

**PROPOSED UG SYLLABUS FOR BIOCHEMISTRY UNDER NORTH-EASTERN HILL
UNIVERSITY, SHILLONG
NEP 2020
4 years Degree Course (FYUP)**

Date of approved by the Academic Council: 21/05/2025

Semester	Course code	Course title	Total credits (4)	
			Theory	Practical
7 th	1. BCH-400	Research Methodology & Proposal Writing	4	0
	2. BCH-401-Major course	Hormone Biochemistry & Cell Signalling	3	1
	3. BCH-402-Major course	Nutritional Biochemistry	3	1
	4. BCH-403-Major course	Medical Biochemistry	3	1
	5. BCH-404-Minor course	Medicinal Biochemistry	3	1
8 th	1. BCH-450- Major course (For both Honours and Honours with Research)	Plant Physiology & Biochemistry	4	0
	2. BCH-451- Major course (For both Honours and Honours with Research)	Introduction to Medicinal & Aromatic Plants	4	0
	3. BCH-452 (For Honours with Research only)	Research Project/ Dissertation	12	
	4. BCH-453-Major course (For Honours only)	Practical-I	4	
	5. BCH-454-Major course (For Honours only)	Practical-II	4	
	6. BCH-455-Major course (For Honours only)	Research Paper, Writing & Plagiarism	3	1

7th Semester

BCH-400

**Research Methodology &
Proposal Writing
(Theory)**

**Credits: 4
Marks: 100
Total contact hours: 60**

Learning Objectives (LOs):

1. To give a brief account of the history of research
2. To point up the methodologies used to do research, understanding the effective lab practices and ethics
3. To prepare structural framework for research and learn the art of analysis.
4. To understand practical aspects of research and learn research proposal and synopsis writing.

Course Outcomes (COs):

1. Graduates will be able to create and organize ideas and objectives for their dissertation
2. Will be prepared to adapt to the research environment, learn synopsis writing and understand how projects are executed in a research laboratory.
3. Will be prepared to present their topics of research and explain its importance.

Unit I:

Credit 1

History of science and scientific research: Introduction to Research Methodology; Empirical science; scientific method; Experimental and control samples; deductive and inductive reasoning; descriptive science; reductionist vs. holistic biology.

Unit II:

Credit 1

Preparation for Research: Choosing a guide; finding a lab and research question; maintaining a lab notebook; Formulating Research Questions and Hypotheses; Research Design and Sampling Techniques; Data Collection Methods

Unit III:

Credit 1

Synopsis preparation; Writing a Research Proposal: Structure and Components; Data Analysis and Interpretation; Ethical Considerations in Research; Academic Writing and Citation Styles; Presenting Research Proposals: Oral Communication Skills; Review and Feedback on Research Proposals

Unit IV

Credit 1

Plagiarism: Understanding what constitutes plagiarism; Citing sources properly to avoid plagiarism; Strategies for paraphrasing and summarizing effectively.

Ethical Considerations: Research ethics and integrity; Avoiding fabrication, falsification, and other forms of misconduct; Intellectual property rights and permissions.

Suggested readings:

1. Leedy, P. D., & Ormrod, J. E. (2018). *Practical Research: Planning and Design*. Pearson.
2. *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (207) J David Cresswell and John Cresswell, eds. Sage Publications.
3. *Research Methodology- a step-by-step guide to beginners* (2011) Ranjit Kumar 6th Edn. Sage Publications.
4. *Research Methodology: Methods and Techniques* (2004) C R Kothari, 2nd revised edition, New Age International Publishers.
5. *Research Methods: A Practical Guide for Graduates and Researchers* (2017) Willie Chee Keong Tanby World Scientific Publ.
6. Sekaran, U., & Bougie, R. (2016). *Research Methods for Business: A Skill-Building Approach*. John Wiley & Sons.
7. Walliman, N. (2017). *Research Methods: The Basics*. Routledge.

BCH-401

**Hormone Biochemistry &
Cell Signaling
(Theory)**

**Credits:3
Marks: 75
Total contact hours: 45**

Learning Objectives (LOs):

1. To allow learning of hormone types, general functions and diversity.
2. To grasp about the key essential components of hormonal action.
3. To learn about the hormonal signal transduction mechanisms.
4. To understand the hormones secreted by different organs/tissue and their precise biological actions.

Course Outcomes (COs):

1. Graduates shall be able to understand and appreciate the general role of hormones, its diversity and composition.
2. Shall be able to comprehend the hormonal secretions and their regulation.
3. Shall be able to differentiate the complex action of hormones in regulating biological functions.

