESTED READING

1. Jayaraman, J., (2007). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.
2. Sadasivam, S., and Manickam, A., (2009). Biochemical Methods, New Age, International Publishers, New Delhi.
3. Sheehan, D., (2010). Physical Biochemistry: Principles and Applications 2nd ed., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
4. Freifelder, D., (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
5. Plummer D. T., (1998). An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Instruction hours/week: L: 3 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

Equip the students:

- On understanding of the principles and concepts of genetics
- On the concepts of genetic disorders
- On the concepts of different types of mutations (inversions, deletions, duplications and translocations)
- On understanding the structure-function relationship of a specific gene
- On different model systems to study hereditary concepts
- On pedigree analysis

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the principles and concepts of genetics
2. Understand the basis of genetic disorders
3. Comprehend different types of mutations (inversions, deletions, duplications and translocations)
4. Understand the structure-function relationship of a specific gene
5. Use appropriate model systems to study hereditary concepts
6. Perform pedigree analysis

Unit I: Model organisms, Mendelism and chromosomal basis of heredity

Model organisms: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Caenorhabditis elegans*, *Danio rerio* and *Arabidopsis thaliana*, Basic principles of heredity. Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.

Unit II: Extensions of Mendelism, genetics of a gene, bacteria and viruses

Allelic variation and gene function- dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy gene interaction- epistatic and non-epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy. Complementation test, limitations of *cis-trans* test, intragenic complementation, rII locus of phage T4 and concept of cistron. Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

Unit III: Genetics of eukaryotes and Human pedigree analysis

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in *Drosophila*, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes. Pedigree conventions, characteristics of dominant and recessive inheritance. Applications of pedigree analysis.

Unit IV: Developmental genetics, epigenetics and chromosomal aberrations

Model organism for genetic analysis, *Drosophila* development, maternal effect genes, morphogens and zygotic gene activity in development, sex chromosomes and sex determination, dosage compensation of X-linked genes. Extra nuclear inheritance, tests for organelle heredity and maternal effect, epigenetic mechanisms of transcriptional regulation & genomic imprinting. Variations in chromosome number- monosomy and trisomy of sex and autosomes. Variations in chromosome structure- inversions, deletions, duplications and translocations.

Unit V: Complex traits inheritance, population & evolutionary genetics

Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hardy- Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle. Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

SUGGESTED READING

1. Snustad, D.P., and Simmons, M.J., (2012). Genetics 6th ed., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Pierce, B.A., (2012). Genetics - A Conceptual Approach 4th ed., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.
3. Griffiths, A.J.F., Wessler, S. R., Carroll, S. B., and Doebley, J., (2010). An Introduction to Genetic Analysis 10th ed., W.H. Freeman & Company (New York), ISBN:10: 1-4292-2943-8.

Course Objectives

To impart hands-on training:

- On the strength of concentrated acids
- On serial dilution of concentrated solutions
- How to determine the molar extension coefficient?
- How to obtain UV spectrum for a given compound?
- How to quantify nucleic acids using spectrophotometer?
- How to estimate the purity of nucleic acids

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Know the strength of laboratory acids and bases
2. Prepare serial dilution of concentrated solutions
3. Determine the molar extension coefficient
4. Obtain UV spectrum for a given compound
5. Quantify nucleic acids using spectrophotometer
6. Assess the purity of nucleic acids

Experiments

1. Preparation of a molar solutions
2. Preparation of normal solutions
3. Preparation of percentage and ppm solutions.
4. Preparation of dilute acids from concentrated acids
5. Preparation of various dilute solutions
6. Conversion of milli equivalent solution to milli molar equivalent solution (eg- KCl, MgSO₄)
7. Preparation of a buffer of given pH and molarity.
8. Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule).
9. Measurement of UV spectrum of compounds .
10. Determination of concentration of a protein solution by Lowry/BCA method.
11. Determination of nucleic acid concentration and purity

SUGGESTED READING

1. Jayaraman, J., (2007). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.
2. Sadasivam, S., and Manickam, A., (2009). Biochemical Methods, New Age, International Publishers, New Delhi.
3. Plummer D. T., (1998). An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Course Objectives

To impart hands-on training:

- Sex determination
- On the method of induction of polyploidy
- On utility of buccal epithelial cells for genetic assessments
- On verification of Monohybrid crosses.
- On calculation of allele and genotype frequencies
- On plasmid conjugation in bacteria (transformation)

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Execute sex determination
2. Understand induction methods of polyploidy
3. Use buccal epithelial cells for genetic assessments
4. Understand monohybrid crosses.
5. Calculate allele and genotype frequencies
6. Understand bacterial transformation

Experiments

1. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
2. Induction of polyploidy in onion roots.
3. Smear technique to demonstrate sex chromatin in buccal epithelial cells.
4. Monohybrid crosses in *Drosophila* for studying autosomal and sex-linked inheritance.
5. PTC testing in a population and calculation of allele and genotype frequencies.
6. Study of abnormal human karyotype and pedigrees (dry lab).
7. Conjugation in bacteria.

SUGGESTED READING

1. Snustad, D.P., and Simmons, M.J., (2012). Genetics 6th ed., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Pierce, B.A., (2012). Genetics - A Conceptual Approach 4th ed., W.H. Freeman & Co. (New York), ISBN: 13:978-1-4292-7606-1 / ISBN: 10:1-4292-7606-1.
3. Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., (2010). An Introduction to Genetic Analysis 10th ed., W.H. Freeman & Company (New York), ISBN: 10: 1-4292-2943-8.

Instruction hours/week: L:4 T:0 P:0 Marks:Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

Equip the students:

- On the genome organization
- To study the mechanism of replication DNA in prokaryotes
- To study the mechanism of replication DNA in eukaryotes
- To study the mechanism of transcription in both prokaryotes and eukaryotes
- To understand the mechanism of recombination and transposition of DNA
- To understand DNA damage, mutation and DNA repair process

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the genome organization
2. Understand the mechanism of replication DNA in prokaryotes
3. Understand the mechanism of replication DNA in eukaryotes
4. Understand the mechanism of transcription in both prokaryotes and eukaryotes
5. Understand the basis of recombination and transposition of DNA
6. Understand DNA damage, mutation and DNA repair process

Unit I: Structure, Genes and genomic organization of DNA

DNA structure, features of the double helix, various forms of DNA, denaturation and reassociation of DNA. Genes and genomic organization - Genome sequence and chromosome diversity, definition of a gene, organization of genes in viruses, bacteria, animals and plants. Nucleosome structure and packaging of DNA into higher order structures.

Unit II: Replication of DNA in Prokaryotes

The chemistry of DNA synthesis, DNA polymerase, the replication fork, origin of replication, enzymes and proteins in DNA replication, various modes of replication, stages of replication of *E. coli* chromosome, relationship between replication and cell division,

Unit3: Replication of DNA in Eukaryotes

Replication in eukaryotes. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine. Supercoiling of DNA and its importance, topoisomerases, critical role of topoisomerases in cell, topoisomerase inhibitors and their application in medicine.

Unit IV: Recombination and transposition of DNA

Homologous recombination, proteins and enzymes in recombination, site-specific recombination, serine and tyrosine recombinases, biological roles of site-specific recombination, transposition, three classes of transposable elements, importance of

transposable elements in horizontal transfer of genes and evolution.

Unit V: Molecular basis of mutations and DNA repair

Importance of mutations in evolution of species. Types of mutations - transition, transversions, frame shift mutations, mutations induced by chemicals, radiation, transposable elements, Ames test. Various modes of DNA repair - Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, translation DNA synthesis.

SUGGESTED READING

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., (2008). Molecular Biology of the Gene 6th ed., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN:978-0-321-50781-5.
2. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
3. Snustad, D.P., and Simmons, M.J., (2010). Principles of Genetics 5th ed., John Wiley & Sons Asia, ISBN:978-0-470-39842-5.
4. Harvey Lodish, Arnold Berk, S Lawrence Ziporsky, Paul Matsudaira, David Baltimore and James Darnell., (2000). Molecular Cell Biology 4th ed., W. H. Freeman & Company (New York), ISBN: 0-7167-3136-3.

Instruction hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

Course Objectives

Equip the students:

- To utilize stages of transcription for drug development
- To understand the stages of RNA biosynthesis
- To understand the antibiotics mechanism of action and applications in medicine
- To understand the specialized system for protein degradation
- To gain knowledge on RNA interference in the treatment of HIV and Cancer
- To gain knowledge on DNA repair mechanisms

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the mechanism of action of drugs
2. Understand the stages of RNA biosynthesis
3. Understand the mechanism of action of broad spectrum and specific antibiotics
4. Utilize the specialized system for protein degradation
5. Gain knowledge on RNA interference in the treatment of HIV and Cancer
6. Gain knowledge on DNA repair mechanisms.

