MAHATMA GANDHI UNIVERSITY

Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2024 Admission Onwards

SYLLABUS						
SIGNATURE COURSE						
Name of the College	B.C.M. College, Kottayam					
Faculty/ Discipline	Zoology					
Programme	BSc (Hons) Zoology					
Course Coordinator	Varun Jolly					
Contributors	Ms. Priya Thomas, Dr. Elezabeth Basil, Ms. Emi Mathew					
Course Name	Biology of Genomes					
Type of Course	DSE					
Specialization title	Genomics					
Course Code	To be prepared by the University					
Course Level	200					
Course Summary	The purpose of this course is to introduce students to the structure, organization, and diversity of genomes across a range of living organisms. It covers the genomes of nine representative organisms spanning prokaryotes, eukaryotes, viruses, and organelles, providing a broad understanding of genomic architecture and function. A key focus of the course is comparative genomics, where students will analyze similarities and differences in genome size, content, and complexity across species. Particular emphasis is placed on higher genomes, especially the human genome, to help students appreciate evolutionary relationships and functional insights. This foundational knowledge prepares students for advanced studies in functional, clinical, and evolutionary genomics.					
Semester	3	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic knowledge in Cell biology and Genetics					

Course Outcomes (CO)

Number of COs		**5**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Describe and compare the structure and organization of human, plant, fungal, and organellar genomes	AN	PO1, PO2, PO3, PO10
2	Analyze genome organization and gene regulation in prokaryotes using model organisms.	A	PO1, PO2, PO3, PO10
3	Evaluate viral genome and their roles in health and evolution.	E	PO1, PO2, PO3, PO6, PO10
4	Construct phylogenetic trees and interpret genome evolution using molecular data.	AN	PO1, PO2, PO3, PO10

Number of COs		5	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	Design a basic genomic or phylogenetic analysis using sample data.	C	PO1, PO2, PO3, PO4, PO6, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	1	-	-	-	-	-	-	1
CO 2	3	2	1	-	-	-	-	-	-	1
CO 3	3	3	2	-	-	1	-	-	-	1
CO 4	3	3	3	-	-	-	-	-	-	2
CO 5	3	3	3	1	-	1	-	-	-	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Eukaryotic Genomes			
	1.1	Human genome: structure, organization, coding vs non-coding regions, repetitive sequences, nuclear and mitochondrial genes. Plant genomes: size variability, polyploidy, transposable elements – maize, study of Arabidopsis genome.	5	["1"]
	1.2	Fungal genomes: Structure, organization, with case study of Saccharomyces cerevisiae genome	5	["1"]
	1.3	Mitochondrial genome: structure. Organization, maternal inheritance, genome content Chloroplast genome: structure, genes for photosynthesis, significance in plant systematics. Evolutionary link to bacterial ancestors (endosymbiont theory).	5	["1"]
2	Prokaryotic Genomes			
	2.1	Bacterial genomes- Chromosomal DNA, Plasmids, Transposons/Integrons, Nucleoid-Associated Proteins	5	["2"]
	2.2	Operons (briefly mention structure and function), Genome size, and coding efficiency.	5	["2"]
	2.3	Study of E. coli. genome	5	["2"]
3	Viral Genomes			
	3.1	Structural and functional features of viral genomes: DNA virus – TMV genome	5	["3"]
	3.2	RNA Virus: SARS-CoV-2 genome: structure, key proteins (spike, envelope, membrane), replication strategy	5	["3"]
	3.3	Genomics in vaccine development and monoclonal antibody therapy with reference to COVID-19.	5	["3"]

Module	Units	Course Description	Hrs	CO No.
4	Evolution and phylogenetics			
	4.1	Geological time scale, Molecular clocks and mutation rates: Concepts and application in evolutionary timelines, use of haplotypes in population genomics.	5	["4"]
	4.2	Phylogenetic tree, phylogram, cladogram, Phylogenetic tree construction- Sequence alignment, distance-based and character-based methods (eg., Maximum Parsimony, Maximum Likelihood). Genomic evidence of evolution: Orthologs, paralogs, conserved sequences.	5	["4"]
	4.3	Comparative genomics of higher primates, human vs chimpanzee chromosome (highlight fusion of ancestral chromosomes 11 & 12 to human chromosome 2).	5	["5"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) ICT- Enabled Learning Practices, Virtual Lab, Group Discussion, Lecturing

