**CURRICULUM AND CREDIT FRAMEWORK**

**for**

**FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUP)**

**in**

**MOLECULAR BIOLOGY & BIOTECHNOLOGY**

**(*As per provisions of NEP 2020*)**

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# With Effect from Academic session 2023 - 2024

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**Undergraduate Board of Studies**

**In**

**Molecular Biology & Biotechnology**

# UNIVERSITY OF KALYANI

**CURRICULUM AND CREDIT FRAMEWORK FOR FOUR-YEAR B.SC. MAJOR IN MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

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**CURRICULUM AND CREDIT FRAMEWORK FOR FOUR-YEAR B.SC. MAJOR IN MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| (A) LIST OF MAJOR COURSES [M] | | | |
|---|---|---|---|
| **Course Code** | **Course Title** | **Credit of Course** | **Semester** |
| **MBBT – M-T-1/ P-1** | **BIOCHEMISTRY & METABOLISM** | 6 | I |
| **MBBT – M-T-2/ P-2** | **CELL BIOLOGY** | 6 | II |
| **MBBT – M-T-3/ P-3** | **GENETICS** | 6 | III |
| **MBBT – M-T-4/ P-4** | **GENERAL MICROBIOLOGY** | 6 | IV |
| **MBBT – M-T-5/ P-5** | **BIOPHYSICS** | 6 | IV |
| **MBBT – M-T-6/ P-6** | **MOLECULAR BIOLOGY** | 6 | V |
| **MBBT – M-T-7/ P-7** | **IMMUNOLOGY** | 6 | V |
| **MBBT – M-T-8/ P-8** | **BIOINFORMATICS** | 6 | VI |
| **MBBT – M-T-9/ P-9** | **RECOMBINANT DNA TECHNOLOGY** | 6 | VI |
| **MBBT – M-T-10/ P-10** | **ENVIRONMENTAL BIOTECHNOLOGY** | 6 | VI |
| **MBBT – M-T-11/ P-11** | **BIOPROCESS TECHNOLOGY** | 6 | VII |
| **MBBT – M-T-12/ P-12** | **BIOANALYTICAL TOOLS** | 6 | VII |
| **MBBT – M-T-13/ P-13** | **GENOMICS AND PROTEOMICS** | 6 | VII |
| **MBBT – M-T-14/ P-14** | **BIOSTATISTICS** | 4 | VIII |
| **MBBT – M-T-15/ P-15** | **ANIMAL BIOTECHNOLOGY** | 4 | VIII |
| **MBBT – M-T-16/ P-16** | **MICROBIAL PHYSIOLOGY** | 4 | VIII |
| **MBBT – M-T-17/ P-17** | **PLANT BIOTECHNOLOGY** | 6 | VIII |
| **MBBT – M-T-18/ P-18** | **BIOTECHNOLOGY AND HUMAN WELFARE** | 6 | VIII |

Course nos. 17 and 18 to be completed by candidates opting for B.Sc. Hons degree without research.

| (B) LIST OF SKILL ENHANCEMENT COURSES [SEC] | | | |
|---|---|---|---|
| **Course Code** | **Course Title** | **Credit of Course** | **Semester** |
| **MBBT – SEC- T-1** | **ENZYMOLOGY** | 3 | I |
| **MBBT – SEC- T-2** | **MICROBIAL DIAGNOSIS IN HEALTH CLINICS** | 3 | II |
| **MBBT – SEC- T-3A/ 3B** | **(A) BIOFERTILIZER OR (B) MOLECULAR DIAGNOSTICS** | 3 | III |

| (C) LIST OF MINOR COURSES [MI]<br>To be **OPTED** by the students from **OTHER** departments | | | |
|---|---|---|---|
| **Course Code** | **Course Title** | **Credit of Course** | **Semester** |
| **MBBT – MI-T-1/ P-1** | **BIOLOGICAL CHEMISTRY** | 4 | I or II |
| **MBBT – MI-T-2/ P-2** | **BIOLOGY OF MICROORGANISMS** | 4 | III or IV |
| **MBBT – MI-T-3/ P-3** | **MOLECULAR BIOLOGY** | 4 | V |
| **MBBT – MI-T-4/ P-4** | **RECOMBINANT DNA TECHNOLOGY** | 4 | VII |

Students from **OTHER** departments opting MBBT as **minor I** in Sem I should study the papers in Semesters I, III, V and VII respectively. Similarly, those who would opt for MBBT as **minor II** should study the papers in Semesters II, IV, V and VII respectively.

| (D) LIST OF COURSES FROM COMMON POOL | | | |
|---|---|---|---|
| **Sl. No.** | **Course Category** | **Credit of Course** | **Semester** |
| **1** | **MULTIDISCIPLINARY COURSE - 1** | 3 | I |
| **2** | **MULTIDISCIPLINARY COURSE - 2** | 3 | II |
| **3** | **MULTIDISCIPLINARY COURSE - 3** | 3 | III |
| **4** | **ABILITY ENHANCEMENT COURSE – 1 [Communicative English]** | 4 | II |
| **5** | **ABILITY ENHANCEMENT COURSE – 2 [Modern Indian Language - MIL]** | 4 | IV |
| **6** | **VALUE ADDED COURSE – 1 [Environmental Education]** | 4 | I |
| **7** | **VALUE ADDED COURSE – 2** | 4 | III |

| (E) LIST OF SUMMER INTERNSHIP/ OUTREACH/ RESEARCH PROJECT | | | | |
|---|---|---|---|---|
| **Sl. No.** | **Course Category** | **Stipulation w.r.t. exit option** | **Credit of Course** | **Semester** |
| **1** | **SUMMER INTERNSHIP - 1** | **Additional** for Certificate [NOT for 3-yr UG/ 4-yr Hons (with/ without research) degree] | 4 | II |
| **2** | **SUMMER INTERNSHIP - 2** | **Additional** for Diploma [NOT for 3-yr UG/ 4-yr Hons (with/ without research) degree] | 4 | IV |
| **3** | **OUTREACH/ INTERNSHIP - 1** | **Mandatory** for 3-yr UG/ 4-yr Hons (with/ without research) degree | 2 | VI |
| **4** | **RESEARCH PROJECT - 1** | **Mandatory** for 4-yr Hons (with research) degree | 12 | VIII |

| (F) Semester-wise Distribution of Curriculum & Credits for Four-Year B.Sc. Major in Molecular Biology and Biotechnology | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sem** | **No. of courses under each category** | | | | | | | | **Total courses** | **Total credits** |
| | **M (6 Cr)** | **MI (4 Cr)** | **MU (3 Cr)** | **AEC (4 Cr)** | **SEC (3 Cr)** | **VAC (4 Cr)** | **SC (4 Cr)** | **RP (12 Cr)** | | |
| **I** | 1 | 1 | 1 | -- | 1 | 1 | -- | -- | 5 | 20 |
| **II** | 1 | 1 | 1 | 1 | 1 | -- | 1 | -- | 5+1 | 20+4 |
| **Certificate** | **12 Cr** | **8 Cr** | **6 Cr** | **4 Cr** | **6 Cr** | **4 Cr** | **4 Cr** | -- | **10+1** | **40+4 Cr** |
| **III** | 1 | 1 | 1 | -- | 1 | 1 | -- | -- | 5 | 20 |
| **IV** | 2 | 1 | -- | 1 | -- | -- | 1 | -- | 4+1 | 20+4 |
| **Diploma** | **30 Cr** | **16 Cr** | **9 Cr** | **8 Cr** | **9 Cr** | **8 Cr** | **4 Cr** | -- | **19+1** | **80+4 Cr** |
| **Sem** | **M (6 Cr)** | **MI (4 Cr)** | **MU (3 Cr)** | **AEC (4 Cr)** | **SEC (3 Cr)** | **VAC (4 Cr)** | **IN (2 Cr)** | **RP (12 Cr)** | **Total courses** | **Total credits** |
| **V** | 2 | 2 | -- | -- | -- | -- | -- | -- | 4 | 20 |
| **VI** | 3 | -- | -- | -- | -- | -- | 1 | -- | 3+1 | 18+2 |
| **UG degree** | **60 Cr** | **24 Cr** | **9 Cr** | **8 Cr** | **9 Cr** | **8 Cr** | **2 Cr** | -- | **26+1** | **118+2 Cr = 120 Cr** |
| **VII** | 3 (6 Cr) | 2 | -- | -- | -- | -- | -- | -- | 5 | 26 |
| **VIII (Hons without research)** | 3 (4 Cr) + 2 (6 Cr) | -- | -- | -- | -- | -- | -- | -- | 5 | 24 |
| **VIII (Hons with research)** | 3 (4 Cr) | -- | -- | -- | -- | -- | -- | 1 (12 Cr) | 3+1 | 24 |
| **UG Hons without research** | **102 Cr** | **32 Cr** | **9 Cr** | **8 Cr** | **9 Cr** | **8 Cr** | **2 Cr** | -- | **36+1** | **168+2 Cr = 170 Cr** |
| **UG Hons with research** | **90 Cr** | **32 Cr** | **9 Cr** | **8 Cr** | **9 Cr** | **8 Cr** | **2 Cr** | **12 Cr** | **34+1+1** | **156+2+12 Cr = 170 Cr** |