Unit I: Biosynthesis of RNA in prokaryotes

RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA foot-printing, the three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as anti-microbial drugs.

Unit II: Biosynthesis of RNA in eukaryotes

Comparison between prokaryotic and eukaryotic transcription. Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, various types of RNA processing, transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their applications. Comparison of fidelity of transcription and replication. **RNA splicing-** Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling, RNA editing.

Unit III: Biosynthesis of proteins

The genetic code-Degeneracy of the genetic code, wobble in the anticodon, features of the genetic code, nearly universal code. **Biosynthesis of proteins-** Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome - initiation, elongation and termination of translation, regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Use of antibiotics in understanding protein synthesis and applications in medicine. **Protein targeting and degradation** - Post translational modifications, glycosylation, signal sequences for nuclear transport, bacterial signal sequences, import of proteins by receptor mediated endocytosis, specialized systems for

protein degradation.

Unit IV: Regulation of gene expression in prokaryotes

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains -, regulation of lac operon and trp operon, induction of SOS response, synthesis of ribosomal proteins, regulation by genetic recombination, transcriptional regulation in λ bacteriophage.

Unit V: Regulation of gene expression in eukaryotes

Heterochromatin, euchromatin, chromatin remodeling, regulation of galactose metabolism in yeast, regulation by phosphorylation of nuclear transcription factors, regulatory RNAs, riboswitches, RNA interference, synthesis and function of miRNA molecules, phosphorylation of nuclear transcription factors.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., (2008). Molecular Biology of the Gene 6th ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.

Instruction hours/week: L:3 T:1 P:0 Marks:Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

Equip the students:

- On the concept of homeostasis
- On the physiological functioning of cardiovascular system
- On the physiological functioning of renal system
- On the physiological functioning of gastro-intestinal and hepatic system
- On the physiological functioning of muscular skeletal system
- On the physiological functioning of reproductive system

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the concept of homeostasis
2. Understand the physiological functioning of cardiovascular system
3. Understand the physiological functioning of renal system
4. Understand the physiological functioning of gastro-intestinal and hepatic system
5. Understand the physiological functioning of muscular skeletal system
6. Understand the physiological functioning of reproductive system

Unit I: Homeostasis and the organization of body fluid compartments

Intracellular, extracellular and interstitial fluid. Homeostasis, control system and their components. Plasma as an extracellular fluid, RBC, molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Anemias, polycythemia, haemophilia and thrombosis.

Respiration :Organization of the pulmonary system. Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport. Regulation of respiration. Pulmonary oedema and regulation of pleural fluid. Hypoxia, hypercapnea, pulmonary distress, emphysema, ARDS.

Unit II: Cardiovascular physiology

Pressure, flow and resistance. Anatomy of heart. Physiology of the cardiac muscle, automaticity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction.

Unit III: Renal physiology

Anatomy of the kidney and the nephron. Regulation of renal blood flow. Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Micturition reflex and voluntary control of micturition. Regulation of ECF electrolyte and water content, blood volume and long

term blood pressure. Blood buffer systems, renal and pulmonary control of blood pH, renal clearance. Assessment of kidney function. Acidosis and alkalosis. Glomerular nephritis, renal failure, dialysis and diuretics.

Unit IV: Gastrointestinal and hepatic physiology

Histology of the gastrointestinal tract. Propulsion and motility of food and digested material. Enteric reflexes, secretory functions of the gastrointestinal tract, digestion and absorption of macro and micronutrients. Peptic ulcer, Sprue, celiac disease, IBD, regurgitation, diarrhoea and constipation. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. enterohepatic cycle, reticuloendothelial system, metabolic importance of liver. Liver function tests. Jaundice, liver cirrhosis and fatty liver.

Musculoskeletal system :Bone structure and formation. Physiology of muscle contraction in striated and non-striated muscle.

Unit V: Reproductive physiology

Sex determination and differentiation. Development of female and male genital tracts. Spermatogenesis, capacitation and transport of sperm, blood testis barrier. Ovarian function and its control. Uterine changes, fertilization and implantation. Placenta as a feto- maternal unit, gestation and parturition.

Neurochemistry and neurophysiology: Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Membrane potentials. Synaptic transmission. Neurotransmitters. Sensory receptors and neural pathways. Somatic sensation, EEG, sleep, coma, learning and memory.

SUGGESTED READING

1. Chatterjee, C.C., (2012). Human Physiology, 11th edition, Mical Alli Agency, Calcutta.
2. Saradha, S., (2004). Textbook of Human Physiology, S. Chand and Company, New Delhi.
3. Guyton, C., and Hall, J.E., (2010). Textbook of Medical Physiology, 12th Edition. Prism Indian edition, W.B. Saunders Company, New Delhi.
4. Murray, R.K., Bender, D.A., Botham, K.M., and Kennelly, P.J., (2012). Harper's illustrated Biochemistry, 29th edition.. McGraw-Hill Medical. London.

**19BCU411 GENE ORGANISATION, REPLICATION AND REPAIR 4H-2C
PRACTICAL****Instruction hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100****End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training on:

- The isolation of prokaryotic chromosomal DNA
- The isolation of eukaryotic chromosomal DNA
- Determination of melting temperature for the given nucleotide sequence
- Concepts of hyper and hypo chromicity
- Determination of viscosity
- Verification of Chargaff's rule (purine=pyrimidine)

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Isolate prokaryotic chromosomal DNA
2. Isolate eukaryotic chromosomal DNA
3. Determine the melting temperature for the given nucleotide sequence
4. Know the concepts of hyper and hypo chromicity
5. Determine the viscosity of DNA
6. Verify Chargaff's rule (purine=pyrimidine)

Experiments

1. Isolation of chromosomal DNA from *E. coli* cells.
2. Isolation of chromosomal RNA from *E. coli* cells.
3. Ultraviolet absorption spectrum of DNA and RNA.
4. Determination of DNA and RNA concentration by A₂₆₀nm.
5. Determination of the melting temperature and GC content of DNA.
6. A study on the viscosity of DNA solutions.
7. Verification of Chargaff's rule by paper chromatography.

SUGGESTED READING

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., (2008). Molecular Biology of the Gene 6th ed., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN:978-0-321-50781-5.
2. Nelson, D.L., and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
3. Snustad, D.P., and Simmons, M.J., (2010). Principles of Genetics 5th ed., John Wiley & Sons Asia, ISBN:978-0-470-39842-5.

Course Objectives

To impart hands-on training:

- To analyze total nucleic acids from plant tissue
- To analyze total nucleic acids from animal tissue
- To isolate mRNA using affinity chromatography
- On the synthesis of cDNA
- On the gene expression using RT-PCR
- To study Lac Operon

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Estimate total nucleic acids from plant tissue
2. Estimate total nucleic acids from animal tissue
3. Isolate mRNA using affinity chromatography
4. Synthesize cDNA
5. Perform RT-PCR
6. Test Lac Operon in E. coli cells

Experiments

1. Extraction of total nucleic acids from plant tissue.
2. Extraction of total nucleic acids from animal tissue.
3. Isolation of mRNA from yeast by affinity chromatography.
4. cDNA synthesis.
5. Assessment of gene expression using RT-PCR.
6. Induction of Lac Operon.

SUGGESTED READING

1. Nelson, D.L., and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., (2008). Molecular Biology of the Gene 6th ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.

Instruction hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

To impart hands-on training on:

- Counting of different cell types using microscopy
- Estimation of haemoglobin in the given blood sample
- Determination of the group of the given blood sample
- Separation of isoenzymes by electrophoresis
- Measurement of blood pressure using sphygmomanometer
- Fixing and staining of microtome sections of tissues for histopathology observations

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Count of different cell types (RBC, WBC) using microscopy
2. Perform the estimation of haemoglobin in the given blood sample
3. Perform and identify the grouping (ABO and Rh) of the given blood sample
4. Separate isoenzymes by electrophoresis
5. Perform blood pressure measurement using sphygmomanometer
6. Perform fixing and staining of microtome sections of tissues for histopathology observations

Experiments

1. Hematology.
 - a. RBC and WBC counting
 - b. Differential leucocyte count.
 - c. Clotting time.
 - d. Bleeding time
2. Estimation of haemoglobin.
3. Determination of blood groups
4. Separation of plasma proteins (Group Experiment).
5. Determination of total iron binding capacity.
6. Pulmonary function tests, spirometry and measurement of blood pressure.
7. Separation of isoenzymes by electrophoresis (Group Experiment).
8. Histology of connective tissue, liver and/ brain - permanent slides.
9. Case studies (Renal clearance, GFR, ECG).