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Quiz, Test Paper, Seminar, Group Discussion, , Research Institute Visit Report **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ MCQ - (10 out of 10) – 10 × 1 = 10 ◦ PART - B ◦ Short answer - (14 out of 16) – 14 × 2 = 28 ◦ PART - C ◦ Short Essays - (8 out of 10) – 8 × 4 = 32

References

- 1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
- 2. Brown, T. A. (2016). Genomes (4th ed.). Garland Science.
- 3. Pevsner, J. (2022). Bioinformatics and Functional Genomics (4th ed.). Wiley-Blackwell.2
- 4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2017). Molecular Biology of the Gene (7th ed.). Pearson.
- 5. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., ... & Darnell, J. (2021). Molecular Cell Biology (9th ed.). W. H. Freeman.
- 6. Strachan, T., & Read, A. P. (2018). Human Molecular Genetics (5th ed.). Garland Science.
- 7. Lewin, B. (2017). Lewin’s Genes XII (12th ed.). Jones & Bartlett Learning.
- 8. Riddle, A. G. (2018). Genome. Head of Zeus.5
- 9. International Human Genome Sequencing Consortium. (2001). Initial sequencing and analysis of the human genome. Nature, 409(6822), 860–921.
- 10. Arabidopsis Genome Initiative. (2000). Analysis of the genome sequence of the flowering plant Arabidopsis thaliana. Nature, 408(6814), 796–815.

- 11. Goffeau, A., Barrell, B. G., Bussey, H., Davis, R. W., Dujon, B., Feldmann, H., ... & Oliver, S. G. (1996). Life with 6000 genes. Science, 274(5287), 546–567.
- 12. Koonin, E. V., & Galperin, M. Y. (2021). Sequence—Evolution—Function: Computational Approaches in Comparative Genomics (2nd ed.). Springer.
- 13. Doudna, J. A., & Charpentier, E. (2014). The new frontier of genome engineering with CRISPR-Cas9. Science, 346(6213), 1258096.
- 14. Wu, F., Zhao, S., Yu, B., Chen, Y. M., Wang, W., Song, Z. G., ... & Zhang, Y. Z. (2020). A new coronavirus associated with human respiratory disease in China. Nature, 579(7798), 265–269.
- 15. Kumar, S., Stecher, G., Suleski, M., & Hedges, S. B. (2017). TimeTree: A resource for timelines, timetrees, and divergence times. Molecular Biology and Evolution, 34(7), 1812–1819.

Suggested Readings

- 1. Weaver, R. F. (2011). Molecular Biology (5th ed.). McGraw-Hill Education.
- 2. Pierce, B. A. (2020). Genetics: A Conceptual Approach (7th ed.). W. H. Freeman and Company.
- 3. Lander, E. S., Linton, L. M., Birren, B., Nusbaum, C., Zody, M. C., Baldwin, J., ... & Collins, F. S. (2001). Initial sequencing and analysis of the human genome. Nature, 409(6822), 860–921.

Affidavit

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2024 Admission Onwards

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Faculty/ Discipline	Zoology					
Programme	BSc (Hons) Zoology					
Course Coordinator	Varun Jolly					
Contributors	Ms. Priya Thomas, Dr. Elezabeth Basil, Ms. Emi Mathew					
Course Name	Genome Technology					
Type of Course	DSE					
Specialization title	Genomics					
Course Code	To be prepared by the University					
Course Level	200					
Course Summary	Genome Technology equips B.Sc. Zoology (Genomics) students with cutting-edge skills to analyze genetic mechanisms in animal systems. The course covers foundational cell culture techniques (laboratory design, primary culture, subculturing), molecular methods (PCR variants, CRISPR, karyotyping), and sequencing technologies (Sanger, NGS, exome/panels) integrated with multi-omics approaches. Students gain proficiency in bioinformatics tools (BLAST, genome browsers, phylogenetics) and learn to design diagnostic/research workflows (e.g., disease panels). Through a theory-to-application framework, learners master genomic data interpretation for zoological research, conservation genetics, and disease diagnostics, preparing them for advanced research or biotechnology careers.						
Semester	4	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