M, Major; MI, Minor, MU, Multidisciplinary; AEC, Ability Enhancement; SEC, Skill Enhancement; VAC, Value added; SC/ IN, Summer course/ Internship/ Outreach; RP, Research project. Entries in red font indicates additional criteria that are required to be fulfilled to activate exit options prior to completion of 3-yr UG/ 4-yr Hons (with/ without research) degree.

| (G) Semester-wise Summary of Marks & Credits for Four-Year B.Sc. Major in Molecular Biology and Biotechnology | | | | | | |
|---|---|---|---|---|---|---|
| **Semester** | **Structured Courses** | | | **Internship/ Outreach/ Research Project** | | |
| | **No. of courses** | **Credits** | **Marks** | **Stipulations** | **No. of courses** | **Credits** |
| **I** | 05 | 20 | 265 | -- | -- | -- |
| **II** | 05 | 20 | 265 | Summer Internship – 1<br>**Additional** for Certificate<br>[NOT for 3-yr UG/ 4-yr Hons (with/ without research) degree] | 01 | 04 |
| **Certificate** | **10** | **40** | **530** | **Certificate summary**<br>Total Credits = 40 + 04<br>Total Marks = 530 | **01** | **04** |
| **III** | 05 | 20 | 265 | -- | -- | -- |
| **IV** | 04 | 20 | 250 | Summer Internship – 2<br>**Additional** for Diploma<br>[NOT for 3-yr UG/ 4-yr Hons (with/ without research) degree] | 01 | 04 |
| **Diploma** | **19** | **80** | **1045** | **Diploma summary**<br>Total Credits = 80 + 04<br>Total Marks = 1045 | **01** | **04** |
| **V** | 04 | 20 | 250 | -- | -- | -- |
| **VI** | 03 | 18 | 225 | **OUTREACH/ INTERNSHIP – 1**<br>**Mandatory** for 3-yr UG/ 4-yr Hons (with/ without research) degree | 01 | 02 |
| **UG Degree** | **26** | **118** | **1520** | **UG Major Degree summary**<br>Total Credits = 118 + 02 = 120<br>Total Marks = 1520 | **01** | **02** |
| **VII** | 05 | 26 | 325 | -- | -- | -- |
| **VIII (Hons without research)** | 3 **(4 Cr)** + 2 **(6 Cr)** | 24 | 300 | -- | -- | -- |
| **VIII (Hons with research)** | 3 **(4 Cr)** | 12 | 150 | **RESEARCH PROJECT – 1**<br>**Mandatory** for 4-yr Hons (with research) degree | 01 | 12 |
| **UG Hons without research** | **36** | **168** | **2145** | **UG Hons (without research) summary**<br>Total Credits = 168 + 02 = 170<br>Total Marks = 2145 | **01** | **02** |
| **UG Hons with research** | **34** | **156** | **1995** | **UG Hons (with research) summary**<br>Total Credits = 156 + 02 + 12 = 170<br>Total Marks = 1995 | **01+01** | **02+12** |

**COURSE STRUCTURE FOR B.SC. MAJOR**
**IN**
**MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| **SEMESTER I** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Nature of Course** | **Credit of Course** | **Class hour/ week** | **Evaluation** | | **Total** |
| | | | | | **IA** | **Sem End** | |
| **MBBT – M-T-1** | **BIOCHEMISTRY & METABOLISM** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-1** | | | 2 | 4 | | 20 | 20 |
| **MBBT – MI-T-1** | **BIOLOGICAL CHEMISTRY** To be **OPTED** by the students from **OTHER** department | Minor | 3 | 3 | 10 | 30 | 40 |
| **MBBT – MI-P-1** | | | 1 | 2 | | 10 | 10 |
| **MBBT– MU- T-1** | To be developed and offered by respective colleges. To be **OPTED** by the students from **OTHER** department | Multidiscipli nary | 3 | 3 | 10 | 35 | 45 |
| **AEC** | XXX | Ability Enhan cement | X | X | X | X | X |
| **MBBT – SEC- T-1** | **ENZYMOLOGY** | Skill Enhan cement | 3 | 3 | 10 | 35 | 45 |
| **VAC-T-1** | **ENVIRONMENTAL EDUCATION** (Content from common pool) | Value added | 4 | 4 | 10 | 40 | 50 |
| **IN** | XXX | Interns hip | X | X | X | X | X |
| **05** | Total | | 20 | 23 | 55 | 210 | 265 |

XXX – Component is not part of course structure of current semester

**COURSE STRUCTURE FOR B.SC. MAJOR**
**IN**
**MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| **SEMESTER II** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Nature of Course** | **Credit of Course** | **Class hour/ week** | **Evaluation** | | **Total** |
| | | | | | **IA** | **Sem End** | |
| **MBBT – M-T-2** | **CELL BIOLOGY** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-2** | | | 2 | 4 | | 20 | 20 |
| **MBBT – MI-T-1** | **BIOLOGICAL CHEMISTRY** To be **OPTED** by the students from **OTHER** department | Minor | 3 | 3 | 10 | 30 | 40 |
| **MBBT – MI-P-1** | | | 1 | 2 | | 10 | 10 |
| **MBBT – MU- T-1** | To be developed and offered by respective colleges. To be **OPTED** by the students from **OTHER** department | Multidisciplinary | 3 | 3 | 10 | 35 | 45 |
| **AEC** | **COMMUNICATIVE ENGLISH** (Content from common pool) | Ability Enhancement | 4 | 4 | 10 | 40 | 50 |
| **MBBT – SEC- T-2** | **MICROBIAL DIAGNOSIS IN HEALTH CLINICS** | Skill Enhancement | 3 | 3 | 10 | 35 | 45 |
| **VAC** | XXX | Value added | X | X | X | X | X |
| **IN** | **Additional for Certificate** | Internship | 4 | 8 | | | |
| **05 + 01** | Total | | 20+4 | 23+8 | 55 | 210 | 265 |

XXX – Component is not part of course structure of current semester

**COURSE STRUCTURE FOR B.SC. MAJOR**
**IN**
**MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| **SEMESTER III** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Nature of Course** | **Credit of Course** | **Class hour/ week** | **Evaluation** | | **Total** |
| | | | | | **IA** | **Sem End** | |
| **MBBT – M-T-3** | **GENETICS** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-3** | | | 2 | 4 | | 20 | 20 |
| **MBBT – MI-T-2** | **BIOLOGY OF MICROORGANISMS** To be **OPTED** by the students from **OTHER** department | Minor | 3 | 3 | 10 | 30 | 40 |
| **MBBT – MI-P-2** | | | 1 | 2 | | 10 | 10 |
| **MBBT– MU- T-3** | To be developed and offered by respective colleges. To be **OPTED** by the students from **OTHER** department | Multidiscipli nary | 3 | 3 | 10 | 35 | 45 |
| **AEC** | XXX | Ability Enhan cement | X | X | X | X | X |
| **MBBT – SEC- T-3** | **(A) BIOFERTILIZER OR (B) MOLECULAR DIAGNOSTICS** | Skill Enhan cement | 3 | 3 | 10 | 35 | 45 |
| **VAC-T-2** | Content from common pool | Value added | 4 | 4 | 10 | 40 | 50 |
| **IN** | XXX | Interns hip | X | X | X | X | X |
| **05** | Total | | 20 | 23 | 55 | 210 | 265 |

XXX – Component is not part of course structure of current semester

**COURSE STRUCTURE FOR B.SC. MAJOR**
**IN**
**MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| SEMESTER IV | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Nature of Course** | **Credit of Course** | **Class hour/ week** | **Evaluation** | | **Total** |
| | | | | | **IA** | **Sem End** | |
| **MBBT – M-T-4** | **GENERAL MICROBIOLOGY** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-4** | | | 2 | 4 | | 20 | 20 |
| **MBBT – M-T-5** | **BIOPHYSICS** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-5** | | | 2 | 4 | | 20 | 20 |
| **MBBT – MI-T-2** | **BIOLOGY OF MICROORGANISMS** To be **OPTED** by the students from **OTHER** department | Minor | 3 | 3 | 10 | 30 | 40 |
| **MBBT – MI-P-2** | | | 1 | 2 | | 10 | 10 |
| **MBBT– MU** | **XXX** | Multidisciplinary | X | X | X | X | X |
| **AEC** | **MIL** (Content from common pool) | Ability Enhancement | 4 | 4 | 10 | 40 | 50 |
| **SEC** | **XXX** | Skill Enhancement | X | X | X | X | X |
| **VAC** | **XXX** | Value added | X | X | X | X | X |
| **IN** | **Additional for Diploma** | Internship | 4 | 8 | | | |
| **04 + 01** | Total | | 20+4 | 25+8 | 50 | 200 | 250 |