SUGGESTED READING

1. Rajan, S., (2012) Manual for Medical laboratory technology, First edition. Anjana Book House, Chennai.
2. Rao, B.S. and Deshpande, V., (2005). Experimental Biochemistry: A Student Companion IK International Pvt. Ltd. (New Delhi), ISBN:81-88237-41-8.

Course Objectives

Equip the students:

- To understand basis and importance of bioinformatics and computer aided drug design
- To get exposed to different types of biological databases
- To look at a biological problem from a computational point of view
- To find out the methods for analyzing the expression, structure and function of proteins, and understanding the relationships between species
- To get knowledge on different methods for construction of a phylogenetic tree
- About the basics and importance of Proteomics and Genomics

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the basics of computer aided drug design
2. Perform experiment pair wise and multiple sequence alignment and will analyze the secondary and tertiary structures of protein sequences
3. Understand the data structure (databases) used in bioinformatics and interpret the information
4. Perform search on protein and metabolic pathway databases
5. Perform BLAST to identify the sequence of amino acids
6. Construct a phylogenetic tree using bioinformatics

Unit I: Introduction to bioinformatics

Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches) and Systems Biology. Applications of bioinformatics.

Unit II: Biological databases and data retrieval

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (RasMol, J mol), file formats.

Unit III: Sequence alignment

Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW.

Unit IV: Phylogenetic analysis

Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods.

Unit V: Protein structure prediction analysis and gene prediction

Levels of protein structure. Protein tertiary structure prediction methods –homology modeling, fold recognition and *ab-initio* methods. Significance of Ramachandran map. Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, gene prediction methods and tools.

SUGGESTED READING

1. Mount, D.W., (2001). Bioinformatics: Sequence and Genome Analysis 1st ed., Cold Spring Harbor Laborator Press (New York), ISBN: 0-87969-608-7.
2. Pevsner, J., (2003). Bioinformatics and Functional Genomics (2003), 1st ed., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47121004-8.
3. Baxevanis, A.D., and Ouellette, B.F., (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd ed., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-4.
4. Ghosh, Z., and Mallick, B., (2008). Bioinformatics – Principles and Applications (2008), 1st ed. Oxford University Press (India), ISBN: 9780195692303.

Course Objectives

Equip the students on:

- The basic principles involved in protein purification
- The basic chemical methods used for protein separation
- The principle, working and applications of different chromatographic techniques for protein characterization
- The principle, working and applications of different electrophoretic techniques for protein purification.
- The principle and applications of dialysis
- Advanced protein purification techniques

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Understand the basic principles pertaining to protein purification
2. Perform gel exclusion, affinity and ion exchange chromatography for protein purification
3. Perform SDS PAGE and identify the molecular weight of the protein
4. Understand the principle, instrumentation and applications of HPLC
5. Perform dialysis technique
6. Identify and apply appropriate techniques for purification of the given protein sample

Unit I: Salting in and salting out

Salting in and salting out- Principle, Debye-Huckel theory, Hofmeister series, Ionic strength, Ammonium sulfate precipitation, applications

Unit II: Gel exclusion Chromatography

Gel exclusion Chromatography- Principle, instrumentation and applications of gel exclusion chromatography, data analysis Advantages and disadvantages. **Affinity, Ion exchange chromatography – Principle, Instrumentation, and applications.**

Unit III: Polyacrylamide gel electrophoresis

Polyacrylamide gel electrophoresis- Principle, instrumentation and applications of PAGE. Gel polymerization- APS, TEMED. Separation and determination of molecular weight of proteins SDS, running gel, stacking gel, electrophoresis buffer.

Unit IV: HPLC

HPLC -Principle, instrumentation and applications of HPLC. Preparation of column, adsorbent materials, void volume, efficiency factor. Van Deemter equation Applications- Manufacturing, legal, research and medical. **Fast Protein Liquid Chromatography - Principle, Instrumentation, and applications**

Unit V: Dialysis

Dialysis- Principle and types- Hemodialysis, pediatric, intestinal and peritoneal dialysis.

Dialyzable substances. Medical applications.

SUGGESTED READING

1. Sheehan, D., (2010). Physical Biochemistry: Principles and Applications 2nd ed., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. Freifelder, D., (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
3. Plummer D. T., (1998). An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10:0-07-099487-0
4. Jayaraman, J., (2007). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.
5. Sadasivam, S.,and Manickam, A., (2009). Biochemical Methods, New Age, International Publishers, New Delhi.

Instruction hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training on:

- Sequence retrieval from NCBI database
- Searching Protein and DNA structure from PDB
- Different molecular file formats for saving a protein/DNA sequence
- Different sequence alignment databases.
- Applying the statistical approaches and models for phylogenetic analysis and tree reconstruction.
- Different protein structure prediction databases

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Be able to retrieve a sequence from NCBI database
2. Be able to search a protein from PDB
3. Understand the different molecular file formats for saving a protein/DNA sequence
4. Apply different sequence alignment databases such as BLAST and CLUSTALW.
5. Apply the statistical approaches and models for phylogenetic analysis and tree reconstruction.
6. Analyze and predict the protein structure using structure prediction databases

Experiments**1. Biological databases and data retrieval**

Sequence retrieval (protein and gene) from NCBI.

Structure download (protein and DNA) from PDB.

Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot, FIR.

Molecular viewer by visualization software.

2. Sequence alignment

BLAST suite of tools for pairwise alignment.

Multiple sequence alignment using CLUSTALW.

3. Phylogenetic analysis

Generating phylogenetic tree using PHYLIP.

4. Protein structure prediction and analysis

Primary sequence analyses (Protparam).

Secondary structure prediction (GOR, nnPredict, SOPMA).

Tertiary structure prediction (SWISSMODEL).

Protein structure evaluation - Ramachandran map (PROCHECK).

5. Gene structure prediction and analysis

Gene prediction using GENSCAN and GLIMMER.

SUGGESTED READING

1. Mount, D.W., (2001). Bioinformatics: Sequence and Genome Analysis 1st ed., Cold Spring Harbor Laborator Press (New York), ISBN: 0-87969-608-7.
2. Pevsner, J., (2003). Bioinformatics and Functional Genomics 1st ed., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47121004-8.
3. Baxevanis, A.D., and Ouellette, B.F., (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins 3rd ed., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-4.
4. Ghosh, Z., and Mallick, B., (2008). Bioinformatics – Principles and Applications 1st ed. Oxford University Press (India), ISBN: 9780195692303.

Instruction hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training on:

- Instrumentation of different protein purification methods
- The basic chemical methods used for protein separation
- The principle, working and applications of different chromatographic techniques for protein characterization
- The principle, working and applications of different electrophoretic techniques for protein purification.
- The principle and applications of dialysis
- Advanced protein purification techniques

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Gain knowledge on the basic principles pertaining to protein purification
2. Perform gel exclusion, affinity and ion exchange chromatography for protein purification
3. Perform SDS PAGE and identify the molecular weight of the protein
4. Understand the principle, instrumentation and applications of HPLC
5. Perform dialysis techniques for protein separation
6. Identify and apply appropriate techniques for purification of the given protein sample

Experiments

1. Preparation of the sample and ammonium sulfate precipitation of protein.
2. Ion-exchange chromatography.
3. Gel filtration chromatography.
4. Paper chromatography /TLC.
5. Electrophoresis.

SUGGESTED READING

1. Jayaraman, J., (2007). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi.
2. Sadasivam, S., and Manickam, A., (2009). Biochemical Methods, New Age, International Publishers, New Delhi.
3. Sheehan, D., (2010). Physical Biochemistry: Principles and Applications 2nd ed., Wiley

Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.

4. Freifelder, D., (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
5. Plummer D. T., (1998). An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10:0-07-099487-0.