Course Outcomes (CO)

Number of COs		**5**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain principles of cell culture systems, including laboratory design, biosafety protocols, media formulation, and techniques for primary/subculture maintenance.	U	PO1, PO2, PO3, PO7, PO8, PO10
2	Analyze molecular, cytogenetic, and genome-editing methods (PCR variants, Southern blotting, RFLP, karyotyping, microarrays, CRISPR-Cas) for detecting genetic polymorphisms and chromosomal abnormalities.	AN	PO1, PO2, PO3, PO8, PO10

Number of COs		5	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
3	Compare DNA sequencing technologies (Sanger, NGS, exome/panel sequencing) and evaluate their role in multi-omics integration (transcriptomics/proteomics/metabolomics).	E	PO1, PO2, PO3, PO6, PO7, PO8, PO10
4	Utilize bioinformatics tools (BLAST, genome browsers, gene predictors) to retrieve, annotate, and analyze genomic data, including phylogenetic inference.	A	PO1, PO2, PO3, PO9, PO10
5	Demonstrate practical genomic techniques, including DNA extraction and sequence analysis using bioinformatic tools.	A	PO1, PO2, PO3, PO8, PO10

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CO-PO Articulation Matrix

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CO 2	3	3	2	-	-	-	-	3	-	2
CO 3	3	3	3	-	-	2	1	1	-	3
CO 4	2	3	2	-	-	-	-	-	1	3
CO 5	1	3	1	-	-	-	-	1	-	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Cell Culture			
	1.1	Cell culture laboratory – Laboratory Design and Biosafety Levels , Essential Equipments, Environmental and Aseptic Conditions, Consumables and Reagents, Waste Disposal and Laboratory Safety.	4	["1"]
	1.2	Sources of specimens for cell culture, primary cell culture initiation, culture types (suspension culture, adherent culture), checking for colonies, determining colony size for trypsinization, confluency assessment of culture, subculturing (secondary culture), cell lines	4	["1"]
	1.3	Preparation of cells directly from tissues, cell culture media formulations.	4	["1"]

Module	Units	Course Description	Hrs	CO No.
2	Gene Analysis – Chromosome technology			
	2.1	DNA Isolation: Extraction of DNA(Demonstration), PCR Techniques- Conventional PCR: principles and applications, Quantitative PCR (qPCR), Reverse Transcription PCR (RT-PCR), Multiplex PCR, Quantitative Fluorescent PCR (QF-PCR)- basics and uses. (Interactive online simulations for virtual hands-on experience)	5	["2", "5"]
	2.2	Karyotyping – steps in karyotyping, spectral karyotyping, chromosome microarray analysis(CMA), array CGH	4	["2"]
	2.3	Molecular techniques- Introduction to satellite DNA and its significance, Southern Blotting for gene analysis, RFLP for DNA fingerprinting and disease detection, Genetic polymorphism analysis- Single-Nucleotide Polymorphism (SNP), Copy Number Polymorphism (CNP), VNTR, Single Sequence Repeats (SSR), SNP array	6	["2"]
	2.4	Genome Editing Technologies: CRISPR-Cas mechanism, applications, and bioinformatic design	3	["2"]
3	Sequencing technology			
	3.1	Maxam-Gilbert sequencing, Sanger sequencing, Next-Generation Sequencing (NGS) overview.	5	["3"]
	3.2	Whole Exome sequencing (WES), Targeted Exome Sequencing, Gene Panel Analysis (Autism panel, Cardiomyopathy Panel).	5	["3"]
	3.3	Introduction to Transcriptomics, Proteomics, and Metabolomics- Integration of Omics	5	["3"]
4	Data Analysis through Bioinformatics			
	4.1	Overview of bioinformatics: scope and significance in genomics, Major biological databases (brief introduction), Introduction to data formats: FASTA, GenBank	5	["4", "5"]
	4.2	Gene prediction tools: ORF Finder, GENSCAN genome annotation	5	["4"]
	4.3	Genome browsers: UCSC, Ensembl, Similarity searches – BLAST , Basics of phylogenetic analysis using MEGA	5	["4"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom Procedure (Mode of transaction) ICT- Enabled Learning Practices, Basic lab, Virtual Lab, Group Discussion, Lecturing