XXX – Component is not part of course structure of the current semester

**COURSE STRUCTURE FOR B.SC. MAJOR**
**IN**
**MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| SEMESTER V | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Nature of Course** | **Credit of Course** | **Class hour/ week** | **Evaluation** | | **Total** |
| | | | | | **IA** | **Sem End** | |
| **MBBT – M-T-6** | **MOLECULAR BIOLOGY** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-6** | | | 2 | 4 | | 20 | 20 |
| **MBBT – M-T-7** | **IMMUNOLOGY** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-7** | | | 2 | 4 | | 20 | 20 |
| **MBBT – MI-T-3** | **MOLECULAR BIOLOGY** To be **OPTED** by the students from **OTHER** department | Minor | 3 | 3 | 10 | 30 | 40 |
| **MBBT – MI-P-3** | | | 1 | 2 | | 10 | 10 |
| **MI – T** | To be offered by other departments. To be **OPTED** by the students from **OTHER** department | Minor | 3 | 3 | 10 | 30 | 40 |
| **MI – P** | | | 1 | 2 | | 10 | 10 |
| **MU** | XXX | Multidisciplinary | X | X | X | X | X |
| **AEC** | XXX | Ability Enhancement | X | X | X | X | X |
| **SEC** | XXX | Skill Enhancement | X | X | X | X | X |
| **VAC** | XXX | Value added | X | X | X | X | X |
| **IN** | XXX | Internship | X | X | X | X | X |
| **04** | Total | | 20 | 26 | 50 | 200 | 250 |

XXX – Component is not part of course structure of current semester

**COURSE STRUCTURE FOR B.SC. MAJOR**
**IN**
**MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| SEMESTER VI | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Nature of Course** | **Credit of Course** | **Class hour/ week** | **Evaluation** | | **Total** |
| | | | | | **IA** | **Sem End** | |
| **MBBT – M-T-8** | **BIOINFORMATICS** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-8** | | | 2 | 4 | | 20 | 20 |
| **MBBT – M-T-9** | **RECOMBINANT DNA TECHNOLOGY** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-9** | | | 2 | 4 | | 20 | 20 |
| **MBBT – M-T-10** | **ENVIRONMENTAL BIOTECHNOLOGY** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-10** | | | 2 | 4 | | 20 | 20 |
| **MBBT– MU** | **XXX** | Multidisciplinary | X | X | X | X | X |
| **AEC** | **XXX** | Ability Enhancement | X | X | X | X | X |
| **MBBT – SEC-T** | **XXX** | Skill Enhancement | X | X | X | X | X |
| **VAC-T** | **XXX** | Value added | X | X | X | X | X |
| **IN** | **OUTREACH/INTERNSHIP [for UG Degree]** | Internship | 2 | 4 | | | |
| **03+01** | Total | | 18+2 | 24+4 | 45 | 180 | 225 |

XXX – Component is not part of course structure of the current semester

**COURSE STRUCTURE FOR B.SC. MAJOR**
**IN**
**MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| **SEMESTER VII** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Nature of Course** | **Credit of Course** | **Class hour/ week** | **Evaluation** | | **Total** |
| | | | | | **IA** | **Sem End** | |
| **MBBT – M-T-11** | **BIOPROCESS TECHNOLOGY** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-11** | | | 2 | 4 | | 20 | 20 |
| **MBBT – M-T-12** | **BIOANALYTICAL TOOLS** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-12** | | | 2 | 4 | | 20 | 20 |
| **MBBT – M-T-13** | **GENOMICS AND PROTEOMICS** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-13** | | | 2 | 4 | | 20 | 20 |
| **MBBT – MI-T-4** | **RECOMBINANT DNA TECHNOLOGY** To be **OPTED** by the students from **OTHER** department | Minor | 3 | 3 | 10 | 30 | 40 |
| **MBBT – MI-P-4** | | | 1 | 2 | | 10 | 10 |
| | To be offered by other departments. To be **OPTED** by the students from **OTHER** department | Minor | 3 | 3 | 10 | 30 | 40 |
| | | | 1 | 2 | | 10 | 10 |
| **MU** | XXX | Multidisciplinary | X | X | X | X | X |
| **AEC** | XXX | Ability Enhancement | X | X | X | X | X |
| **SEC** | XXX | Skill Enhancement | X | X | X | X | X |
| **VAC** | XXX | Value added | X | X | X | X | X |
| **IN** | XXX | Internship | X | X | X | X | X |
| **05** | Total | | 26 | 34 | 65 | 260 | 325 |

XXX – Component is not part of course structure of current semester

**COURSE STRUCTURE FOR B.SC. MAJOR**

**IN**

**MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

| SEMESTER VIII | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Nature of Course** | **Credit of Course** | **Class hour/ week** | **Evaluation** | | **Total** |
| | | | | | **IA** | **Sem End** | |
| **MBBT – M-T-14** | **BIOSTATISTICS** | Major | 3 | 3 | 10 | 30 | 40 |
| **MBBT – M-P-14** | | | 1 | 2 | | 10 | 10 |
| **MBBT – M-T-15** | **ANIMAL BIOTECHNOLOGY** | Major | 3 | 3 | 10 | 30 | 40 |
| **MBBT – M-P-15** | | | 1 | 2 | | 10 | 10 |
| **MBBT – M-T-16** | **MICROBIAL PHYSIOLOGY** | Major | 3 | 3 | 10 | 30 | 40 |
| **MBBT – M-P-16** | | | 1 | 2 | | 10 | 10 |
| **MBBT – M-T-17** | **PLANT BIOTECHNOLOGY [for Hons. Degree without Research]** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-17** | | | 2 | 4 | | 20 | 20 |
| **MBBT – M-T-18** | **BIOTECHNOLOGY AND HUMAN WELFARE [for Hons. Degree without Research]** | Major | 4 | 4 | 15 | 40 | 55 |
| **MBBT – M-P-18** | | | 2 | 4 | | 20 | 20 |
| **MI** | **XXX** | Minor | X | X | X | X | X |
| **MU** | **XXX** | Multidisciplinary | X | X | X | X | X |
| **AEC** | **XXX** | Ability Enhancement | X | X | X | X | X |
| **SEC** | **XXX** | Skill Enhancement | X | X | X | X | X |
| **VAC** | **XXX** | Value added | X | X | X | X | X |
| **RP** | **1 Research project/Dissertation [for Hons. Degree with Research]** | Research Project | 12 | | | | |
| **03 + 02 + 01** | Total | | 12 + 12 + 12 | 15 + 16 | 30+ 30 | 120 + 120 | 150 + 150 |

XXX – Component is not part of course structure of the current semester

Detailed Syllabus for

Four-Year B.Sc. MAJOR IN MOLECULAR BIOLOGY & BIOTECHNOLOGY

**MAJOR COURSES**

**Title of the Paper: BIOCHEMISTRY AND METABOLISM**

Code: MBBT – M-T-1

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| Water, buffer, and acid-base chemistry: Physical and chemical properties of water, Weak interactions in aqueous systems, Basis of acidity and basicity, Ionization of water, weak acids and weak bases, Equilibrium constant, Dissociation constant and the pH scale, Ionic product of water, Buffers – systems that resist pH changes, Henderson-Hasselbalch equation, significance of pH in biological systems, Measurement of pH – indicators, pH meter.<br>Chromatography: Principles and Applications in protein purification. |
| **UNIT II (20 periods)** |
| Structure, classification and properties of Amino acids, Peptide bond, Conformation of peptide bonds, Backbone torsion angles, Ramachandran plot, Forces stabilizing protein structure, Different Level of structural organization of proteins: alpha helix, beta sheet, reverse turns, helix propensity scale, collagen helix and coiled coil, Motifs and domains, Fibrous and globular proteins, Structural features of membrane proteins, hydrophobicity scale.<br>Strategies of protein purification.<br>Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides (glycogen, starch, cellulose). |
| **UNIT III (10 periods)** |
| Lipids: Structure and functions –Classification, nomenclature, and properties of fatty acids, essential fatty acids. Triglycerides, Membrane lipids: Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Archaebacterial ether lipids, Prostaglandins, Cholesterol.<br>Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, purines & pyrimidines, Nucleosides & Nucleotides, Anti and syn conformations of nucleotides, sugar pucker in DNA and RNA, Double helical model of DNA structure and forces responsible for A, B, & Z – DNA, DNA-RNA hybrid. Supercoiling of DNA, Topoisomers. |
| **UNIT IV (20 periods)** |
| Carbohydrates Metabolism (Reactions and regulations): Glycolysis, Fate of pyruvate under aerobic and anaerobic conditions, TCA cycle, Electron transport chain, Oxidative phosphorylation, Gluconeogenesis, Glycogenolysis, glycogen synthesis, Pentose phosphate pathway, Fatty acid metabolism (Reactions and regulations): Synthesis and ß-oxidation of fatty acids, $CO_2$ fixation in higher plants – $C_2$, $C_3$, $C_4$ and CAM. |

**Title of the Paper: BIOCHEMISTRY AND METABOLISM**

Code: MBBT – M-P-1

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Examination of physical properties of biomolecules – colour, odour, texture.
2. Preparation of normal, molar, and gm% solutions.
3. Qualitative tests for Carbohydrates, proteins, and lipids.
4. Operation of pH meter.
5. Preparation of buffers.
6. Separation of Amino acids and plant pigments by Paper chromatography.
7. Separation of Amino acids and plant pigments by Thin Layer chromatography.