Instruction hours/week: L:3 T:1 P:0 Marks:Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

Equip the students on:

- The fundamentals of hormones and receptors
- Different mechanisms of hormonal actions
- Understanding of physiological and biochemical actions of hypothalamic, thyroid and pituitary hormones
- The role and applications of gastrointestinal hormones
- Understanding the clinical significance of adrenal and gonadal hormones
- Understanding of various endocrine disorders

Course Outcomes (CO's)

After successful completion of the course, the student will:

1. Gain knowledge on functions, classification and transport of hormones
2. Understand the role of secondary messengers, effector systems and protein kinases, tyrosine kinases in hormonal action
3. Have knowledge on the biochemical action and regulation of various endocrine hormones
4. Understand the role and applications of gastrointestinal hormones
5. Have knowledge on the role and functions of adrenal and gonadal hormones
6. Be able to identify an endocrine disorder if symptoms are available

Unit I: Introduction to hormones and receptors

Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology. Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins

Unit II: Mechanisms of hormonal actions

Second messengers - cAMP, cGMP, IP₃, DAG, Ca²⁺, NO. Effector systems - adenylate cyclase, guanylate cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Growth factor signaling, PDGF, EGF, IGF-II, and erythropoietin. Receptor tyrosine kinases - EGF, insulin, erythropoietin receptor; ras - MAP kinase cascade, JAK - STAT pathway. Steroid hormone/ thyroid hormone receptor mediated gene regulation. Receptor regulation and cross talk.

Unit III: Hypothalamic, pituitary and thyroid hormones

Hypothalamic - pituitary axis. Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus. Thyroid gland. Biosynthesis

of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology - Goiter, Graves disease, cretinism, myxedema, Hashimoto's disease.

Unit IV: PTH, calcitonin and gastrointestinal hormones

PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis. Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adiponectin, leptin and ghrelin. Summary of hormone metabolite control of GI function. Physiological and biochemical action. Pathophysiology - diabetes type I and type II.

Unit V: Adrenal and gonadal hormones

Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. Fight or flight response, stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome. Male and female sex hormones. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Hormone based contraception.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman & Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
2. Widmaier, E.P., Raff, H., and Strang, K.T., (2008). Vander's Human Physiology 11th ed., McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
3. Hadley, M.C., and Levine, J.E., (2007). Endocrinology 6th ed., Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
4. Cooper, G.M., and Hausman, R.E., (2009). The Cell: A Molecular Approach 5th Ed. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893-300-6.

Course Objectives

Equip the students on:

- Organization of clinical laboratory
- Specimen collection
- Precision, accuracy
- Quality control
- Automated systems
- Assessment of organ functions

Course Outcomes (CO's)

After successful completion of the course, the student will

1. Know about organization of clinical laboratory
2. Specimen collection
3. Precision, accuracy calculations
4. Quality control
5. Automated systems
6. Know to use the diagnosis to assess organ functioning

Unit I: Introduction

Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations.

Unit II: Evaluation of biochemical changes in diseases

Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. **Thyroid profile.**
Gastric, Pancreatic & Intestinal function.

Unit III: Assessment of glucose metabolism in blood

Clinical significance of variations in blood glucose. Diabetes mellitus.

Lipid profile

Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein.

Unit IV: Liver function tests

Serum enzymes in liver disease- Serum transaminases (SGOT and SGPT), and phosphatases.

Renal function tests - Introduction, clinical significance of GGT, LDH and creatine phosphokinase in kidney function.

Urine analysis - Physical examination of urine

Disorders of thyroid profile and Bilirubin metabolism

Unit V: Tests for cardiovascular diseases

Tests for cardiovascular diseases– ECG, Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin.

Tumour markers for diagnosing various cancers – AFB and CEA

Disorders of Bilirubin metabolism.Coagulation tests

SUGGESTED READING

1. Mukherjee, K.L., (2010). Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I (2010), Tata Mc Graw–Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631
2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.
3. Baynes, J.W. and Dominiczak, M.H., (2005). Medical Biochemistry 2nd ed., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.
4. Rao, B.S. and Deshpande, V., (2005). Experimental Biochemistry: A Student Companion IK International Pvt. Ltd. (New Delhi), ISBN:81-88237-41-8.

Course Objectives

Equip the students with:

- Inborn errors of metabolism
- Nutritional disorders
- Life style disorders
- Autoimmune diseases
- Contagious diseases
- Vaccine strategies

Course Outcomes (CO's)

After successful completion, the students will understand:

1. Inborn errors of metabolism
2. Nutritional disorders
3. Life style disorders
4. Autoimmune diseases
5. Contagious diseases
6. Vaccine strategies

Unit I: Inborn errors of metabolism

Alkaptonuria, Phenylketonuria, Glycogen and Lipid storage diseases, SCID, Clotting disorders.

Unit II: Nutritional deficiency based diseases

Kwashiorkor, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindness, Rickets, Osteomalacia, Osteoporosis, Wilson's disease.

Unit III: Life style diseases

Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes mellitus-II. Inflammatory Bowel Disease (IBD).

Hormonal Imbalances

Outline of hormone action and imbalances leading to disease - precocious puberty, hyper and hypopituitarism. Hyper and hypothyroidism.

Unit4: Autoimmune diseases

Concepts in immune recognition - self and non self discrimination, organ specific autoimmune diseases – Hashimoto's thyroiditis, Grave's disease, myasthenia gravis;. Systemic diseases - SLE, rheumatoid arthritis; Diabetes Mellitus-I.

Diseases caused due to misfolded proteins

Alzheimer's, Huntington's disease, Kuru, Creutzfeldt-Jakob disease, Sickle cell anaemia, Thalassemia.

Unit V: Infectious diseases

Viral infection (polio, measles, mumps, influenza, HIV); Bacterial infections (tetanus, diphtheria, tuberculosis, typhoid, cholera); Protozoan (*Plasmodium* and *Trypanosoma*) and parasitic infections. Vaccines against diseases. General strategies in the design and development of vaccines.

SUGGESTED READING

1. Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Coico, R., and Sunshine, G., (2009). Immunology: A Short Course. 6th ed., John Wiley & sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Berg, J.M., Tymoczko, J.L. and Stryer, L., (2012). Biochemistry. 7th ed., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
4. Snustad, D.P. and Simmons, M.J., (2012). Genetics. 6th ed., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

Course Objectives

Equip the students with:

- Origin of microbiology field and theories
- Diverse nature of microbial organisms
- Life cycle of viruses
- Life cycle of bacteria
- Life cycle of algae, fungi and protozoa

Course Outcomes (CO's)

After successful completion, the students will understand:

1. Origin of microbiology field and theories
2. Diverse nature of microbial organisms
3. Life cycle of viruses
4. Life cycle of bacteria
5. Life cycle of algae, fungi and protozoa
6. Emerging microbial threats

Unit I: History of Development of Microbiology

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit II: Diversity of Microbial world

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit III: Viruses, viroids and prions

An introduction to viruses with special reference to the structure and replication of the following: Poxvirus, Poliovirus, HIV, T4 and λ phage, lytic and lysogenic cycles.

Unit IV: Bacteria

An account of typical eubacteria, chlamydiae and rickettsiae (obligate intracellular parasites), mycoplasma, and archaeobacteria (extremophiles). Applications of bacteria in industry, environment and food.

Unit V: Algae, Fungi and Protozoa

History of phycology; General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Applications of Algae in agriculture, industry, environment and food. Historical developments in the field of Mycology, significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance of Fungi in Agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins. General characteristics with special reference to Amoeba.

SUGGESTED READING

1. Powar, C.B., and Dahinwala, H.F., (2007). General Microbiology, Himalaya Publishing house, Mumbai.
2. Prescott, L.J., and Klein, D., (2007). Microbiology, 7th edition McGraw Hill Publishers, London.
3. Pelzar, A., (2004). Microbiology, McGraw Hill Publishers, London
4. Atlas, R.M., (1997). Principles of Microbiology. 2nd edition. W M.T.Brown Publishers

Course Objectives

Equip the students with

- Concepts of nutrition
- Calorific value of carbohydrates, fats and proteins
- Recommended dietary allowances
- Nutrition as a strategy to prevent diseases
- Nutrition deficiency disorders
- Food drug interactions

Course Outcomes (CO's)

After successful completion, the students will understand

1. Concepts of nutrition
2. Calorific value of carbohydrates, fats and proteins
3. Recommended dietary allowances
4. Nutrition as a strategy to prevent diseases
5. Nutrition deficiency disorders
6. Food drug interactions

Unit I: Introduction to Nutrition and Energy Metabolism

Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. measurement of energy content of food, Physiological energy value of foods, SDA. Measurement of energy expenditure. Direct and Indirect Calorimetry, factors affecting thermogenesis, energy utilization by cells, energy output – Basal and Resting metabolism, physical activity, factors affecting energy input - hunger, appetite, energy balance Energy expenditure in man. Estimating energy requirements, BMR factors Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit II: Dietary carbohydrates, lipid and health

Review functions of carbohydrates. Digestion, absorption ,utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, Dietary fiber, role of fibre in lipid metabolism, colon function, blood glucose level and GI tract functions.