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Quiz, Test Paper, Seminar, Group Discussion, Research Institute Visit Report **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ MCQ - (10 out of 10) – 10 × 1 = 10 ◦ PART - B ◦ Short answer - (14 out of 16) – 14 × 2 = 28 ◦ PART - C ◦ Short Essays - (8 out of 10) – 8 × 4 = 32

References

- Brown, T. A. (2018). Genomes (5th ed.). Garland Science.
- Hartwell, L., Hood, L., Goldberg, M. L., Reynolds, A. E., & Silver, L. M. (2017). Genetics: From genes to genomes (6th ed.). McGraw-Hill Education.
- Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2016). Molecular cell biology (8th ed.). W. H. Freeman and Company.
- Davis, J. M. (2011). Basic cell culture: A practical approach (3rd ed.). Oxford University Press.
- Pevsner, J. (2015). Bioinformatics and functional genomics (3rd ed.). Wiley-Blackwell.
- Pierce, B. A. (2020). Genetics: A conceptual approach (7th ed.). W. H. Freeman and Company.
- Sambrook, J., & Russell, D. W. (2001). Molecular cloning: A laboratory manual (3rd ed.). Cold Spring Harbor Laboratory Press.
- Claverie, J. M., & Notredame, C. (2011). Bioinformatics for dummies (2nd ed.). Wiley.

Suggested Readings

- Brown, T. A. (2018). Genomes (5th ed.). Garland Science.
- Mount, D. W. (2004). Bioinformatics: Sequence and genome analysis (2nd ed.). Cold Spring Harbor Laboratory Press.

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SYLLABUS						
SIGNATURE COURSE						
Name of the College	B.C.M. College, Kottayam					
Faculty/ Discipline	Zoology					
Programme	BSc (Hons) Zoology					
Course Coordinator	Varun Jolly					
Contributors	Ms. Priya Thomas, Dr. Elezabeth Basil, Ms. Emi Mathew					
Course Name	Clinical Genomics					
Type of Course	DSE					
Specialization title	Genomics					
Course Code	To be prepared by the University					
Course Level	300					
Course Summary	This course introduces advanced concepts in clinical genomics, spanning reproductive, pediatric, adult, and infectious disease genetics. Students will explore diagnostic techniques including next-generation sequencing, pharmacogenetics, and epigenetic analysis. Real-world clinical case studies and panels will guide application in diagnosis and personalized medicine. Ethical and psychosocial considerations are integrated throughout the curriculum to encourage responsible and empathetic practice.					
Semester	5	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic knowledge in Genome Biology					

Course Outcomes (CO)

Number of COs		**5**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain the genomic principles and technologies involved in assisted reproduction, reprogenetics, and evaluate their clinical and ethical implications	U, A	PO1, PO2, PO3, PO6, PO8, PO10
2	Analyse the genetic factors in paediatric and adult diseases including neurogenetic and behavioural conditions.	AN	PO1, PO2, PO3, PO8, PO10
3	Analyse the genetic factors in paediatric and adult diseases including neurogenetic and behavioural conditions.	E	PO1, PO2, PO3, PO6, PO7, PO8, PO10
4	Interpret genetic case studies, panels and clinical genomics report for accurate diagnosis and genetic counseling.	A	PO1, PO2, PO3, PO6, PO7, PO8, PO10

Number of COs		5	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	Apply genetic counseling skills to interpret tests	A	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

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CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
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CO 2	3	3	3	-	-	-	-	1	-	-
CO 3	3	3	3	-	-	2	1	1	-	1
CO 4	3	3	3	-	-	1	1	1	-	1
CO 5	3	3	3	2	1	2	1	1	1	-