Unit I:

Credit 1

Hormones: Endocrine, paracrine, autocrine, intracrine and neurocrine mechanisms and regulations; Classification of hormones; transport of hormones in circulation; General introduction to Endocrine methodology.

Unit II:

Credit 1

Hormones of Hypothalamus (Corticotropin-releasing hormone, Thyrotropin-releasing hormone, Gonadotropin-releasing hormone, Oxytocin, Vasopressin, Somatostatin); Pituitary (Thyroid-stimulating hormone (TSH), adrenocorticotrophic hormone (ACTH), follicle-stimulating hormone (FSH), and luteinizing hormones (LH); Thyroid (Thyroxine (T4) and triiodothyronine (T3) and Calcitonin); Parathyroid hormone; Adrenal Glands (Cortisol, Aldosterone, Adrenaline (Epinephrine) and Norepinephrine (Noradrenaline), DHEA and Androgenic Steroids); Testes (Testosterone); Ovary (Estrogens and progesterone), Pineal Gland (Melatonin); Pancreatic (Insulin and glucagon) & Gastrointestinal (GIT) hormones (Gastrin, cholecystokinin (CCK) and secretin); Hormones of adipose tissues (leptin/ adoleptin). Hormones of HPA axis.

Unit III:

Credit 1

Hormone receptors (cell surface and intracellular); Receptor – hormone receptor binding; GPCRs (G- protein coupled receptors); G proteins; Second messengers (cAMP, cGMP, IP3, DAG, Ca²⁺, NO); Effector systems (adenylate cyclase, guanylate cyclase); Mechanism of action of Protein / Peptide Hormones; Receptor Tyrosine kinases; MAP kinase cascade, JAK - STAT pathway. Mechanism of action of Steroid hormone/ thyroid hormones; Receptor regulation and cross talk.

BCH-401

**Hormone Biochemistry &
Cell Signaling
(Practical)**

**Credit: 1
Marks: 25
Total contact hours: 30**

1. Estimate the level of any protein receptor/ hormone (thyroxine) by using ELISA
2. Estimate the level of any protein receptor/ hormone by using Western Blot.

Suggested readings:

1. Alberts B, et al. (2022) Molecular Biology of The Cell 7th Edn., WW Norton Pubn.
2. Barrett K E et. Al. (2009) Ganong's Review of Medical Physiology 23rd Edn. LANGE Basic Science
3. Bhagavan N V et. al. (2011) Essentials of Medical Biochemistry with Clinical cases 1st Edn., Acad.
4. Darnell J, Lodish H and Baltimore D (2016) Molecular Cell Biology 8th Edn., W H Freeman and co.
5. Ganong W F (2019) Review of Medical Physiology 26th Edn. McGraw- Hill
6. Guyton A C & Hall (2020) Textbook of Medical Physiology 14th Edn., Elsevier.
7. Karp Gerald (2009) Molecular cell Biology 6th edn., Wiley Pubn.
8. Physiology & Biochemistry in Modern Medicine (2012) by Books Group, General Books Pbn.
9. Weaver R (2011) Molecular Biology 5th Edn., McGraw Hill Sc.
10. Wilson K and Walker J (2002) Principles and Techniques of Practical Biochemistry 5th Edn. Cambridge

7th Semester

BCH-402

**Nutritional Biochemistry
(Theory)**

**Credits:3
Marks: 75
Total contact hours: 45**

Learning Objectives (LOs):

1. To evaluate and describe the fundamental concepts of nutrition and dietetics.
2. To assess and examine the dietary requirements and role of essential macro and micro nutrients.
3. To analyse the factors that influence nutritive habits.
4. To understand the causes and effects of malnutrition and over-nutrition.
5. To understand the concept of quality control and food safety standards.

Course Outcomes (COs):

1. Graduates will be able to outline the importance and role of nutrition and its impact on health of an individual.
2. Shall be able to analyse the nutritive values and dietary recommendation of nutrients.
3. Graduates will be able to understand diseases in relation to nutrition.
4. Able to highlight the importance of food quality and standards of food safety and hygiene.

Unit I:

Credit:1

Nutrition & Diet; Concept of balanced diet, Nutritive values of water, carbohydrates, fats, protein; Dietary Fibers; Role of vitamins (A, D, E, K, C and B complex); Role of minerals – iron, calcium, phosphorous, iodine, magnesium, potassium, selenium and zinc; Electrolytes -sodium, chloride; Deficiency diseases.

Unit II:

Credit:1

Factors effecting nutritive habits; Nutrition during pregnancy, childhood & adulthood;; Role of nutrition in health & disease. Basal metabolic rate (BMR); Body Mass Index (BMI); Calorimetry; Specific dynamic action (SDA) and Recommended Daily Allowance (RDA) of foods; Basic concepts of diet therapy.