Review of classification, sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA. Lipotropic factors, role of saturated fat, cholesterol, lipoprotein and triglycerides. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b)

Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids. Dietary implications of fats and oils, Combination ratios of n6 and n3, MUFA, PUFA and SFA.

Unit III: Dietary Proteins and health

Review of functions of proteins in the body, Digestion and absorption. Essential and Non-essential amino acids. Amino Acid Availability Antagonism, Toxicity and Imbalance, Amino acid Supplementation. Effects of deficiency. Food source and Recommended Dietary Allowances for different age group. Amino acid pool. NPU, Biological Value, Nitrogen balance. PEM and Kwashiorkor.

Unit IV: Fat and water soluble Vitamins, Minerals

Vitamin A, C, E, K and D Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C role as cofactor in amino acid modifications. Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP. Vitamin B6- Dietary source, RDA, conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12 and folate; Dietary source, RDA, absorption, metabolic role Biochemical basis for deficiency symptoms. Calcium, Phosphorus and Iron - Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Calcium: Phosphorus ratio, Role of iron in prevention of anemia. Iodine and iodine cycle. Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources

Unit V: Assessment of Nutritional status, Food and drug interactions and Nutraceuticals

Anthropometric measurements; Z scores, BMI, skinfold, circumference ratios. Biochemical assessment; Basal metabolic panel, Comprehensive metabolic panel, CBC, Urine Analysis, Assessment of Anemia, ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate. Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Anti-depressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.

SUGGESTED READING

1. Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Williams, M.H., Anderson, D.E, and Rawson, E.S., (2013). Nutrition for health, fitness and sport. McGraw Hill international edition. ISBN-978-0-07-131816-7.
3. Mahan, L.K. Strings, S.E., and Raymond, J., (2012). Krause's Food and Nutrition Care process. Elsevier's Publications. ISBN- 978-1-4377-2233-8.

4. Coombs, G.F., (2008). The vitamins, Fundamental aspects in Nutrition and Health. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
5. Gibson R., (2005). Principles of Nutritional Assessment. Oxford University Press.

Course Objectives

Equip the students with

- Plant cell structure
- Synthesis of proteins by plants
- Metabolism in plants
- Microenvironment for plant growth
- Nitrogen fixation
- Biosynthesis of secondary metabolites by plants

Course Outcomes (CO's)

After successful completion, the students will understand

1. The difference between Animal and Plant cell structure
2. Significance of plant proteins
3. Metabolism in plants
4. Various microenvironment required for plant growth
5. The process of nitrogen fixation
6. Biosynthesis of secondary metabolites by plants

Unit I: Plant cell structure and Photosynthesis

Structure of Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes. Photosynthesis - Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation.

Unit II: Carbon assimilation and Plant Respiration

Carbon assimilation - Calvin cycle and regulation; C₄ cycle and Crassulacean acid metabolism (CAM). Respiration - Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration and Photorespiration.

Unit III: Nitrogen metabolism

Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase- glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

Unit IV: Regulation of plant growth and Plant tissue culture

Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light. Plant tissue culture - Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

Unit V: Plant Secondary metabolites

Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

SUGGESTED READING

1. Bowsher, C., Steer, M., Tobin, A., (2008). Plant Biochemistry. Garland science ISBN 978-0-8153-4121-5.
2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1st edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.
3. Dey, P.M., and Harborne, J.B., (1997). Plant Biochemistry. Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749

Instruction hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

Equip the students with

- Concept of infection
- Classification of infectious pathogens
- Steps involved in the infection of a pathogenic bacteria
- Steps involved in the infection of a pathogenic viruses
- Steps involved in the infection of a pathogenic parasites
- Methods to prevent/treat infections

Course Outcomes (CO's)

After successful completion, the students will understand

1. Concept of infection
2. Variety of infectious pathogens
3. The process of infection by pathogenic bacteria
4. The process of infection by pathogenic viruses
5. The process of infection by pathogenic parasites
6. How to prevent/treat infections

Unit I: Classification of infectious agents

Bacteria, Viruses, protozoa and fungi. Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens, Antigenic shift and antigenic drift. Host parasite relationship, types of infections associated with parasitic organisms. Overview of viral and bacterial pathogenesis. Infection and evasion.

Unit II: Overview of diseases caused by bacteria

Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Typhoid, Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia.

Unit III: Overview of diseases caused by Viruses

Detailed study of AIDS, history, causative agent, pathogenesis, Diagnostics, Drugs and inhibitors. Other viral diseases including hepatitis, influenza, rabies, chikungunya and polio.

Unit IV: Overview of diseases caused by Parasites

Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including leishmaniasis, amoebiasis.

Unit V: Overview of diseases caused by other organisms

Fungal diseases, General characteristics. Medical importance of major groups, pathogenesis, treatment.

SUGGESTED READING

1. Willey, J.M., Sherwood, L.M., Woolverton, C.J. Prescott, Harley, (2008) Klein's Microbiology 7th Ed., Mc Graw Hill International Edition (New York) ISBN: 978-007-126727.
2. Mandell, Douglas and Bennett, S., (2010). Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.
3. Kenneth, J., Ryan, C., Ray, G., (2010). Sherris Medical Microbiology: An Introduction to Infectious Diseases by Publisher: McGraw-Hill.
4. Patrick R. Murray, Ken S. Rosenthal, Michael A., (2010). Medical Microbiology Elsevier Health Sciences.

Instruction hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

To impart hands-on training on

- Qualitative and quantitative measurement of glucose
- Calcium assessment methods (inorganic)
- Assay of insulin using enzyme linked immunosorbent assay
- Basis of pregnancy detection kit
- Assessments of electrolytes to understand hormonal functioning
- Case studies related to hormonal imbalance

Course Outcomes (CO's)

After successful completion, the students will understand

1. The different Qualitative and quantitative methods of glucose estimation
2. Titrimetric and colorimetric methods for Calcium assessment
3. Enzyme linked immunosorbent assay
4. The principle behind the making of hCG kit and working procedure
5. Assessments of electrolytes to understand hormonal functioning
6. The fundamental defects due to hormonal imbalance

Experiments:

1. Glucose tolerance test.
2. Estimation of serum Ca^{2+} .
3. Estimation of Insulin.
4. hCG based pregnancy test.
5. Estimation of serum electrolytes.
6. Case studies.

SUGGESTED READING

1. Nelson, D.L. and Cox, M.M., (2013). Lehninger: Principles of Biochemistry 6th ed., W.H. Freeman & Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
2. Widmaier, E.P., Raff, H. and Strang, K.T., (2008). Vander's Human Physiology 11th ed., McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
3. Hadley, M.C. and Levine, J.E., (2007). Endocrinology 6th ed., Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
4. Cooper, G.M., and Hausman, R.E., (2009). The Cell: A Molecular Approach 5th Ed. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893-300-6.

Course Objectives

To impart hands-on training on

- Collection and processing of serum
- Collection and processing of urine sample
- Assessment of liver function
- Assessment of renal function
- Assessment of cardiac function
- Principles behind Dipstick method for fast diagnosis

Course Outcomes (CO's)

After successful completion, the students will understand

1. How to collect and process serum/plasma samples
2. How to collect and process urine samples
3. Assessment of liver function
4. Assessment of renal function
5. Assessment of cardiac function
6. Principles behind Dipstick method for fast diagnosis

Experiments

1. Collection of blood and storage.
2. Separation and storage of serum.
3. Estimation of blood glucose by glucose oxidase peroxidase method.
4. Estimation of triglycerides.
5. Estimation of bilirubin (direct and indirect).
6. Quantitative determination of serum creatinine and urea.
7. Estimation of creatine kinase.
8. Physical Examination of urine.
9. Use of urine strip / dipstick method for urine analysis.

SUGGESTED READING

1. Mukherjee, K.L., (2010). Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I Tata Mc Graw-Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631
2. Mukherjee, K.L., (2010). Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests. Vol. II, Tata Mc Graw - Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.
3. Baynes, J.W., and Dominiczak, M.H., (2005). Medical Biochemistry, 2nd ed., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.
4. Rao, B.S., and Deshpande, V., (2005). Experimental Biochemistry: A Student Companion IK International Pvt. Ltd. (New Delhi), ISBN:81-88237-41-8.