SUGGESTED READING


1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry.VI Edition. W.H Freeman and Co.
2. Segel, I. H., (2004) Biochemical calculations, 2nd Edition, John Wiley and Sons.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Molecules of Life. John Kuriyan, Boyana Konforti, David Wemmer. Garland Science. 2013
5. Student Companion to Accompany Biochemistry. Richard I Gumport, Frank H Deis, Nancy Counts Gerber, Roger Koeppe II. 5th Edition. W. H. Freeman. 2002
6. Upadhyay, A., Upadhyay, K., Nath, N., (2006) Biophysical Chemistry – principles and techniques. Himalaya Publishing House.
7. Plummer, D. T., (2005) An Introduction to Practical Biochemistry, Tata McGraw-Hill publishing Co. Ltd.

**Title of the Paper: CELL BIOLOGY**

Code: MBBT – M-T-2

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation, visualisation of cells<br>Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport |
| **UNIT II (15 periods)** |
| Membrane Vacuolar system, cytoskeleton, and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments<br>Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion. Lysosomes: Vacuoles and micro bodies: Structure and functions |
| **UNIT III (20 periods)** |
| Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis<br>Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes, and their structure<br>Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function |
| **UNIT IV (15 periods)** |
| Cell Signaling: Principles of cell signaling, Signaling through G protein coupled receptor and enzyme coupled receptors, Signaling routes in regulation of gene expression<br>Cell Cycle: Overview of the cell cycle, Cell cycle control system, Control of cell division and cell growth<br>Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics, and molecular basis of cancer |

**Title of the Paper: CELL BIOLOGY**

Code: MBBT – M-P-2

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or Yeast cell.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING


1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. 2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006.Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. 3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press& Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009.The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

**Title of the Paper: GENETICS**

Code: MBBT – M-T-3

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their significance.<br>Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity. |
| **UNIT II (15 periods)** |
| Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.<br>Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic and viral genome.<br>Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. Packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function. |
| **UNIT III (15 periods)** |
| Chromosome and gene mutations: Definition and types of mutations, causes of mutations, molecular basis, Phenotypic effects, Ames test for mutagenic agents, screening procedures for isolation of mutants, variation in chromosome number and structure - Ploidy- euploid, aneuploid, monoploid, diploid, triploid, tetraploid, polyploid, amphidiploid, nullisomy, monosomy, trisomy, etc., deletion, duplication, inversion and translocation (reciprocal and Robertsonian), Associated diseases and Evolutionary Significance; Cytogenetics of human disorder - Turner syndrome, Klinefelter syndrome, Down syndrome etc., Human karyotype, Procedures to detect chromosomal aberrations in human fetuses. |
| **UNIT IV (10 periods)** |
| Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. |
| **UNIT V (10 periods)** |
| Analysis of single gene inheritance in pedigrees – symbols used in pedigree charts, autosomal, X-linked, mitochondrial, and pseudoautosomal inheritance patterns, Hemophilia, Colour blindness, Fragile-X- syndrome, LHON; mosaicism, unstable repeat |

expansions.
Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors, Genic balance theory, Barr bodies, Dosage compensation – hyperactivation, hypoactivation, and inactivation of X-linked genes, sex influenced traits.

**Title of the Paper: GENETICS**
Code: MBBT – M-P-3
**Course Category: MAJOR (Practical)**
Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body –
5. Translocation study in Rheo.
6. Karyotyping with the help of photographs
7. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
8. Study of polyploidy in onion root tip by colchicine treatment.

SUGGESTED READING


1. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics.V Edition. John Wiley and Sons
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics.IX Edition. Benjamin Cummings.
3. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings.
4. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co
5. Nussbaum R.L., McInnes R.R., Willard H.F. (2007). Thompson and Thompson – Genetics in Medicine. VIII Edition, Saunders – Elsevier
6. Elrod S L & Stansfield W D. Schaum's Outline Genetics. McGraw Hill

**Title of the Paper: GENERAL MICROBIOLOGY**

Code: MBBT – M-T-4

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| 1.1 Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.<br>1.2 Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses. |
| **UNIT II (10 periods)** |
| 2.1 Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. |
| **UNIT III (20 periods)** |
| 3.1 Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.<br>3.2 Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. |
| **UNIT IV (20 periods)** |
| 4.1 Control of Microorganisms: By physical, chemical and chemotherapeutic Agents.<br>Water Microbiology: Bacterial pollutants of water, coliforms and non-coliforms. Sewage composition and its disposal.<br>4.2 Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods. |

**Title of the Paper: GENERAL MICROBIOLOGY**

Code: MBBT – M-P-4

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

SUGGESTED READING

1.Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. Johnand Sons, Inc.

2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

3. Kumar HD. (1990). Introductory Phycology.2nd edition.Affiliated East Western Press.

4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.

5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology.5th edition. McGraw Hill Book Company.

6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.

8. Willey JM, Sherwood LM, and Woolverton CJ.(2008). Prescott, Harley and Klein's Microbiology.7th edition.McGraw Hill Higher Education.

**Title of the Paper: BIOPHYSICS**

Code: MBBT – M-T-5

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| 1.1 Atomic structure and bonding: Intermolecular attractions, hydrogen bonding, vanderwaals force, hydrophobic and hydrophilic bond, polar bond, properties of water.<br>1.2 Thermodynamics, reaction kinetics and energy transduction: Isolated, closed, and open systems; First and second laws of thermodynamics and their biological significance; Activation energy and transition-state theory; Different orders of chemical reactions, free energy, and chemical reaction. high energy phosphate compounds (ATP, creatine phosphate, thioesters).<br>1.3 General Biophysics and biochemistry– Acid, base, salt, buffers, pH, pK, Henderson, Hasselbalch equation, principle of measurement of pH. |
| **UNIT II (20 periods)** |
| 2.1 Isotopes and radioactivity: Radioactivity, decay law, Radioactive labeling, Detection and measurement of radioactive dose by GM counter, scintillation counter, autoradiography.<br>2.2 Hydrodynamic properties: Surface tension, diffusion, osmosis, sedimentation at molecular level. Factors affecting them.<br>2.3 Centrifugation – Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems, Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation. |
| **UNIT III (20 periods)** |
| 3.1 X-Ray Crystallography – X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, determination of crystal structure [concept of rotating crystal method, powder method].<br>3.2 Absorption Spectroscopy – Properties of light, molecular mechanism of the absorption of light by molecules, Beer-Lambert law, Factors affecting the absorption properties of a Chromophore. Infrared spectroscopy, Atomic absorption and emission spectroscopy, dynamic light scattering. |
| **UNIT IV (10 periods)** |
| 4.1 Spectroscopy: Raman Spectroscopy – Raman Effect, Quantum mechanical reason of Raman effect, NMR Spectroscopy – Basic principle of NMR spectroscopy, Experimental technique & instrumentation, Chemical shift, Hyperfine splitting, Relaxation process. |

**Title of the Paper: BIOPHYSICS**

Code: MBBT – M-P-5

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Preparation of buffers: Citrate, Tris-HCl, Phosphate buffer.
2. Use of pH meter
3. Titration of amino acid (Glycine) for determination of pKa
4. ECG pattern study.
5. Column chromatography.
6. Interpretation and measurement of X-ray diffraction pattern.
7. Verify Lambert-Beer's law by Spectrophotometer.
8. Spectrophotometric determination of unknown concentration of biomolecules (Protein/ carbohydrate/ DNA/ RNA)
9. Study the activity of any enzyme under optimum conditions
10. Paper chromatographic separation technique: Separation of amino acids and pigments after extractionfrom plants.
11. Thin layer (TLC) & Column chromatographic technique.

SUGGESTED READING

1. Physical Biochemistry. David Friefelder.2-nd edition, W.H.Freeman and Company.

2. Physical Biochemistry, Upadhaya, Upadhaya, Nath, Himalaya Publishers.

3. Nelson, D.L. Cox M.M. Lehninger Principles of Biochemistry, 6-th edition.

**Title of the Paper: MOLECULAR BIOLOGY**

Code: MBBT – M-T-6

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods): DNA structure and replication** |
|---|
| DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication. |
| **UNIT II (10 periods): DNA damage, repair, and homologous recombination** |
| DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism. |
| **UNIT III (15 periods): Transcription and RNA processing** |
| RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation, and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing. |
| **UNIT IV (18 periods): Regulation of gene expression and translation** |
| Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, Differences between prokaryotic and eukaryotic translation initiation, elongation and role of peptidyl transferase, termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins. |
| **UNIT IV (07 periods): Transposable genetic elements** |
| Transposons, transposition, types of transposons, mechanism, P elements of Drosophila, Ac/Ds element in maize, hybrid dysgenesis, regulation of kernel colour in maize |

**Title of the Paper: MOLECULAR BIOLOGY**

Code: MBBT – M-P-6

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method.
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA.
5. Preparation of restriction enzyme digests of DNA samples.
6. Demonstration of AMES test for carcinogenicity

SUGGESTED READING


1. Weaver R. Molecular Biology.
2. Watson, J, Baker, T, Bell S, Gann, A, Levine, M, Losick, R. (2013). Molecular Biology of the Gene. VII Edition. Pearson.
3. Berk A. Kaiser, C. A., Lodish, H et. al. Molecular Cell Biology (2016). VIII Edition. W. H. Freeman.
4. Alberts, B, Johnson, A, Lewis, J, et al., Molecular Biology of the Cell, (2002) VI edition. New York: Garland Science.