Unit III:

Credit:1

Food quality; food hazards; food safety standard; food toxins; food allergens; food contaminants; food adulterants; food law's; FSSAI; Protein-Calorie malnutrition (Kwashiokor and Marasmus); Overnutrition & Obesity.

7th Semester

BCH-402

**Nutritional Biochemistry
(Practical)**

**Credits:1
Marks: 25
Total contact hours: 30**

1. Isolation and estimation of: a. casein from milk; b. starch from potato.
2. Estimation of ascorbic acid, total carbohydrates and protein content in food.
3. Study on the BMI-anthropometric measurements, Z-scores, skin fold, BM, circumference ratios.
4. Detection of adulteration in oils.

Suggested readings:

1. Bhargava Gupta (2010) Practical Biochemistry, CBS Publishers
2. Boyer R F (2009) Modern Experimental Biochemistry 3rd Edn. , 5th Impression Pearson edn.
3. Damodaran G K (2011) Practical Biochemistry, Pub Jaypee bros.
4. DivyaSanthi (2010) An Easy Guide for Practical Biochemistry, Jaypee brothers & Medical Publ.
5. Elsayy H (2010) Nutritional Biochemistry, Lap Lambert AcadPbn.
6. Farrell et al (2005) Experiments in Biochemistry: A Hands-on Approach 2nd Edn. Brooks Cole Pbn.
7. Grooper S S (2000) Biochemistry of Human Nutrition – A Desk Reference 2nd Edn. Wadsworth Pbn.
8. Haugen S (2010) Handbook of Nutritional Biochemistry, Nova Science Pbn.
9. Jayaraman (2011) Laboratory Manual in Biochemistry, New Age Int. Pub.
10. Nigam A & Ayyagiri A (2008) Lab Manual in Biochemistry, Immunology & Biotechnology, Tata
11. Plummer D T (2008 reprint) An Introduction to Practicals in Biochemistry 3rd Edn., Tata McGraw- Hill
12. Rao B S & Deshpande (2005) Experimental Biochemistry Graduates Companion I K International Pub
13. Sadasivam S and Manickam A (2005) Biochemical Methods, (Rev Edn.) New Age Int. Pub, New Delhi.
14. Sawhney S K. (2005) Introductory Practical Biochemistry, Alpha Science International Ltd.
15. Trueman P (2007) Nutritional Biochemistry MJP Publ.
16. Yadav V. K. et al (2012) Biochemistry & Biotechnology- A Lab Manual, Pointer Publ.

7th Semester

BCH-403

**Medical Biochemistry
(Theory)**

**Credits:3
Marks:75
Total contact hours: 45**

Learning Objectives (LOs):

1. To identify and classify different types of inherited metabolic disorders based on their biochemical and clinical manifestations.
2. To describe the pathophysiology of common inherited metabolic disorders, including disorders of carbohydrate, amino acid, and lipid metabolism.
3. To understand the epidemiology, transmission, and pathogenesis of communicable diseases.
4. To identify the etiology, risk factors, and pathophysiological mechanisms underlying common organ-specific diseases.
5. To conceptualize the treatment modalities including pharmacological and lifestyle interventions.
6. To comprehend the biochemical and molecular mechanisms underlying these different medical conditions.

Course Outcomes (COs):

1. A Graduate will have an understanding of the molecular basis of inherited metabolic disorders and their inheritance patterns.
2. Will be able to identify and differentiate between various types of inherited metabolic disorders based on their clinical presentations and biochemical abnormalities.
3. Will be able to identify common bacterial, viral and fungal pathogens responsible for communicable diseases.
4. Will be able to interpret clinical manifestations and laboratory findings to diagnose communicable diseases accurately.
5. Will be able to identify common etiologies, risk factors, and pathophysiological mechanisms underlying organ-specific diseases, including cardiovascular, respiratory, gastrointestinal, renal and hepatic disorders.

Unit I:

Credit 1

Inherited disorders of metabolism: Changes occurring in tyrosinosis, Hartnup's disease, galactosemia. Tay-Sach's disease, Niemann Pick's disease, Hunter's and Hunter's syndrome, Lys-Nyhan syndrome - detection of these anomalies, Metabolic disorder diseases; Hypertension, Coronary Heart diseases (Atherosclerosis & myocardial infarction), Stroke, Diabetes, Obesity.

Unit II:**Credit 1**

Causes, symptoms, diagnosis, treatment and prevention of parasitic and communicable diseases (Malaria, Filaria, Measles, Polio, Rabies, Plague, Leprosy, AIDS); Water borne diseases: Cholera, Hepatitis and Polio; Air borne diseases: Chickenpox, Influenza, Measles and Tuberculosis.