Course Objectives

To impart hands-on training on

- The execution of glucose challenge and tolerance test
- Measurement of cholesterol
- Basis of cell counting using hemocytometer
- Principles behind automated cell counters
- Assessment of bone mineral density
- Measurement of thyroid hormones using ELISA

Course Outcomes (CO's)

After successful completion, the students will understand

1. Glucose challenge and tolerance test
2. The measurement of cholesterol
3. Basis of cell counting using hemocytometer
4. Principles behind automated cell counters
5. Assessment of bone mineral density
6. How to measure thyroid hormones using ELISA

Experiments

1. Glucose tolerance test.
2. Lipid profile: triglycerides and total cholesterol.
3. Obesity parameters.
4. RBC counting and haemoglobin estimation.
5. Blood pressure measurements.
6. Bone density measurements (visit to a nearby clinic).
7. T4/TSH assays.

SUGGESTED READING

1. Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Coico, R., and Sunshine, G., (2009). Immunology: A Short Course, 6th ed., John Wiley & sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Berg, J.M., Tymoczko, J.L., and Stryer, L., (2012). Biochemistry, 7th ed., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
4. Snustad, D.P., and Simmons, M.J., (2012). Genetics, 6th ed., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

Instruction hours/week: L:0 T:0 P:4 Marks:Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

To impart hands-on training on

- Sterilization methods
- Autoclave, filtration techniques
- Preparation of microbial culture media
- Assessment of bacterial strains
- Pure cultures using streaking methods
- Colony counting

Course Outcomes (CO's)

After successful completion, the students will

1. Perform sterilization of glassware and media
2. Autoclave, filtration techniques
3. Prepare microbial culture media
4. Assess bacterial strains
5. Employ streaking methods for pure culture
6. Count the cells present in a colony

Experiments

1. Microbiology Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter).
3. Preparation and sterilization of culture media for bacterial cultivation.
4. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs.
5. Staining of bacteria using Gram stain.
6. Isolation of pure cultures of bacteria by streaking method.
7. Estimation of CFU count.

SUGGESTED READING

1. Atlas, R.M., (1997). Principles of Microbiology. 2nd edition. W M.T.Brown Publishers.
2. Pelczar, M.J, Chan, E.C.S., and Krieg, N.R., (1993). Microbiology. 5th edition. McGraw Hill Book Company .
3. Kannan, N., (2003). Laboratory Manual in Microbiology, Panima Publishing Corporation, Bangalore.

Instruction hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives

To impart hands-on training on

- Estimation of vitamin
- Homocysteine measurements
- Assessment of protein energy malnutrition
- Obesity assessments
- Oxidative stress measurements
- BMD assessments

Course Outcomes (CO's)

After successful completion, the students will understand

1. Estimation of vitamin
2. Homocysteine measurements
3. Assessment of protein energy malnutrition
4. Obesity assessments
5. Oxidative stress measurements
6. BMD assessments

Experiments

1. Bioassay for vitamin (Any one).
2. Homocysteine estimation by colorimetric method.
3. Serum/ urine MMA estimation.
4. Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
5. Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.
6. Vitamin A/E estimation in food item.
7. Bone densitometry /bone ultrasound test demonstration (visit to a nearby clinic)

SUGGESTED READING

1. Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Williams, M.H., Anderson, D.E., Rawson, E.S., (2013). Nutrition for health, fitness and sport. McGraw Hill international edition. ISBN-978-0-07-131816-7.
3. Mahan, L.K, Strings, S.E., Raymond, J., (2012). Krause's Food and Nutrition Care process. Elsevier's Publications. ISBN- 978-1-4377-2233-8.
4. Coombs, G.F., (2008). The vitamins, Fundamental aspects in Nutrition and Health. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
5. Gibson R., (2005). Principles of Nutritional Assessment. Oxford University Press.

Instruction hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

Course Objectives:

To impart hands-on training on

- Preparation of plant tissue lysates
- Estimation of enzymes during germination
- Extraction of enzymes from plant source
- Separation of plant metabolites using TLC
- PTC media preparation, culturing techniques
- Vitamin assessments

Course Outcomes (CO's):

After successful completion, the students will understand

1. Preparation of plant tissue lysates
2. Estimation of enzymes during germination
3. Extraction of enzymes from plant source
4. Separation of plant metabolites using TLC
5. PTC media preparation, culturing techniques
6. Vitamin assessments

Experiments

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
2. Extraction and assay of Urease from Jack bean
3. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables
4. Separation of plant pigments by TLC
5. Culture of plants (explants)

SUGGESTED READING

1. Bowsher, C., Steer, M., and Tobin, A., (2008). Plant Biochemistry, Garland science ISBN 978-0-8153-4121-5.
2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.
3. Dey P.M and Harborne J.B. (1997). Plant Biochemistry (Editors) Publisher: Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749.

PRACTICAL**Instruction hours/week: L:0 T:0 P:4 Marks:Internal: 40 External: 60 Total: 100****End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training on

- Preparation of slides for infectious pathogens
- the principle behind WIDAL test
- the basis of Gram staining
- the detection of pathogens using PCR
- Dot Blot principles
- differential diagnosis

Course Outcomes (CO's)

After successful completion, the students will understand

1. Preparation of slides for infectious pathogenes
2. the principle behind WIDAL test
3. the basis of Gram staining
4. the detection of pathogens using PCR
5. Dot Blot principles
6. differential diagnosis

Experiments

1. Permanent slides of pathogens. *Mycobacterium tuberculosis*, *Leishmania*, *Plasmodium falciparum*
2. WIDAL test
3. Gram staining
4. Acid fast staining
4. PCR based diagnosis (Demo)
5. Dot Blot ELISA

SUGGESTED READING

1. Willey, J.M., Sherwood, L.M., and Woolverton, C.J., (2008). Prescott, Harley, Klein's Microbiology, 7th Ed., Mc Graw Hill International Edition (New York) ISBN: 978-007-126727.
2. Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.
3. Ryan, K.J., and Ray, C.G., (2008). Sherris Medical Microbiology: An Introduction to Infectious Diseases by Publisher: McGraw-Hill
4. Murray, P.R., Rosenthal, K.S., and Pfaller, M.A., (2008). Medical Microbiology by Elsevier Health Sciences.

Course Objectives

Equip the students with:

- Organs involved in immunity
- Acquired and innate arms of immune system
- The significance of humoral and cell mediated immunity during infection
- Various immunodeficiency diseases and hypersensitive reactions
- Structure and function of various immune cells and their role to combat infection
- Principles of vaccination

Course Outcomes (CO's)

After successful completion, the students will understand

1. Organs involved in immunity
2. Acquired and innate arms of immune system
3. The significance of humoral and cell mediated immunity during infection
4. Various immunodeficiency diseases and hypersensitive reactions
5. Structure and function of various immune cells and their role to combat infection
6. Principles of vaccination

Unit I: Cells and organs of the immune system and immunity

Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT). Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response.

Unit II: Antigens, Antibodies and receptor diversity

Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes. Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification.

Unit III: Biology of the B and T lymphocyte and complement system

Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response, anatomical distribution of B cell populations. Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies.

Unit IV: Cell mediated cytotoxic responses and hypersensitivity

General properties of effector T cells, cytotoxic T cells (T_c), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC). Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and cell mediated (Type IV) hypersensitivity.

Unit V: Antigen presentation, MHC complex and transplantation

General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, linkage disequilibrium, pathways of antigen processing and presentation. Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy and privileged sites. Vaccines - active and passive immunization, types of vaccines.

SUGGESTED READING

1. Kuby., (2007). Immunology ; 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590-0.
2. Coico, R., and Sunshine, G., (2009). Immunology: A Short Course 6th ed., John Wiley & sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Murphy, K., Mowat, A., and Weaver, C.T., (2012). Janeway's Immunobiology 8th ed., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt., (2017). Roitt's Essential Immunology: 6th ed., Wiley Blackwell (New Jersey), ISBN: 978-1-118-41577-1

Course Objectives

Equip the students on:

- Principles behind recombinant DNA technology
- Tools required for recombinant DNA technology
- Cloning and expression vectors
- Production of industrial relevant proteins
- Production of drugs for clinical applications
- Application of rDNA technology in crop improvement

Course Outcomes (CO's)

After successful completion, the students will understand

1. The principles behind recombinant DNA technology
2. Various tools required for recombinant DNA technology
3. Cloning and expression vectors
4. Production of industrial relevant proteins
5. Production of drugs for clinical applications like insulin
6. Application of rDNA technology in crop improvement

Unit I: Introduction to recombinant DNA technology

Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, separation of DNA by gel electrophoresis. Extraction and purification of plasmid and bacteriophage DNA.

Joining of DNA fragments :Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides, synthesis and use.

Unit II: Cloning vectors for prokaryotes and eukaryotes

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Vectors for yeast, higher plants and animals.