**Title of the Paper: IMMUNOLOGY**

Code: MBBT – M-T-7

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (20 periods):** |
|---|
| Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination. |
| **UNIT II (15 periods):** |
| Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity. |
| **UNIT III (13 periods):** |
| Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS. |
| **UNIT IV (12 periods):** |
| Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines – Vaccines against SARS nCOV2 (Covid19), bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA. |

**Title of the Paper: IMMUNOLOGY**

Code: MBBT – M-P-7

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Determination of blood groups
2. Total RBC count
3. Total leucocytes count
4. Differential leucocytes count
5. Haemagglutination/ latex agglutination assay
6. Haemagglutination inhibition assay
7. Separation of serum from blood
8. Ouchterlony double immunodiffusion test using specific antibody and antigen.
9. Dot/ standard ELISA

SUGGESTED READING


1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

**Title of the Paper: BIOINFORMATICS**

Code: MBBT – M-T-8

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| 1.1 History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Indian Biological Data Centre (IBDC). Understanding the structure of each source and using it on the web. |
| **UNIT II (20 periods)** |
| 2.1 Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry. |
| **UNIT III (20 periods)** |
| 3.1 Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis. |
| **UNIT IV (10 periods)** |
| 4.1 Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.<br>4.2 Genome Annotation: Pattern and repeat finding, Gene identification tools. |

**Title of the Paper: BIOINFORMATICS**

Code: MBBT – M-P-8

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Proteininformation resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

SUGGESTED READING


1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. OxfordUniversity Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. IIEdition. Benjamin Cummings.

**Title of the Paper: RECOMBINANT DNA TECHNOLOGY**

Code: MBBT – M-T-09

**Course Category: MAJOR (Theory)**

Theory - 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods) - Cutting and Joining of DNA Fragments** |
|---|
| 1.1 Host-controlled restriction and modification, Different types of restriction enzymes and their characteristic features. Restriction mapping of linear and circular DNA fragments |
| 1.2 Modifying enzymes: Calf intestinal alkaline phosphatase, T4 and *E. coli* DNA Ligase, Klenow DNA polymerase, T4 Polynucleotide kinase, Terminal transferase, Reverse transcriptase, T4 RNA Ligase. |
| 1.2 Viewing DNA Fragments, principle of gel electrophoresis, Southern blotting |
| 1.3 Ligation and Transformation using *E. coli* system |
| **UNIT II (15 periods) - Vectors** |
| 2.1 Different types of Plasmid vectors and their characteristic features, Concept, and the use of selective markers |
| 2.2 Bacteriophage (λ) vectors, Cosmid vectors |
| 2.3 Expression vectors |
| 2.4 Cloning vectors for eukaryotes, Yeast artificial chromosomes (YACs), Bacterial artificial chromosomes (BACs), Ti plasmid |
| 2.5 Designing of cloning experiments |
| **UNIT III (10 periods) - Strategies of Finding Genes** |
| 3.1 Functional and positional cloning |
| 3.2 Preparation and screening of genomic and cDNA library |
| 3.3 Chromosome walking |
| 3.4 Polymerase Chain Reaction to Amplify DNA, Applications of PCR, site-directed mutagenesis in plasmid. Techniques of gene deletion. |
| **UNIT IV (10 periods) - Strategies to understand the functions of genes** |
| 4.1 Techniques to study expression of genes: Northern blot, semi-quantitative RT PCR, Quantitative RT PCR and Western blot |
| 4.2 Techniques to study DNA –protein interaction: DNA Foot printing, Gel mobility shift assay, Chromatin Immunoprecipitation (ChIP), |
| 4.3 PCR-mediated gene tagging |
| 4.4 Techniques to generate Knockout mice |
| **UNIT V (10 periods) - Genetic engineering in plants** |
| 5 Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors. |
| **Unit VI (5 periods) - Applications** |
| Applications of Recombinant DNA Technology in different fields<br>DNA fingerprinting, Recombinant vaccines against SARS-Cov-2 |

**Title of the Paper: RECOMBINANT DNA TECHNOLOGY**

Code: MBBT – M-P-09

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Isolation of RNA
9. Design of primer with a web-based tool and demonstration of PCR
10. Virtual demonstration of RT – qPCR and significance of Ct value

SUGGESTED READING


1. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

**Title of the Paper: ENVIRONMENTAL BIOTECHNOLOGY**

Code: MBBT – M-T-10

**Course Category: MAJOR (Theory)**

Theory - 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| 1.1 Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol |
| **UNIT II (20 periods)** |
| 2.1 Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products |
| **UNIT III (20 periods)** |
| 3.1 Treatment of municipal waste and Industrial effluents.<br>3.2 Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM) |
| **UNIT IV (10 periods)** |
| 4.1 Bioleaching, Enrichment of ores by microorganisms (Gold, Copper, and Uranium)<br>4.2 Environmental significance of genetically modified microbes, plants and animals. |

**Title of the Paper: ENVIRONMENTAL BIOTECHNOLOGY**

Code: MBBT – M-P-10

**Course Category: MAJOR (Pract)**

Practical- 2 Credit

Total: 60 hrs (4hrs/week)

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

SUGGESTED READING

1. Environmental Science, S.C. Santra

2. Environmental Biotechnology, Pradipta Kumar Mohapatra

3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter

4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill

5. Agricultural Biotechnology, S.S. Purohit

6. Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer

7. Introduction to Environmental Biotechnology, Milton Wainwright

8. Principles of Environmental Engineering, Gilbert Masters

9. Wastewater Engineering – Metcalf & Eddy

**Title of the Paper: BIOPROCESS TECHNOLOGY**

Code: MBBT – M-T-11

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture. |
| **UNIT II (20 periods)** |
| Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization. |
| **UNIT III (15 periods)** |
| Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control. |
| **UNIT IV (15 periods)** |
| Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid, and Single Cell Proteins. |

**Title of the Paper: BIOPROCESS TECHNOLOGY**

Code: MBBT – M-P-11

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.
7. Industry/ Institute visit or virtual exposure to depict set up of large scale production and processing units.

SUGGESTED READING


1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

**Title of the Paper: BIOANALYTICAL TOOLS**

Code: MBBT – M-T-12

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (10 periods)** |
|---|
| Simple microscopy, phase contrast microscopy, fluorescence, and electron microscopy (TEM and SEM), pH meter, absorption, and emission spectroscopy |
| **UNIT II (15 periods)** |
| Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra- red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles. |
| **UNIT III (15 periods)** |
| Introduction to the principle of chromatography. Partition chromatography (Paper chromatography, thin layer chromatography), Size exclusion chromatography, Ion-exchange chromatography and affinity chromatography, gas chromatography, HPLC. |
| **UNIT IV (20 periods)** |
| Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose- gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. |

**Title of the Paper: BIOANALYTICAL TOOLS**

Code: MBBT – M-P-12

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of cells.
4. Separation of amino acids by paper chromatography.
5. Separation of components of a mixture by TLC.
6. To verify the validity of Beer's law and determine the molar extinction coefficient of any given sample.
7. Virtual/ hands-on demonstration of western blotting technique.

SUGGESTED READING


1. Freifelder, D. (1982). Physical biochemistry: applications to biochemistry and molecular biology. Macmillan.
2. Segel, I. H. (1991). Biochemical calculations: how to solve mathematical problems in general biochemistry. John Wiley and Sons.
3. Cooper TG. The Tools of Biochemistry. John Willy & Sons.
4. Upadhyay, A., Upadhyay, K., & Nath, N. (2003). Biophysical Chemistry Principles & Techniques Handbook.
5. Banerjee, P. K. (2010). Introduction to Biophysics. S Chand & Company Limited.

**Title of the Paper: GENOMICS AND PROTEOMICS**

Code: MBBT – M-T-13

**Course Category: MAJOR (Theory)**

Theory – 4 Credits

Total: 60 hrs (4hrs/week)

| **UNIT I (15 periods)** |
|---|
| Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sanger's method, Chain termination chemistry vs sequencing by synthesis and reversible termination, Next generation sequencing (NGS) – Massively Parallel sequencing technologies, Concept of emulsion PCR and clonal bridge amplification, Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Exome sequencing, Computer tools for sequencing projects: Genome sequence assembly software. |
| **UNIT II (10 periods)** |
| Management and Distribution of Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases. |
| **UNIT III (20 periods)** |
| Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation. |
| **UNIT IV (15 periods)** |
| Introduction to Proteomics, Analysis of proteomes. 2D-PAGE, Mass spectrometry-based methods for protein identification. De novo sequencing using mass spectrometric data. |

**Title of the Paper: GENOMICS AND PROTEOMICS**

Code: MBBT – M-P-13

**Course Category: MAJOR (Practical)**

Practical – 2 Credits

Total: 60 hrs (4hrs/week)

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Virtual demonstration of NGS workflow.