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Reproductive Genetics			
	1.1	Assisted reproduction technologies (ART)-In Vitro Fertilization (IVF), Intracytoplasmic Sperm Injection (ICSI), Zygote Intrafallopian Transfer (ZIFT), Gamete Intrafallopian Transfer (GIFT), Cryopreservation of gametes and embryos, Use of donor sperm, eggs, or embryos, Gestational surrogacy and its genomic implications Genetic counseling in ART- Role and scope of genetic counseling in reproductive medicine	5	["1"]
	1.2	Reprogenetics and Preimplantation Genetic Diagnosis (PGD)-Definition , Importance of PGT in IVF and reproductive genomics. Indications for PGT, Types of PGT (PGT-A ,PGT-M ,PGT-SR), Techniques in PGT (Embryo Biopsy Techniques, Genetic Analysis Technologies), Ethical and legal aspects	5	["1"]
	1.3	Prenatal Genetic Diagnosis;- Introduction, timing of testing , Screening Tests and Diagnostic Test, Invasive techniques: Amniocentesis, CVS , Non-invasive prenatal testing (NIPT), Maternal serum screening and fetal DNA analysis, Understanding test sensitivity, specificity	5	["1"]

Module	Units	Course Description	Hrs	CO No.
2	Paediatric and Adult Genetics and Genomics			
	2.1	Genetics of Newborns and Infants; Definition, Overview of common neonatal genetic disorders, Neonatal screening test, (Heel Prick, Tandem MS , Enzyme Assays, DNA-Based Testing), Genetic syndromes associated with delay: Down syndrome (Trisomy 21), Fragile X syndrome, Rett syndrome, Prader-Willi and Angelman syndromes	5	["2"]
	2.2	Genetics of Adolescents and Adults; Puberty, Genetic control of puberty onset: (KISS1, KISS1R, GNRH1, TAC3, MKRN3), disorders of sexual development (Turner Syndrome, Klinefelter Syndrome, CAH (21-hydroxylase deficiency), Androgen Insensitivity Syndrome, 5α-reductase deficiency), sexual orientation and its genetic basis, Infertility genetics -Genetic causes of male infertility, Genetic causes of female infertility.	5	["2"]
	2.3	Neurogenetics- Genetic basis of neurological disorders(Epilepsy, Huntington's disease, Alzheimer's disease, Neuromuscular disorders- SMA, dystrophies),Whole –exome/genome sequencing in neurological evaluation.	5	["2"]
3	Genetics of Infection and Epigenomics			
	3.1	Genomics and Disease Susceptibility; genetic variation and disease susceptibility- (Breast Cancer, Type 1 Diabetes, Alzheimer's Disease, Malaria resistance, TB), Genome-Wide Association Studies (GWAS)	5	["3"]
	3.2	Pharmacogenetics; Definition- Pharmacokinetics and Pharmacodynamics, Genetic Polymorphisms in Drug Metabolism, Drug metabolism genes (e.g., CYP450), Case examples: Warfarin, Tamoxifen, Clopidogrel, Ethical, Legal, and Regulatory Aspects	5	["3"]
	3.3	Epigenetics and Epigenomics – Definition, Difference between genetics and epigenetics, DNA methylation- Role in gene silencing, X-chromosome inactivation, and development, Hypermethylation in cancer (e.g., BRCA1), Histone Modifications and Chromatin Remodeling- Role in neurodevelopment and cancer, Genomic Imprinting and Imprinting Disorders (e.g., Prader-Willi, Angelman syndromes), Environmental epigenetics: diet, toxins, stress, Epigenetics in Therapy	5	["3"]
4	Case Studies in Clinical Genomics			
	4.1	Clinical case study- definition, role of clinicians, genetic counselors, and lab geneticists, Mendelian Disorders and Single-Gene Testing, Cystic Fibrosis, Thalassemia	5	["4"]
	4.2	Cancer Genomics Case Studies- Hereditary Breast and Ovarian Cancer, Colorectal Cancer – Lynch syndrome, Tumor vs. germline testing	5	["4"]
	4.3	Neurological and Developmental Disorders- Autism Spectrum Disorder – CNV and exome sequencing, Epileptic Encephalopathy – Whole-exome approach, ethical and counseling aspects in genomic diagnostics	5	["4", "5"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) ICT Enabled Learning Practices, Virtual Lab, Group Discussions, Lecturing