Unit III**Credit 1**

Organ Specific Diseases: liver (fatty liver, jaundice, hepatitis, cirrhosis); kidney (nephrotic syndrome, glomerulonephritis, amyloidosis); bone (Rickets, Paget's disease); ocular tissue (cataract and night blindness); gastrointestinal disorders (Gastroesophageal reflux disease (GERD) & irritable bowel syndrome (IBS), pancreatitis, gall stones); blood coagulation disorders (Hemophilia, Von Willebrand disease (VWD), thalassemia).

7th Semester

BCH-403

**Medical Biochemistry
(Practical)**

**Credit: 1
Marks: 25
Total contact hours: 30**

1. Estimation of blood glucose.
2. Estimation of blood hemoglobin.
3. Estimation of serum creatine and creatinine.
4. Assay of LDH activity in serum.

Suggested readings:

1. Barrett K E et. Al. (2009) Ganong's Review of Medical Physiology 23rd Edn. LANGE Basic Science
2. Baynes J W, et al. (2022) Medical Biochemistry 6th Edn., Elsevier Health Sciences
3. Bhagavan N V et. al. (2011) Essentials of Medical Biochemistry with Clinical cases 1st Edn., Acad.
4. Blanco A, Blanco G (2022) Medical Biochemistry 2nd Edn., Elsevier
5. Ganong W F (2003) Review of Medical Physiology 2nd Edn. Appleton & Lange USA
6. Guyton A C & Hall (2010) Textbook of Medical Physiology 12th Edn., W B Saunders.
7. Lieberman M, Peet A (2022) Marks' Basic Medical Biochemistry: A Clinical Approach 6th Edn., Wolters Kluwer Health
8. Meisenberg G, Simmons W H (2018) Principles of Medical Biochemistry 3rd Edn., Elsevier/Saunders
9. Physiology & Biochemistry in Modern Medicine (2012) by Books Group, General Books Pbn.
10. Puri D (2022) Textbook of Medical Biochemistry 5th Edn., Elsevier
11. Harold Varley (2005) Practical Clinical Biochemistry, 4th Edition, CBS Publishers & Distributors.

BCH-404

**Medicinal Biochemistry
(Theory)**

**Credit: 3
Total marks: 75
Total contact hours: 45**

Learning Objectives (LOs):

- 1 To aid in learning the physicochemical principles of drug action in the body.
2. To determine the prime drug targets in the body tissues and cells such as proteins and nucleic acids.
3. To understand the therapeutic commercial drugs and their intended targets in the body to treat complications.

Course Outcomes (COs):

1. Graduates shall be able to examine the physicochemical basis of drug action in the body
2. Graduates shall be able to identify important drug targets in organs/tissues in mediating their effects.
3. Graduates will be able to analyze some select classes of therapeutic drugs in providing treatment and relief in various body complications and diseases.
4. Students will learn the importance of pKa in drug absorption and distribution.
5. Students will be able to link between oxidative stress, free radicals, and drug development.

Unit I

Credit 1

History and development of medicinal biochemistry; Drug definition; types of drugs; Lepinski's Rules of Five & ADMET; Physicochemical principles of drug action: partition coefficient, drug dissolution, chelation, acid-base properties, surface activity, bioavailability and stereochemistry. Xenobiotics; Phase I and phase II trials; Factors affecting drug metabolism.

Unit II

Credit 1

Drug targets: receptors, ion channels, enzymes (soluble and membrane-bound) and nucleic acids. Drug agonists, antagonists and inverse agonists. Affinity, efficacy and potency of drugs. Adverse drug reaction; drug side effects; LD50, AC50; Therapeutic index of drugs.

Unit III

Credit 1

Adrenergics: alpha blockers (doxazosin and prazosin) and beta blockers (atenolol and timolol). Cholinergics: atropine, dextromethorphan and chlorpheniramine. Anti-inflammatory and antipyretics: Paracetamol, acetaminophen, ibuprofen and sodium salicylate. Antibiotics: Erythromycin, amoxicillin and azithromycin. Antivirals: Acyclovir and abacavir. Antineoplastic (cancer) drugs: Flurouracil, methotrexate and doxorubicin.

BCH-404

**Medicinal Biochemistry
(Practical)**

**Credit: 1
Total Marks: 25
Total contact hours: 30**

1. Determination of the solubility of drug at room temperature.
2. Study on the effect of inhibitors (Drugs) on enzymes (name).
3. Determine the pKa of a weakly acidic or basic drug using UV-Vis spectroscopy or pH titration.
4. Measure antioxidant activity of natural compounds (e.g., Vitamin C, plant extracts) using DPPH assay.