SUGGESTED READING


1. Genes XI by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
6. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
7. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
8. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
9. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

**Title of the Paper: BIOSTATISTICS**

Code: MBBT – M-T-14

**Course Category: MAJOR (Theory)**

Theory – 3 Credits

Total: 45 hrs (3hrs/week)

| |
|---|
| **UNIT I (10 periods)** |
| 1.1 Types of Data, Collection representation of data; Primary & secondary data, Classification and Graphical data. Statistical skewness and measures of central tendency and Dispersion. Measures of Kurtosis. |
| **UNIT II (10 periods)** |
| 2.1 Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions. |
| **UNIT III (15 periods)** |
| 3.1 Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA) |
| **UNIT IV (10 periods)** |
| Correlation and Regression. Emphasis on examples from Biological Sciences. |

**Title of the Paper: BIOSTATISTICS**

Code: MBBT – M-P-14

**Course Category: MAJOR (Practical)**

Practical – 1 Credit

Total: 30 hrs (2hrs/week)

1. Practical Based on graphical Representation
2. Practical Based on measures of Central Tendency & Dispersion
3. Practical Based on Distributions Binomial Poisson Normal
4. Practical Based on t, f, z and Chi-square

SUGGESTED READING


1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield™ Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and SonsInc.

**Title of the Paper: ANIMAL BIOTECHNOLOGY**

Code: MBBT – M-T-15

**Course Category: MAJOR (Theory)**

Theory – 3 Credits

Total: 45 hrs (3hrs/week)

| |
|---|
| **UNIT I (10 periods)** |
| 1.1 Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer. |
| **UNIT II (10 periods)** |
| 2.1 Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis. |
| **UNIT III (15 periods)** |
| 3.1 Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications. |
| **UNIT IV (10 periods)** |
| 4.1 Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics. |

**Title of the Paper: ANIMAL BIOTECHNOLOGY**

Code: MBBT – M-P-15

**Course Category: MAJOR (Practical)**

Practical – 1 Credit

Total: 30 hrs (2hrs/week)

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization,Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

SUGGESTED READING

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

**Title of the Paper: MICROBIAL PHYSIOLOGY**

Code: MBBT – M-T-16

**Course Category: MAJOR (Theory)**

Theory - 3 Credits

Total: 45 hrs (3hrs/week)

| **UNIT I (10 periods)** |
|---|
| 1.1 Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron. |
| **UNIT II (10 periods)** |
| 2.1 Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity |
| **UNIT III (10 periods)** |
| 3.1 Effect of the environment on microbial growth<br>Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation, and pressure. Chemolithotrophic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogen-oxidizing bacteria and methanogens. |
| **UNIT IV (15 periods)** |
| 4.1 Phototrophic metabolism. Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non- cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle. |

**Title of the Paper: MICROBIAL PHYSIOLOGY**

Code: MBBT – M-P-16

**Course Category: MAJOR (Practical)**

Practical- 1 Credit

Total: 30 hrs (2hrs/week)

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger* by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

SUGGESTED READING

1. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

2. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms.10th edition. Pearson/ Benjamin Cummings.

3. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.

4. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.

5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.

6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7thedition. McGraw Hill Higher Education

**Title of the Paper: PLANT BIOTECHNOLOGY**

Code: MBBT – M-T-17

**Course Category: MAJOR (Theory)**

Theory - 4 Credits

Total: 60 hrs (4hrs/week)

| |
|---|
| **UNIT I (15 periods)** |
| 1.1 History of plant tissue culture, concept on differentiation, dedifferentiation and redifferentiation. Types of culture: Seed, Embryo, Callus, Organs, Cell, and Protoplast culture. Micropropagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages, and disadvantages of micropropagation. |
| **UNIT II (20 periods)** |
| 2.1 In vitro haploid production Androgenic methods: Anther culture, Microspore culture, andogenesis, Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals. |
| **UNIT III (15 periods)** |
| 3.1 Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations.<br>3.2 Somaclonal variation, methods, applications basis and disadvantages |
| **UNIT IV (10 periods)** |
| 4.1 Plant Growth Promoting bacteria.<br>Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria. |

**Title of the Paper: PLANT BIOTECHNOLOGY**

Code: MBBT – M-P-17

**Course Category: MAJOR (Practical)**

Practical- 2 Credits

Total: 60 hrs (4hrs/week)

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid andliquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. Selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various stages of Micropropagation.

SUGGESTED READING


1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue andOrgan Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation ofPlants, Oxford University Press.

**Title of the Paper: BIOTECHNOLOGY & HUMAN WELFARE**

Code: MBBT – M-T-18

**Course Category: MAJOR (Theory)**

Theory - 4 Credits

Total: 60 hrs (4hrs/week)

| |
|---|
| **UNIT I (10 periods)** |
| 1.1 Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol, and antibiotic formation. |
| **UNIT II (10 periods)** |
| 2.1 Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock. |
| **UNIT III (15 periods)** |
| 3.1 Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB. |
| **UNIT IV (12 periods)** |
| 4.1 Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing. |
| **UNIT V (13 periods)** |
| 5.1 Health: e.g. development of non- toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project. |

**Title of the Paper: BIOTECHNOLOGY & HUMAN WELFARE**

Code: MBBT – M-P-18

**Course Category: MAJOR (Practical)**

Practical- 2 Credits

Total: 60 hrs (4hrs/week)

1. Perform of ethanolic fermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

*(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated throughany other material or medium including videos/virtual labs etc.)*

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New ageinternational publishers
3. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation ofPlants, Oxford University Press.
4. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.

**SKILL ENHANCEMENT COURSES**

**Title of the Paper: ENZYMOLOGY**

Code: MBBT – SEC- T-1

**Course Category: SEC (Theory Only)**

Theory – 3 Credits

Total: 45 hrs (3hrs/week)

**UNIT I (15 periods) Bioenergetics and Enzyme kinetics**

Bioenergetics: Bioenergetics and Thermodynamics; Chemical logic and common biochemical reactions; Phosphoryl group transfers and ATP; Biological oxidation-reduction reactions.

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric &oligomeric enzymes, activation energy and transition state, enzyme activity and enzyme Unit, Enzyme substrate complex: concept of E-S complex, lock and key and induced fit hypothesis, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH, Significance of activation energy and free energy.

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition: types of inhibition, Lineweaver-Burk plots, suicide inhibitor. Zymogens and their activation (Proteases and Prothrombin).

Biocatalysts from extreme thermophilic and hyper-thermophilic archaea and bacteria.

Mechanism of enzyme action: General mechanistic principle, Enzyme regulation: Product inhibition, feed-back control, covalent modification.

Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

**UNIT II (15 periods) Properties, purification, Immobilization, and sequencing**

Allosteric enzymes with special reference to phosphofructokinase, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes. Ribozymes. Multifunctional enzyme – examples.

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Application of Immobilized and soluble enzyme in health and industry.

Methods for protein sequencing. Brief overview of the methods for analysis of secondary and tertiary structures of enzymes.

**UNIT III (15 periods) Applications**

Application based capacity building through educational tours or virtual/ hands-on demonstration of principles and concepts with respect to the following:

1. Demonstration of the digestion of starch by amylase.
2. Investigation of the effect of temperature on enzyme activity.
3. Demonstration of the action of lipase.
4. Demonstration of Enzyme/Cell Immobilization.
5. Demonstration of Isolation and purification of enzymes.
6. Demonstration of Protein sequencing techniques.

SUGGESTED READING


1. Biochemistry, Lubert Stryer,6thEdition, WH Freeman,2006.
2. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
3. Biochemistry, Donald Voet and JudithVoet,2ndEdition, Publisher: John Wiley and Sons, 1995.
4. Molecules of Life. John Kuriyan, Boyana Konforti, David Wemmer. Garland Science. 2013
5. Student Companion to Accompany Biochemistry. Richard I Gumport, Frank H Deis, Nancy Counts Gerber, Roger Koeppe II. 5th Edition. W. H. Freeman. 2002.