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Quiz, Test Paper, Seminar, Group Discussion, ,Research Institute Visit Report **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Test Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ MCQ - (10 out of 10) – 10 × 1 = 10 ◦ PART - B ◦ Short answer - (14 out of 16) – 14 × 2 = 28 ◦ PART - C ◦ Short Essays - (8 out of 10) – 8 × 4 = 32

References

- Connor, M., & Ferguson-Smith, M. (2007). Essential medical genetics (6th ed.). Wiley-Blackwell.
- Dale, J. W., Schantz, M. V., & von Schantz, M. (2021). From genes to genomes: Concepts and applications of DNA technology (4th ed.). Wiley.
- Reece, R. J. (2004). Analysis of genes and genomes. Wiley-Blackwell.
- Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R. B. (2019). Campbell biology (11th ed.). Pearson. (Includes sections relevant to genomics and molecular biology fundamentals)
- Korf, B. R., & Irons, M. B. (2012). Human genetics and genomics: A problem-based approach (4th ed.). Wiley-Blackwell.
- Barnett, T., & Mercer, J. (2018). Clinical genetics and genomic medicine (1st ed.). Oxford University Press.
- McConkey, E. H. (2004). Human genetics: The molecular revolution. Jones & Bartlett Learning
- Nussbaum, R. L., McInnes, R. R., & Willard, H. F. (2020). Thompson & Thompson genetics in medicine (9th ed.). Elsevier.
- Strachan, T., & Read, A. (2018). Human molecular genetics (5th ed.). Garland Science.
- Turnpenny, P. D., & Ellard, S. (2016). Emery's elements of medical genetics (15th ed.). Elsevier.

Suggested Readings

- "Clinical application of gene panels for autism and epilepsy" – Nature Reviews Genetics
- "The role of genomics in TB susceptibility" – Lancet Infectious Diseases
- "Epigenetics in Human Disease" – New England Journal of Medicine
- "Pharmacogenomics: An Update" – American Journal of Human Genetics

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Programme	BSc (Hons) Zoology					
Course Coordinator	Varun Jolly					
Contributors	Ms. Priya Thomas, Dr. Elezabeth Basil, Ms. Emi Mathew					
Course Name	Cancer Genomics and Precision Medicine					
Type of Course	DSE					
Specialization title	Genomics					
Course Code	To be prepared by the University					
Course Level	300					
Course Summary	The course, 'Cancer Genomics and Precision Medicine,' explores how genes influence cancer development and how cutting-edge science transforms cancer care through personalized medicine. It introduces the basics of cancer biology, the genetic changes that drive cancer, and the advanced tools used to analyze cancer at the DNA level. They will discover how scientists use genomics to identify cancer-causing mutations, decode tumour behaviour, and customize treatments based on each patient's unique genetic makeup. By the end of the course, students will understand how genomics is reshaping cancer diagnosis, treatment, and the future of healthcare—empowering them with knowledge about the rapidly evolving field of precision medicine.						
Semester	6	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any	Basic knowledge in Cell biology and Genetics					

Course Outcomes (CO)

Number of COs		**5**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain the fundamental principles of cancer biology and classification..	U	PO1, PO2, PO3, PO10
2	Analyze the genetic basis of carcinogenesis and inheritance patterns..	AN	PO1, PO2, PO3, PO6, PO9, PO10
3	Evaluate genomic technologies and data for understanding cancer development and heterogeneity.	E	PO1, PO2, PO3, PO6, PO10
4	Appraise the role of genomic biomarkers and tumor profiling in cancer diagnosis, prognosis, and targeted therapy selection.	E	PO1, PO2, PO3, PO6, PO8, PO10