DNA sequencing: DNA sequencing by Sanger's method, modifications based on Sanger's method. Automated DNA sequencing. Pyro-sequencing.

Unit III: Introduction of DNA into cells and selection for recombinants

Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants - insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Introduction of DNA into animal cells, electroporation.

Methods for clone identification

The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

Unit IV: Polymerase chain reaction

Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products. Cloning PCR products. Real time PCR.

Expression of cloned genes : Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Challenges in producing recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit V: Applications of genetic engineering in Biotechnology

Site-directed mutagenesis and protein engineering. Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns.

SUGGESTED READING

1. Brown, T.A., (2010). Gene Cloning and DNA Analysis 6th ed., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Primrose, S.B., and Twyman, R. M., (2006). Principles of Gene Manipulation and Genomics 7th ed., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
3. Glick, B.R., Pasternak, J.J. and Patten, C.L., (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA 4th ed., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

Instruction hours/week: L:3 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

Equip the students with:

- Literature search tools
- Usage of research tools
- Processing of data and statistical analysis
- Template for research draft preparation
- Communication of research outputs
- Fundamentals of plagiarism and IPR

Course Outcomes (CO's)

After successful completion, the students will understand

1. Literature search tools such as Pubmed, Scopus, Google scholar
2. Usage of research tools (Data export, management of citation styles)
3. Processing of data and statistical analysis
4. Template for research draft preparation (Structure of an article)
5. Communication of research outputs (Usage of MS-PPT and verbal skills)
6. Fundamentals of plagiarism and IPR

Unit I: Introduction to Research Methodology

Introduction to Research Methodology - Objectives and motivation in research. Defining the Research Problem - Selecting and defining a research problem, reviewing and conducting literature search, developing a research plan.

Unit II: Design of Experiment

Different experimental designs – single and multifactorial design, Making measurements and sources of error in measurements, Methods of data collection and record keeping.

Unit III: Data Processing and Statistical Analysis

Processing operations, tabulation, and graphical representation, Statistics in research: Concepts of sample and population, Measure of central tendency, dispersion, asymmetry (skewness, kurtosis), Normal distribution (p-value), Statistical tests and hypothesis (Standard error, t-test, chi-square test), and regression analysis.

Unit IV: Writing research paper

Writing research paper - abstract, introduction, methodology, results and discussion. Reference formatting styles, Harvard and Vancouver systems. Citation styles – APA and MLA. Introduction to journals and types of publications, research article, review article, short communication, letter to editor. Plagiarism.

Unit V: Intellectual Property Rights (IPR)

Copyright – Conceptual basis, International Protection of Copyright and Related rights. Indian Copyright Act and Laws. Duration, renewal and termination of Copyright.

Patents - Introduction to Indian Patent Act and Laws. Indian Patent System, Types of patents, Patent Search and Indian Patent filing.

SUGGESTED READING

1. Research in Education (1992) 6th ed., Best, J.W. and Kahn, J.V., Prentice Hall of India Pvt. Ltd. At the Bench: A Laboratory Navigator (2005) Barker, K., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-087969708-2. 51
2. Research Methodology - Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers.
3. Research Methodology: A Step by Step Guide for Beginners (2005) 2nd ed., Kumar R., Pearson Education.
4. Biostatistics: A Foundation for Analysis in the Health Sciences (2009) 9th ed., Daniel W.W., John Wiley and Sons Inc.
5. Statistics at the Bench: A Step-by-Step Handbook for Biologists (2010) Bremer, M. & Doerge, R.W., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-0-879698-57-7.
6. Intellectual property rights in the global economy (2000), Keith E. Maskus. Oxford Publications.

Instruction hours/week: L:4 T:0 P:0**Marks: Internal: 40 External: 60 Total: 100****End Semester Exam: 3 Hours****Course Objectives**

Equip the students with:

- Definition and classification of drugs
- Basics of Pharmacokinetics of a drug
- Basics of Pharmacodynamics in living system
- Mechanism of action of drugs
- Toxicity assessment
- Drug abuse

Course Outcomes (CO's)

After successful completion, the students will understand

1. Definition and classification of drugs
2. Basics of Pharmacokinetics of a drug
3. Basics of Pharmacodynamics in living system
4. Mechanism of action of drugs
5. Toxicity assessment
6. Drug abuse

Unit I: Introduction to Drug Biochemistry

Classification, routes of administration – factors influencing dosage and drug action, Absorption and distribution of drugs, binding of drugs to plasma proteins, Drug Dose relationship (LD_{50} , ED_{50} , therapeutic index), Drug – Receptor interaction, Drug binding forces, Receptor theories, Drug – Receptor interaction. Bioavailability; Pharmacokinetics.

Unit II: Drug Metabolism

Drug Biotransformation pathways - phase I – oxidation, reduction and hydroxylation. Phase II- Conjugation, Elimination of drugs from body system. Storage of drugs in adipose tissue.

Unit III: Drug Abuse

Drug abuse; drug dependence; drug resistance- Biological mechanism, ways to overcome.

Chemotherapy: Antibacterials – Mode of action of sulfonamides, penicillin, streptomycin, tetracycline, chloramphenicol, antiviral drugs, antifungal drugs; Antimetabolites of folate, purines & pyrimidines, Anti tubercular drugs.

Unit IV: Mechanism of Action Drugs

Mechanism of action drugs used in the treatment of diabetes mellitus (Acarbose, Biguanides), AIDS (Azidothymidine, Didanosine), cancer (Methotrexate, Busulfan), heart (Digoxin) and kidney disorder (Benzothiadiazines, furosemide); antiepileptic drug (Lamictal, Topiramate), drugs for cough (Dextromethorphan Hydrobromide, Noscipine) and bronchial asthma (Salbutamol, Aminophylline), diuretics (Manitol, Xanthine), anti ulcer drugs (Cimetidine, Ranitidine) and drugs for fever (Paracetamol, Ibuprofen).

Unit V: Toxicology

Introduction, definition and disciplines of toxicology, classification of toxicity and toxicants, Mechanisms of toxic effect, treatment of intoxication, methods in toxicology testing, heavy metal toxicity and chelation therapy. Environmental pollution, mycotoxins, mushroom poisons

SUGGESTED READING

1. Satoskar, R.S., Bhandarkar, S.P., and Ainapuri, S.S., (2003). Pharmacology and Pharmacotherapeutic, 18th edition, PopularPrakashan, Mumbai.
2. Hamilton, D., Philips, R.J., and Scott, D., (2004). Occupational, Industrial and Environmental Toxicology, Mosby Inc Publishers.
3. Berg, G., Hendrickson, R.G., and Morocco, A., (2005). Medical Toxicology Review. McGraw Hill Mical Publishing Company.
4. Foye, W., (2012). Principles of Medicinal Chemistry, 7th edition, B.I. Wanerly Pvt. Ltd, New Delhi.
5. Grahame-Smith, D.G., and Aronson, J.K., (2002). Oxford textbook of ClinicalPharmacology and Drug Therapy: 3rd edition. Oxford University Press.
6. Tripathy, K.D., (2009). Essentials of Medical Pharmacology, Jaypee brothers medical publishers, New Delhi.

Instruction hours/week: L:4 T:0 P:0 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

Equip the students with:

- Definition and representation styles of data
- Analysis of data using correlation to understand the interdependence
- Analysis of data using regression to understand the interdependence
- To learn various measures of central values and standard deviation.
- To understand the relationship between two variables.
- To test the significance of a particular data by various parameters.

Course Outcomes (CO's)

After successful completion, the students will:

1. Use appropriate representation styles to present the data
2. Perform correlation analysis
3. Perform regression analysis
4. Calculate mean, median, mode and standard deviation.
5. Calculate the relationship between two variables.
6. Test the significance of a particular data by various parameters.

Unit I: Introduction of Biostatistics

Definitions-Scope of Biostatistics- Variables in biology, collection, classification and tabulation of data- Graphical and diagrammatic representation.

Unit II: Calculation of Biostatistics

Measures of central tendency – Arithmetic mean, median and mode. Measures of dispersion- Range, standard deviation, Coefficient of variation.

Unit III: Correlation & Regression

Correlation – Meaning and definition - Scatter diagram –Karl Pearson's correlation coefficient. Rank correlation.

Regression: Regression in two variables – Regression coefficient problems – uses of regression.

Unit IV: Test of significance

Test of significance: Testing of hypothesis, Errors in hypothesis testing, Standard errors. Tests based on means only-Both Large sample and Small sample tests.