**Title of the Paper: MICROBIAL DIAGNOSIS IN HEALTH CLINICS**

Code: MBBT – SEC- T-2

**Course Category: SEC (Theory Only)**

Theory – 3 Credits

Total: 45 hrs (3hrs/week)

| **UNIT I (15 periods) Importance of Diagnosis of Diseases** |
|---|
| Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis. How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine, and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage. Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa-stained thin blood film for malaria; Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens. |
| **UNIT II (15 periods) Methods of Diseases Diagnosis** |
| Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes; Kits for Rapid Detection of Pathogens- typhoid, Dengue and HIV, Swine flu. Testing for Antibiotic Sensitivity in Bacteria- Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method |
| **UNIT III (15 periods) Applications** |
| Application based capacity building through educational tours or virtual/ hands-on demonstration of principles and concepts with respect to the following:<br>1. Preparation and use of culture media for culturing various pathogenic microorganisms<br>2. Determination of minimal inhibitory concentration (MIC) of an antibiotic.<br>3. Serological Methods - Agglutination, ELISA |

SUGGESTED READING


1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

**Title of the Paper: BIOFERTILIZER**

Code: MBBT – SEC- T-3 A

**Course Category: SEC (Theory Only)**

Theory – 3 Credits

Total: 45 hrs (3hrs/week)

| **UNIT I (15 periods)** |
|---|
| General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier-based inoculants, Actinorrhizal symbiosis. Azospirillum: isolation and mass multiplication – carrier-based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance, and mass multiplication. Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azollain rice cultivation. |
| **UNIT II (15 periods)** |
| Mycorrhizal association- types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth, and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. |
| **UNIT III (15 periods)** |
| Application based capacity building through educational tours or virtual/ hands-on demonstration of principles and concepts with respect to the following:<br>1. Preparation and sterilization of Media- Jensen's medium, Pikovskaya's agar, Aleksandrow agar.<br>2. Isolation of Nitrogen-fixing, Phosphate & Potassium solubilizing bacteria from soil.<br>3. Preparation of Biofertilizer using Plant Growth Promoting Bacteria and Vermicompost.<br>4. Visit to an Organic Farm or Biogas Plant. |

SUGGESTED READING


1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand& Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John JothiPrakash, E. 2004. Outlines of Plant Biotechnology.Emkay _Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad

**Title of the Paper: MOLECULAR DIAGNOSTICS**

Code: MBBT – SEC- T-3 B

**Course Category: SEC (Theory Only)**

Theory – 3 Credits

Total: 45 hrs (3hrs/week)

**UNIT I (15 periods)**

Enzyme Immunoassays:

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immune-histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

Molecular methods in clinical microbiology:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

**UNIT II (15 periods)**

Laboratory tests in chemotherapy:

Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests. Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts, and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

**UNIT III (15 periods)**

Virtual demonstration/ study tour to depict the application of molecular diagnostic techniques in the identification and diagnosis of the following genetic disorders, and microbial diseases:

1. *Bacterial & viral diagnostics*-
   PCR diagnosis of *Mycobacterium tuberculosis*.
   HIV and SARS nCOV-2 detection by RT-qPCR.
2. *Molecular diagnostics of genetic diseases*-
   Genetic testing in Sickle cell anemia, Beta thalassemia, Cystic fibrosis.
3. *Cancer diagnostics*-
   Checking of BRCA gene polymorphism for susceptibility to breast cancer.
4. *Foetal diagnostics*-
   Prenatal molecular diagnosis by Chorionic Villus Sampling and Amniocentesis
5. *Cytogenetic diagnostics*-
   Karyotype by Q-banding and G-banding - Molecular diagnosis of Klinefelter, Down and Turner syndromes; Molecular cytogenetics: FISH - Types and clinical applications.

SUGGESTED READING


1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker.
2. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic.
3. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology.7th edition (edited by Paniker CKJ).University Press Publication.
4. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology.24th edition.McGraw Hill Publication.
5. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition.Elsevier.
6. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology.19th edition.Appleton-Centuary- Crofts publication.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology.7th edition.McGraw Hill Higher Education.
8. Microscopic Techniques in Biotechnology, Michael Hoppert
9. Strachan, T. and A.P. Read. 2004. Human Molecular Genetics. 3rd Edition. Garland Science, UK.
10. A Practical Guide to Clinical Virology. 2nd Ed. L.R. Haaheim., J.R. Pattison. R.J.Whitley. John Wiley &Sons, 1994.
11. Biomedical Methods Hand Book– John M. Walkser, Ralph Raplay. Humana Press, 2005.

**MINOR COURSES**

**To be opted by OTHER DEPARTMENT students either during Sem I OR Sem II**

**Title of the Paper: BIOLOGICAL CHEMISTRY**

Code: MBBT – MI-T-1

**Course Category: MINOR (Theory)**

Theory - 3 Credits

Total: 45 hrs (3hrs/week)

| **UNIT I (10 periods): Carbohydrates and Lipids** |
|---|
| 1.1. Carbohydrates-Importance and classification<br>1.2. Structure, configuration, and biochemical importance of Monosaccharides (Glucose and Fructose) Oxidation, Reduction, Osazone formation, Aldose &Ketose, Glycosides (Streptomycin, Cardiac glycosides and Ouabain)<br>1.3. Structure, configuration, and biochemical importance of Disachharides and glycosidic bond, Mutarotation, Haworth projection (Sucrose, Trehalose, Lactose, Maltose, Isomaltose, Cellobiose)<br>1.4. Structure, and biochemical importance Polysaccharides (Starch, Glycogen, Cellulose)<br>1.5. Lipids, Fatty acids-importance, properties and classification, Simple lipids-TAG, Complex lipids, Derived lipids, sterols, Fatty acids: Saturated and Unsaturated fatty acids with examples. |
| **UNIT II (15 periods): Proteins and Enzymes** |
| 2.1 Classification, structure, and physical and chemical properties of amino acids & proteins<br>2.2 Enzymes-classification and nomenclature. Michaelis-Menten Equation-Factors influencing the enzyme reactions and Enzyme inhibition (Competitive and Non-competitive), role of co-enzymes.<br>2.4 Hormones, mode of action (Thyroid gland)<br>2.5 Vitamins- classification, sources, functions, and applications<br>2.6 Paper chromatography and Thin Layer Chromatography: Principles and Applications. |
| **UNIT III (15 periods): Bioenergetics of biomolecules** |
| 3.1 Glycolysis<br>3.2 Gluconeogenesis and its significance<br>3.3 TCA Cycle, electron transport, Oxidative phosphorylation<br>3.4 Biosynthesis of Fatty acids -palmitoyl-CoA, Cholesterol, β-oxidation of fatty acid.<br>3.5 Transamination and Oxidative deamination reactions of amino acids. Amino acid catabolism (Phenyl ketonuria, albinism) |
| **UNIT IV (5 periods): Intermediary Metabolism** |
| 4.1 Urea cycle<br>4.2 Biosynthesis and regulation of purine and pyrimidine nucleotides, de novo and salvage pathways |

**Title of the Paper: BIOLOGICAL CHEMISTRY**

Code: MBBT – MI-P-1

**Course Category: MINOR (Practical)**

Practical- 1 Credit

Total: 30 hrs (2hrs/week)

1. Preparation of normal, molar, and gm% solutions.
2. Preparation of buffers.
3. Qualitative tests of sugars, amino acids, and lipids.
4. Separation of amino acids by paper chromatography and TLC.

SUGGESTED READING


1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry.VI Edition. W.H Freeman and Co.
2. Segel, I. H., (2004) Biochemical calculations, 2nd Edition, John Wiley and Sons.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Upadhyay, A., Upadhyay, K., Nath, N., (2006) Biophysical Chemistry – principles and techniques. Himalaya Publishing House.
5. Plummer, D. T., (2005) An Introduction to Practical Biochemistry, Tata McGraw-Hill publishing Co. Ltd.

**To be opted by OTHER DEPARTMENT students either during Sem III OR Sem IV**

**Title of the Paper: BIOLOGY OF MICROORGANISMS**

Code: MBBT – MI-T-2

**Course Category: MINOR (Theory)**

Theory - 3 Credits

Total: 45 hrs (3hrs/week)