Suggested readings:

1. Aftab T, Hakeem K R (2020) Medicinal and Aromatic Plants, Elsevier Science Publishing
2. Benzie I F F, Wachtel-Galor S (2011) Herbal Medicine 2nd Edn. CRC Press/Taylor & Francis
3. Dolui A K, Sharma H K, Marein T B, Lalhriatpuii T C (2004) Folk herbal remedies from Meghalaya, Indian Journal of Traditional Knowledge 3(4):358-364
4. Handique P J (2015) Medicinal Plants of North East India: Status diversity conservation cultivation and trade; International Book Distributors
5. Hanson B A (2005) Understanding Medicinal Plants: Their Chemistry and Therapeutic Action 1st Edn. Routledge (Taylor and Francis Group)
6. Kayang H, Kharbuli B, Myrboh B, Syiem D (2005) Medicinal plants of Khasi hills of Meghalaya, India; International Society for Horticultural Science (ISHS) Acta Horticulturae 675: III WOCMAP Congress on Medicinal and Aromatic Plants - Volume 1: Bioprospecting and Ethnopharmacology
7. Mathe A, Khan I A (2022) Medicinal and Aromatic Plants of India (Vol. 1) 1st Edn. Springer Cham
8. Rai M, et al. (2012) Medicinal Plants: Biodiversity and Drugs 1st Edn., Taylor & Francis/ CRC Press
9. Ross I A (2005) Medicinal Plants of the World: Chemical Constituents, Traditional and Modern Medicinal Uses, Vol.3 Humana Totowa, NJ
10. Shankaraswamy J, Neelavathi R (2022) Comprehensive Book on Medicinal Plants. Narendra Publishing House
11. Singh Saroya A S (2018) Textbook of Medicinal and Aromatic Plants, Indian Council of Agricultural Research.
12. Thangaraj P (2018) Medicinal Plants: Promising Future for Health and New Drugs, Taylor & Francis Inc

8th Semester

BCH-450

Plant Physiology & Biochemistry

Credit: 4

Total marks: 100

Total contact hours: 60

Learning Objectives (LOs):

1. To comprehend the uptake and metabolism of vital plant nutrients such as water, N, S and P.
2. To understand the environmental stressors that modulate plant biochemistry and physiology and the role of antioxidant systems.
3. To analyze the various phytohormones and secondary metabolites and their role in plant growth and adaptation.

Course Outcomes (COs):

1. Graduate will be able to understand plant nutrient metabolism
2. Graduate will be able to compare the various stressors that influences plant physiology
3. Graduate will be able to differentiate the various phytohormones and secondary metabolites in control of plant physiology and protection.

Unit I:

Credit 1

Biochemistry & genetics of water absorption, conduction, transpiration and guttation; role of water. Nitrogen fixation by diazotrophs; Nitrate assimilation: nitrate and nitrite reduction; primary and secondary ammonia assimilation by plants; ammonia assimilation by GS-GOGAT pathways. Sulfate and phosphate uptake and their metabolism.

Unit II:

Credit 1

Introduction to environmental stress in plants; stress due to variation in temperature, water, light, salt and toxic substances. Plant toxins: mycotoxins, nitriles, protease inhibitors and protein toxins. Antioxidant enzymes (Superoxide dismutase, peroxidase, catalase and GST). Antioxidant vitamins (Carotenoids, Vitamin C & E).

Unit III:

Credit 1

Structure, actions and functions of phytohormones (Auxins, gibberellins, cytokinins, abscisic acid, salicylic acid, jasmonic acid and ethylene). Structure and functions of plant secondary metabolites: flavonoids, coumarins, alkaloids, tannins, lignin, terpenoids and anthocyanins.

Unit IV:**Credit 1**

Plant Growth and Development: Growth phases and growth curve; Plant growth regulators: auxins, gibberellins, cytokinins, ethylene, abscisic acid; Seed dormancy and germination; Photoperiodism and Vernalization; Senescence and abscission.

Suggested Readings:

- a. Bowsher C, Tobin A (2021) Plant Biochemistry 2nd Edn. CRC Press
- b. Buchanan B B, Gruissem W, Jones R L (2015) Biochemistry and Molecular Biology of Plants 2nd Edn. Wiley
- c. Dey P M, Harborne J B (1997) Plant Biochemistry, Academic Press
- d. Granger T (2018) Plant Biochemistry: Concepts and Applications, Callisto Reference
- e. Heldt H W, Piechulla B (2025) Plant Biochemistry 5th Edn. Academic Press Inc
- f. Millar H (2023) Textbook of Biochemistry and Molecular Biology of Plants, American Academic Publisher
- g. Nagaraj G (2015) Plant Biochemistry: Techniques and Procedures, New India Publishing Agency
- h. Roberts D (2021) Plant Biochemistry and Molecular Biology, ED Tech Press.
- i. Noggle, G.R. and Fritz, G.J. (1983). *Introductory Plant Physiology*.
- j. Bowsher C. and Tobin A. (2021) Plant Biochemistry, Garland Science.