Unit V: Chi square test

Chi square test - goodness of fit; Analysis of variance – one way and two way classification.

SUGGESTED READING

1. Pillai R.S.N., and Bagavathi V., 2002., Statistics , S. Chand & Company Ltd, New Delhi.

2. Jerrold H.Z., (2003). Biostatistical Analysis, Fourth Edition, Pearson Education (Pte) .Ltd, New Delhi.
3. Arora, P.N., (1997). A foundation course statistics, S.Chand& Company Ltd, New Delhi.
4. Navnitham, P.A., (2004). Business Mathematics And Statistics, Jai Publications, Trichy,
5. Gupta S.P., (2001). Statistical methods, Sultan Chand & Sons, New Delhi.

Instruction hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training on:

- Isolation of lymphocytes
- Purification of immunoglobulins using protein A
- Immunodiffusion techniques (Single and Double)
- Agglutination techniques
- Blood grouping
- ELISA technique

Course Outcomes (CO's)

After successful completion, the students will:

1. Perform isolation of lymphocytes
2. Purify immunoglobulins using protein A
3. Perform Immunodiffusion techniques (Single and Double)
4. Perform agglutination techniques
5. Carry out blood grouping
6. Conduct ELISA experiments

Experiments

1. Isolation of lymphocytes from blood and macrophages from peritoneal cavity or spleen.
2. Purification of immunoglobulins.
3. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.
4. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
5. Enzyme linked immune-sorbent assay (ELISA).

SUGGESTED READING

1. Kuby, J., (2007) Immunology; 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590-0.
2. Coico, R., and Sunshine, G., (2009). Immunology: A Short Course 6th ed., John Wiley & sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Murphy, K., Mowat, A., and Weaver, C.T., (2012). Janeway's Immunobiology 8th ed., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.

**19BCU612A GENETIC ENGINEERING AND BIOTECHNOLOGY
PRACTICAL****3H-1C****Instruction hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100****End Semester Exam: 3 Hours****Course Objectives**

Equip the students with:

- Handling of *Escherichia coli*
- Isolation of plasmid DNA from *Escherichia coli*
- Restriction digestion using enzymes
- Amplification using PCR
- Transformation of plasmid into *Escherichia coli*
- Western blotting demonstration

Course Outcomes (CO's)

After successful completion, the students will

1. Know the precautions of handling *Escherichia coli*
2. Isolate the plasmid DNA from *Escherichia coli*
3. Restriction digestion using enzymes such as EcoRI, Hind III
4. Amplify the rDNA using PCR
5. Understand the techniques related to transformation of plasmid into *Escherichia coli*
6. Understand the steps involved in Western blot analysis

Experiments

1. Isolation and estimation of DNA, RNA and protein from animal source
2. Isolation of plasmid DNA from *E. coli* cells.
3. Agarose gel electrophoresis of DNA
4. Digestion of plasmid DNA with restriction enzymes.
5. Amplification of a DNA fragment by PCR.
6. Transformation of *E. coli* cells with plasmid DNA.
7. Western Blotting(Demo)

SUGGESTED READING

1. Glick R. Bernard and Pasternak J. Jack. 1994. Molecular Biotechnology. ASM press, Washington D.C.
2. Old, R. W. and Primrose, S. B. 1994. Principles of Gene Manipulation. Black Well Scientific Publications. USA.
3. Smita Rastogi and Neelam Pathak. 2010. Genetic Engineering. Oxford University Press. New Delhi.

Instruction hours/week: L:0 T:0 P:3 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training in:

1. Literature survey related to life sciences/medical research
2. Exporting the data to appropriate format
3. Collating the data
4. Identifying the gap
5. Originality in writing
6. IPR concepts

Course Outcomes (CO's)**After successful completion, the student will:**

1. Perform Literature survey related to life sciences/medical research
2. Export the data to appropriate format
3. Collate the data
4. Identify the gap in the literature
5. Inculcate originality in writing
6. Understand IPR concepts

Exercises

1. A teacher (adviser) who would guide the student will discuss with student and identify a topic of mutual interest.
2. The student will collect the literature, collate the information and write the same in the form of a term paper with proper incorporation of using different styling systems.
3. The student will identify scope of research on the topic and will frame objectives to be addressed in the project through a work plan.
4. The student will write standard operating protocols (SOPs) and identify requirement for equipment and reagents.
5. Student will be trained to write results, discussion and conclusion pertaining to their topic.
6. Each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologies as described above.
7. Patent search in USPTO, Espacenet, WIPO and InPASS databases (demo).

SUGGESTED READING

1. Research in Education (1992) 6th ed., Best, J.W. and Kahn, J.V., Prentice Hall of India Pvt. Ltd. At the Bench: A Laboratory Navigator (2005) Barker, K., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-087969708-2. 51
2. Research Methodology - Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers.
3. Research Methodology: A Step by Step Guide for Beginners (2005) 2nd ed., Kumar R., Pearson Education.
4. Intellectual property rights in the global economy (2000), Keith E. Maskus. Oxford Publications.

Instruction hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training in:

- Handling of small experimental animals
- Enteral and parenteral route of drug administration
- Assessment of behavioral changes
- Assessment of drug toxicity
- Calculation of LD₅₀
- Monitoring for adverse effects of drugs

Course Outcomes (CO's)

After successful completion, the student will:

1. Handle small experimental animals such as rats, mice and rabbits
2. Learn Enteral and parenteral route of drug administration
3. Learn to assess behavioural changes
4. Learn to assess drug toxicity
5. Learn the basis of LD₅₀
6. Monitor adverse effects of drugs

Experiments

1. Handling of small experimental animals
2. Route of drug administration – Oral and parenteral
3. Behavioural Changes upon drug Administration
4. Liver toxicity Studies
 - SGOT
 - SGPT
 - GGT
5. Renal toxicity studies
 - Urea
 - Uric acid
 - Creatinine
6. LD₅₀ Determination

SUGGESTED READING

1. Hamilton, D., Philips, R.J., and Scott, D., (2004). Occupational, Industrial and Environmental Toxicology, Mosby Inc Publishers.
2. Berg, G.M.I., Hendrickson R.G., and Morocco, A., (2005). Medical Toxicology Review. McGraw Hill Mical Publishing Company.
3. Foye, W., (2012). Principles of Medicinal Chemistry, 7th edition, B.I. Wanerly Pvt. Ltd, New Delhi.
4. Grahame-Smith, D.G., and Aronson, J.K., (2002). Oxford textbook of ClinicalPharmacology and Drug Therapy: 3rd edition. OxfordUniversity Press.
5. Tripathy, K.D., (2009). Essentials of Medical Pharmacology, Jaypee brothers medical publishers, New Delhi.

Instruction hours/week: L:0 T:0 P:4 Marks: Internal: 40 External: 60 Total: 100**End Semester Exam: 3 Hours****Course Objectives**

To impart hands-on training in the usage of software's to perform:

- Measures of central tendency
- Coefficient of variation
- Correlation analysis
- RANK Correlation test
- Regression analysis
- T-test

Course Outcomes (CO's)

After successful completion, the student will:

1. Measure mean, median and mode
2. Perform Coefficient of variation
3. Execute Correlation analysis
4. Perform Regression analysis
5. Perform RANK correlation test
6. Analysis the difference between means using T-test

Experiments

1. Mean for individual, discrete series using SPSS Package.
2. Mean for continuous series using SPSS Package.
3. Median for individual and discrete series using SPSS Package.
4. Median for continuous series using SPSS Package.
5. Mode for individual and discrete series using SPSS Package.
6. Standard deviation for individual and discrete series using SPSS Package.
7. Coefficient of variation for individual and discrete series using SPSS Package.
8. Karl Pearson's Correlation using SPSS Package.
9. Rank Correlation Coefficient for Untied Rank using SPSS Package.
10. Rank Correlation Coefficient for Tied Rank using SPSS Package.

SUGGESTED READING

1. Jerrold, H.Z., (2003). Biostatistical Analysis, Fourth Edition, Pearson Education Ltd, New Delhi.
2. Arora, P.N., (1997). A foundation course statistics, S.Chand & Company Ltd, New Delhi.
3. Navnitham, P.A., (2004). Business Mathematics And Statistics, Jai Publications, Trichy,
4. Gupta, S.P., (2001). Statistical methods, Sultan Chand & Sons, New Delhi.

B.Sc., Biochemistry		2019-2020
19BCU691	Semester VI RESEARCH PROJECT	8H-6C
Instruction hours/week: L:2 T:0 P:6Marks:Internal: 40 External: 60 Total: 100		