| **UNIT I (10 periods): History of microbiology and an overview of bacterial structure** |
|---|
| 1.1 The Discovery of Microorganisms and contributions of Louis Pasteur, and Edward Jenner, Leeuwenhoek, the Conflict over spontaneous generation, Koch's postulates, the Scope and relevance of Microbiology<br>1.2 An overview of procaryotic cell structure; procaryotic cell membranes; the cytoplasmic matrix (inclusion bodies), ribosomes, the nucleoid, the procaryotic cell wall (gram positive & gram negative), the mechanism of gram staining; Components external to the cell wall (capsules, slime layers, and s-layers; pili and fimbriae), flagella and motility (flagellar ultrastructure, mechanism of flagellar movement, chemotaxis); the bacterial endospore |
| **UNIT II (15 periods): Microbial nutrition, growth, and control** |
| 2.1 Nutrient requirement for bacterial growth (macro- and micronutrients, purines, pyrimidines, amino acids, vitamins), iron Uptake and Siderophores, Nutritional Types of Microorganisms; types of media (synthetic, complex, differential media)<br>2.2 Isolation of Pure Cultures (The Spread Plate and Streak Plate, The Pour Plate); the Growth Curve, the mathematics of growth Measurement of Microbial Growth (Cell Numbers, Cell Mass), The Continuous Culture of Microorganisms (Chemostat, Turbidostat)<br>2.3 The Influence of Environmental Factors on Growth (extremophiles, Halophiles), effect of pH, Temperature (Psychrophiles, Mesophiles, thermophiles, hyperthermophiles) Pressure; Quorum Sensing and Microbial Populations<br>2.4 The physical Methods used to control bacteria (Heat, Low Temperatures, Filtration, Radiation), The chemical Methods used to control bacteria (Phenolics, Alcohols, Halogens |
| **UNIT III (10 periods): Virology** |
| 3.1 General Properties of Viruses, cultivation of Viruses, Viral multiplication, Attachment, entry, un-coating, replication, assembly, release, Cell transformations, Cultivation of viruses-Assay techniques<br>3.2 The Structure of Viruses (Virion Size, General Structural Properties, Helical Capsids) types of viral nucleic Acids, Viral Envelopes and Enzymes<br>3.3 Animal viruses-Virus-Host interactions - Viral infections, plant viruses, bacteriophages<br>3.4 Host response and antiviral agents, immune responses to viruses, interferon and other cytokines, antiviral therapy, vaccines against SARS nCOV-2 and the Covid19 pandemic |
| **UNIT IV (10 periods): Food and Industrial Microbiology** |
| 4.1 Microbial Growth and Food Spoilage, Controlling Food Spoilage, Removal of Microorganisms (Low Temperature, High Temperature, Pasteurization) Chemical-Based Preservation, Radiation, bacteriocins<br>4.2 Food-Borne Diseases, Food-Borne Infection, Food-Borne Intoxications, Detection of Food-Borne Pathogens<br>4.3 Production of Fermented Milks (buttermilk, sour cream, and yogurt); Cheese Production; Production of Alcoholic Beverages (Wines and Champagnes, Beers and Ales, Distilled Spirits), Production of Breads, a brief concept on probiotics. |

**Title of the Paper: BIOLOGY OF MICROORGANISMS**

Code: MBBT – MI-P-2

**Course Category: MINOR (Practical)**

Practical- 1 Credit

Total: 30 hrs (2hrs/week)

1. Demonstration, use and care of microbiological equipment.
2. Preparation of media, sterilization, and isolation of bacteria.
3. Simple staining of bacteria
4. Gram staining of Bacteria
5. Endospore staining.
6. Demonstration of starch hydrolysis by bacterial cultures.
7. Growth of fecal coliforms on selective media.
8. Isolation of pure culture by streak plate method.
9. Antibiotic sensitivity assay.

SUGGESTED READING


1. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
2. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
3. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
4. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
5. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education
7. Cappucino, J. and Sherman, N. (2007) Microbiology: A laboratory manual. VII Edition. Pearson Education.
8. Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.

**To be opted by OTHER DEPARTMENT students during Sem V**

**Title of the Paper: MOLECULAR BIOLOGY**

Code: MBBT – MI-T-3

**Course Category: MINOR (Theory)**

Theory - 3 Credits

Total: 45 hrs (3hrs/week)

| **UNIT I (10 periods): Structure of Nucleic Acids** |
|---|
| 1.1 DNA as the genetic material – Griffiths experiments, Avery, McLeod, and Mc Carty's experiments. Hershey – Chase experiments.<br>1.2 RNA as genetic material – Tobacco Mosaic Virus<br>1.3 Structure and chemistry of DNA – Watson and Crick Model<br>1.4 Forms of DNA – A, B and Z forms of DNA, Super coiled and relaxed DNA – Role of DNA topoisomerases.<br>1.5 Structure of Cytoplasmic DNA – chloroplast DNA and Mitochondrial DNA. |
| **UNIT II (15 periods): Functions & Mechanisms of Nucleic Acids** |
| 2.1 DNA Replication – Models of DNA replication (Semi-conservative, non-conservative models)<br>2.2 Mechanisms of DNA replication – Linear and circular – Rolling circle and theta mechanism of replication. Enzymes involved in DNA replication.<br>2.5 DNA Recombination |
| **UNIT III (10 periods): Gene expression** |
| 3.1 Transcription in prokaryotes: Enzymatic Synthesis of RNA, Basic features of RNA synthesis, E.coli RNA polymerase, Classes of RNA molecules, Transcription mechanism in prokaryotes- Promoter, initiation, elongation, proof reading and Rho dependent and Rho independent termination.<br>3.2 Transcription in Eukaryotes: Polymerases of eukaryotes, Promoters of eukaryotes,<br>3.3 Synthesis of hn RNA, Splicing mechanisms -Self splicing, protein mediated splicing, alternative splicing, Capping and polyadenylation.<br>3.4 The Genetic Code, properties of genetic code, Wobble hypothesis.<br>3.5 Translation mechanism in prokaryotes and eukaryotes |
| **UNIT IV (10 periods): Regulation of Gene expression** |
| 4.1. Regulation in Prokaryotes: General aspects of Regulation<br>4.2. Transcription level regulation-positive, negative, auto and coordinated regulation<br>4.3. Operon concept – lac, trp operons.<br>4.4. Transcriptional Control through Transcription factors.<br>4.5. Translation regulation in Eukaryotic and prokaryotic organism |

**Title of the Paper: MOLECULAR BIOLOGY**

Code: MBBT – MI-P-3

**Course Category: MINOR (Practical)**

Practical- 1 Credit

Total: 30 hrs (2hrs/week)

1. Isolation of total DNA from plant, animal/bacterial cells
2. Isolation of plasmid DNA
3. Identification of different topological forms of plasmid DNA
4. Analysis of DNA by agarose gel electrophoresis
5. Demonstration of PCR
6. Competent cell preparation, transformation, and selection.
7. Study of induction β-Galactosidase Activity in *E.coli*

SUGGESTED READING


1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry.VI Edition. W.H Freeman and Co.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons.
3. Watson, J, Baker, T, Bell S, Gann, A, Levine, M, Losick, R. (2013). Molecular Biology of the Gene. VII Edition. Pearson.
4. Berk A. Kaiser, C. A., Lodish, H et. al. Molecular Cell Biology (2016). VIII Edition. W. H. Freeman.
5. Alberts, B, Johnson, A, Lewis, J, et al., Molecular Biology of the Cell, (2002) VI edition. New York: Garland Science.
6. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.

**To be opted by OTHER DEPARTMENT students during Sem VII**

**Title of the Paper: RECOMBINANT DNA TECHNOLOGY**

Code: MBBT – MI-T-4

**Course Category: MINOR (Theory)**

Theory - 3 Credits

Total: 45 hrs (3hrs/week)

| **UNIT I (10 periods): Cutting and Joining DNA Fragments** |
|---|
| 1.1 Host-controlled restriction and modification, Different types of restriction enzymes and their characteristic features |
| 1.2 Modifying enzymes: Calf intestinal alkaline phosphatase, T4 and *E. coli* DNA Ligase, Klenow DNA polymerase, T4 Polynucleotide kinase, Terminal transferase, Reverse transcriptase, T4 RNA Ligase. |
| 1.3 Viewing DNA Fragments, principle of gel electrophoresis, Southern, Northern blotting |
| 1.4 Joining DNA molecules and Transformation of *E. coli*, |
| **UNIT II (15 periods): Cloning of genes** |
| 2.1 Different types of Plasmid vectors and their characteristic features, Concept, and the use of selective markers |
| 2.2 Bacteriophage (λ) vectors, Cosmid vectors |
| 2.3 Expression vectors |
| 2.4 Cloning vectors for eukaryotes, Yeast artificial chromosomes (YACs), Bacterial artificial chromosomes (BACs), Ti plasmid |
| **UNIT III (10 periods): Strategies of Finding Genes** |
| 3.1 Functional and positional cloning |
| 3.2 Creating a genomic and cDNA library, Screening DNA libraries |
| 3.3 Chromosome walking |
| 3.4 Polymerase Chain Reaction to Amplify DNA, Applications of PCR, site-directed mutagenesis |
| **UNIT IV (10 periods): Strategies to understand the functions of genes, and applications of RDT** |
| 4.1 Techniques to study expression of genes: Northern blot, Real Time PCR and Western blot. |
| 4.2 Techniques to study DNA –protein interaction: DNA Foot printing, Gel mobility shift assay, Chromatin Immunoprecipitation (ChIP). |
| 4.3 Techniques to generate Knockout mice. |
| Applications of Recombinant DNA Technology in COVID 19 pandemic: |
| 4.4 Recombinant vaccines against SARS-Cov-2. |

**Title of the Paper: RECOMBINANT DNA TECHNOLOGY**

Code: MBBT – MI-P-4

**Course Category: MINOR (Practical)**

Practical- 1 Credit

Total: 30 hrs (2hrs/week)

1. Artificial transformation of *E. coli* with plasmid.
2. Primer design for PCR amplification
3. Agarose gel electrophoresis of DNA
4. SDS – PAGE electrophoresis.
5. Restriction digestion of DNA and Restriction mapping.
6. Isolation of RNA

SUGGESTED READING


1. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Reece, R. J. (2003). Analysis of genes and genomes. John Wiley & Sons.