8th Semester

BCH-451

**Introduction to Medicinal &
Aromatic Plants
(Theory)**

**Credit: 4
Total Marks: 100
Total contact hours: 60**

Learning Objectives (LOs):

1. To inculcate in students the traditional knowledge of various medicinal and aromatic plants in treating various ailments.
2. To make students aware of the problems of overharvesting of plant species.
3. To educate on the need to conserve such plants and their natural habitat through proper conservation techniques.
4. To learn basic extraction techniques for isolation of plant metabolites.
5. To familiarize students with surveys and fieldwork using locally available medicinal and aromatic plants.

Course Outcomes (COs):

1. Graduates will understand the importance of medicinal and aromatic plants in traditional knowledge system.
2. Will be aware of the cultivation and community conservation of endangered plants.
3. Will be able to identify medicinal plants of Meghalaya in relation to their uses in treating diseases and other applications.
4. Will be able to make basic extracts from medicinal and aromatic plants.
5. Will be able to identify and document few important medicinal and aromatic plants known locally.

Unit I

Credit 1

History, Scope and Importance of Medicinal Plants; Definition: endemic and endangered medicinal plants; Red list criteria; Conservation of endangered and endemic medicinal plants; In situ conservation: Biosphere reserves, sacred groves, National parks; Ex situ conservation: Botanical & Ethnomedicinal plant Gardens.

Unit II

Credit 1

Important Medicinal plants of North-East India: systematics, geographical distribution and uses. Application of medicinal plant products; Nutraceuticals in aging, jaundice, cardiac, infertility, diabetes, blood pressure and skin diseases.

Unit III

Credit 1

Important aromatic plants of India with their systematics, geographical distribution and uses. Introduction and historical background of aromatic plants. Aromatic and cosmetic products. Uses of important aromatic plants (citronella, geranium, large cardamom, lavender, lemon grass, mentha, basil).

Unit IV

Credit 1

Advances in medicinal and aromatic plants; Micropropagation of rare and endangered species (e.g., *Withania somnifera*, *Taxus baccata*); Hairy root culture for enhanced production of bioactive compounds (e.g., production of alkaloids from *Catharanthus roseus*); High-Throughput Screening (HTS); Rapid identification of novel therapeutic molecules from plant extracts; Nanoformulations of Plant Extracts; Development of nano-herbals for improved delivery, stability, and bioavailability.

Suggested Readings:

- a. Benzie I F F, Wachtel-Galor S (2011) Herbal Medicine 2nd Edn. CRC Press/Taylor & Francis
- b. Dolui A K, Sharma H K, Marein T B, Lalhriatpuii T C (2004) Folk herbal remedies from Meghalaya, Indian Journal of Traditional Knowledge 3(4):358-364
- c. Handique P J (2015) Medicinal Plants of North East India: Status diversity conservation cultivation and trade; International Book Distributors
- d. Hanson B A (2005) Understanding Medicinal Plants: Their Chemistry and Therapeutic Action 1st edn. Routledge (Taylor and Francis Group)
- e. Kayang H, Kharbuli B, Myrboh B, Syiem D (2005) Medicinal plants of Khasi hills of Meghalaya, India; International Society for Horticultural Science (ISHS) Acta Horticulturae 675: III WOCMAP Congress on Medicinal and Aromatic Plants - Volume 1: Bioprospecting and Ethnopharmacology
- f. Mathe A, Khan I A (2022) Medicinal and Aromatic Plants of India (Vol. 1) 1st edn. Springer Cham
- g. Rai M K, Cordell G A, Martinez J L, Marinoff M, Rastrelli L (2012) Medicinal Plants: Biodiversity and Drugs 1st edn. CRC Press
- h. Ross I A (2005) Medicinal Plants of the World: Chemical Constituents, Traditional and Modern Medicinal Uses, Vol.3 Humana Totowa, NJ.
- i. Shankaraswamy J, Neelavathi R (2022) Comprehensive Book on Medicinal Plants. Narendra Publishing House.

8th Semester**BCH-452****Research Project/
Dissertation****Total contact hours: 360****Credit: 12****Total Marks: 300**

	Credits	Maximum marks
Problem identification, review of literature, proposal writing and presentation	3	75
Dissertation: experiments, data collection, analysis, interpretation and discussion	6	150
Dissertation presentation and viva voce	3	75
Total	12	300

8th Semester

BCH-453

Practical-I

Credit: 4

Total Marks: 100

Total contact hours: 60

Learning Objectives (LOs):

1. The students will be taught to understand the practical aspects to be used in Microbiology which will enhance their knowledge of the domain
2. . The students will be taught to understand the practical aspects to be used in Bioinformatics which will enhance their knowledge of the domain

Course Outcomes (COs):

1. Develop skills to analyse scientific problems and design appropriate molecular biology experiments.
2. Develop and conclude effective communication skills for presenting experimental results towards dissemination of knowledge.
3. Develop and conclude effective retrieval skills for presenting experimental results towards dissemination of knowledge.
4. Design and execute experiments in molecular biology.

1. Effect of inhibitors/uncouplers on the activity of photosynthetic Electron Transport Chain.
2. Estimation of superoxide dismutase (SOD), catalase (CAT) and peroxidase (POD) activity in plant seedlings.
3. Extraction and visualization of Plasmids from bacterial culture
4. Bacterial transformation by CaCl₂ method
5. Isolation of protein using ammonium sulphate fractionation
6. Restriction digestion of lambda DNA
7. Sequence alignment using BLAST Multiple alignment
8. PCR of 16S rRNA gene of *E. coli*
9. Retrieval of protein and nucleotide sequences from biological databases – NCBI – protein and nucleotide databases, DDBJ, EMBL, Uniprot and KEGG
10. Retrieval of three-dimensional structures of biomolecules from PDB and its visualization.
11. Estimation of carotene/phenols/tannins in fruits and vegetables
12. Estimation of nitrate.

Suggested Readings:

1. Barrett K E et. Al. (2009) Ganong's Review of Medical Physiology 23rd Edn. LANGE Basic Science
2. Baynes J W, et al. (2022) Medical Biochemistry 6th Edn., Elsevier Health Sciences
3. Bhagavan N V et. al. (2011) Essentials of Medical Biochemistry with Clinical cases 1st Edn., Acad.
4. Blanco A, Blanco G (2022) Medical Biochemistry 2nd Edn., Elsevier
5. Ganong W F (2003) Review of Medical Physiology 2nd Edn. Appleton & Lange USA
6. Guyton A C & Hall (2010) Textbook of Medical Physiology 12th Edn., W B Saunders.

7. Lieberman M, Peet A (2022) Marks' Basic Medical Biochemistry: A Clinical Approach 6th Edn., Wolters Kluwer Health
8. Meisenberg G, Simmons W H (2018) Principles of Medical Biochemistry 3rd Edn., Elsevier/Saunders
9. Physiology & Biochemistry in Modern Medicine (2012) by Books Group, General Books Pbn.
10. Puri D (2022) Textbook of Medical Biochemistry 5th Edn., Elsevier
11. Harold Varley (2005) Practical Clinical Biochemistry, 4th Edition, CBS Publishers & Distributors.

8th Semester:

BCH-454

Practical-II

Credits: 4

Marks: 100

Total contact hours: 60

Learning Objectives (LOs):

1. The students will be taught to understand the practical aspects to be used in Microbiology which will enhance their knowledge of the domain

Course Outcomes (COs):

1. To understand, learn and isolate, culture and maintenance of pure culture
2. Understand the safety protocols involved in handling microorganisms and demonstrate ethical aspects in the collection, handling, and dissemination of microbial data
3. Understand the method for estimating the quality of environmental samples.
4. Apply and analyse various microbiological tools for identification of microorganisms and interpret the results.

1. Negative staining using Nigrosine or India Ink
2. Endospore Staining of bacteria using the Schaeffer-Fulton Method
3. Lactophenol Cotton Blue Staining for the observation of fungal structures.
4. Bacterial Identification Tests using – Catalase, Oxidase and Nitrate Reduction
5. Determination of Minimum Inhibitory Concentration (MIC) of an antibiotic
6. Isolation of amylase producing organisms from the environment
7. Isolation of protease producing organism from the environment
8. Isolation of lactic acid bacteria from fermented milk.
9. Determination of microbiological quality of milk sample by methylene blue reduction test
10. Isolation and estimation of water-soluble metabolite from available plant sample.
11. Isolation and estimation of non-polar metabolite from available plant sample.
12. Effect of plant extract on microbial growth.
13. Field survey and identification of *three each* of the medicinal and aromatic plants from Meghalaya.

Suggested Readings:

- a. Benzie I F F, Wachtel-Galor S (2011) Herbal Medicine 2nd Edn. CRC Press/Taylor & Francis
- b. Dolui A K, Sharma H K, Marein T B, Lalhriatpuii T C (2004) Folk herbal remedies from Meghalaya, Indian Journal of Traditional Knowledge 3(4):358-364
- c. Handique P J (2015) Medicinal Plants of North East India: Status diversity conservation cultivation and trade; International Book Distributors
- d. Hanson B A (2005) Understanding Medicinal Plants: Their Chemistry and Therapeutic Action 1st

edn. Routledge (Taylor and Francis Group)

- e. Kayang H, Kharbuli B, Myrboh B, Syiem D (2005) Medicinal plants of Khasi hills of Meghalaya, India; International Society for Horticultural Science (ISHS) Acta Horticulturae 675: III WOCMAP Congress on Medicinal and Aromatic Plants - Volume 1: Bioprospecting and Ethnopharmacology
- f. Mathe A, Khan I A (2022) Medicinal and Aromatic Plants of India (Vol. 1) 1st edn. Springer Cham
- g. Rai M K, Cordell G A, Martinez J L, Marinoff M, Rastrelli L (2012) Medicinal Plants: Biodiversity and Drugs 1st edn. CRC Press
- h. Ross I A (2005) Medicinal Plants of the World: Chemical Constituents, Traditional and Modern Medicinal Uses, Vol.3 Humana Totowa, NJ
- i. Shankaraswamy J, Neelavathi R (2022) Comprehensive Book on Medicinal Plants. Narendra Publishing House.

8th Semester

BCH-455

**Research Paper, Writing &
Plagiarism
(Theory)**

**Credit: 3
Total Marks: 75
Total contact hours: 45**

Learning Objectives (LOs):

1. To learn the skill of writing literature review.
2. To learn the skill of writing research paper.
3. To learn the skills of preparing and delivering oral presentations.

Course Outcomes (COs):

1. Graduates will be able to draft a literature review
2. Will be prepared to write a research paper
3. Will be able to prepare for oral presentations.

Unit I

Credit 1

Introduction to Academic Writing: Understanding the purpose of academic writing; Differentiating between review papers and research papers; Overview of the publication process in academic journals.

Structure and Organization: Components of a review paper and a research paper (introduction, literature review, methodology, results, discussion, conclusion); Crafting clear and concise research questions or objectives; Logical flow and coherence in writing.

Unit II

Credit 1

Literature Review: Conducting a comprehensive literature search; Critically evaluating and synthesizing existing literature; Proper citation and referencing techniques.

Research Methodology: Choosing appropriate research methods and designs; Data collection techniques and instruments; Data analysis methods and interpretation.

Unit III

Credit 1

Results Presentation: Formatting and presenting research findings effectively; Incorporating tables, figures, and images; Interpreting and discussing results in relation to research questions.

Discussion and Conclusion: Interpreting findings in the context of existing literature; Drawing conclusions and implications for future research; Addressing limitations and suggesting avenues for further study; Research matrices; Impact factor; H-index; i10-index; Open access and subscription-based journals.

8th Semester

BCH-455

**Research Paper, Writing &
Plagiarism
(Oral Presentation on
literature review/synopsis)**

**Credit: 1
Total Marks: 25
Total contact hours: 30**

1. Oral Presentation on Literature review/synopsis

Suggested Reading:

1. Leedy, P. D., & Ormrod, J. E. (2018). Practical Research: Planning and Design. Pearson.
2. Plagiarism in Scientific Research and Publications and How to Prevent It" by Izet Masic in Materiasociomedica - The Journal of Academy of Medical Science of Bosnia and Herzegovina (2014)
3. Plagiarism, Intellectual Property and the Teaching of L2 Writing" by Joel Bloch (2012)
4. Research Design: Qualitative, Quantitative and Mixed Methods Approaches (207) J David Cresswell and John Cresswell, eds. Sage Publications.
5. Research Methodology- a step-by-step guide to beginners (2011) Ranjit Kumar 6th Edn. Sage Publications.
6. Research Methodology: Methods and Techniques (2004) C R Kothari, 2nd revised edition, New Age International Publishers.
7. Research Methods: A Practical Guide for Graduates and Researchers (2017) Willie Chee Keong Tanby World Scientific Publ.
8. Sekaran, U., & Bougie, R. (2016). Research Methods for Business: A Skill-Building Approach. John Wiley & Sons.
9. The Scientist's Guide to Writing: How to Write More Easily and Effectively throughout Your Scientific Career" by Stephen B Heard (2016)
10. Walliman, N. (2017). Research Methods: The Basics. Routledge.