Number of COs		5	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	Evaluate the foundations of precision oncology, critically assess the clinical translation potential of emerging genomic technologies, and navigate the ethical implications of personalized cancer medicine.	E	PO1, PO2, PO3, PO6, PO8, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	2	-	-	-	-	-	-	2
CO 2	2	3	2	-	-	1	-	-	1	3
CO 3	3	3	3	-	-	1	-	-	-	1
CO 4	3	3	3	-	-	2	-	1	-	2
CO 5	3	3	3	-	-	2	-	3	-	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Fundamentals of Cancer Biology			
	1.1	Introduction to Cancer: Definition, biological overview; differences between normal and cancer cells; Hallmarks of Cancer: Sustained proliferative signalling, evasion of cell death, Evasion of Growth Suppressors, Inducing Angiogenesis, Activating Invasion & Metastasis (introductory concepts)	6	["1"]
	1.2	Basic Cancer Terminologies: Tumor, neoplasia, metastasis, benign vs malignant; cancer staging and grading Cell cycle and apoptosis.	5	["1"]
	1.3	Classification of Cancer: Understanding the Diversity: Classification by Cell/Tissue of Origin: (Carcinoma, Sarcoma, Leukaemia, Lymphoma, Myeloma) Tissue and Organ-Based Classification: Organ-Specific Cancers (e.g., Lung Cancer, Breast Cancer, Colorectal Cancer)	4	["1"]

Module	Units	Course Description	Hrs	CO No.
2	Genetics of Cancer			
	2.1	Genetic Mutations in Cancer: Point mutations, insertions, deletions; somatic vs germline mutations; genetic vs environmental carcinogenesis	5	["2"]
	2.2	Cancer genes–Proto-oncogenes, Tumor suppressor genes & Genome Stability / DNA Repair Genes Two hit hypothesis and Multi-hit model of cancer formation.	6	["2"]
	2.3	Cancer Risk and Heredity: Familial vs sporadic cancers; inherited cancer syndromes (e.g., BRCA mutations)	4	["2"]
3	Cancer Genomics			
	3.1	Genomic Instability and Cancer: DNA repair defects, genome instability, tumorigenesis, mutation accumulation	4	["3"]
	3.2	Genomic technologies in cancer research: NGS (WES, WGS), transcriptome analysis, microarray, gene expression profiling (conceptual overview)	4	["3"]
	3.3	Cancer Genomics Databases and Mutation Profiling: Global Cancer Genomics Initiatives: The Cancer Genome Atlas (TCGA), cBioPortal Mutation Spectrum: SNVs, CNVs, Rearrangements	4	["3"]
4	Diagnostic and Therapeutic Genomics in Cancer & Precision Oncology			
	4.1	Traditional Cancer Diagnostics & Screening i) Screening Modalities: Population-level: Mammography (breast), PAP smear (cervical), PSA testing (prostate) Limitations ii) Diagnostic Confirmations: Histopathology: Biopsy types (FNAC/core/excisional), H&E staining Imaging: CT (tumor staging), MRI (soft-tissue resolution), PET-CT (metastasis detection)	5	["4"]
	4.2	Genomic Biomarkers & Tumor Profiling: Biomarker Classification: : Diagnostic, prognostic, predictive biomarkers (HER2, EGFR, KRAS, PD-L1, PSA) Genetic Testing and Tumor Profiling: Gene panel testing for breast, colon, and lung cancers; molecular subtyping	5	["4"]
	4.3	Precision Oncology & Clinical Translation: Personalized medicine, therapy selection, ethical considerations, targeted therapies, immunogenomics	4	["5"]
	4.4	Emerging Technologies and Future Trends: Liquid biopsy, cfDNA, CRISPR, gene editing, big data, AI in cancer genomics	4	["5"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) ICT- Enabled Learning Practices, Basic lab, Virtual Lab, Group Discussion, Lecturing

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Quiz, Test Paper, Seminar, Group Discussion, Research Institute Visit Report **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ MCQ - (10 out of 10) – 10 × 1 = 10 ◦ PART - B ◦ Short answer - (14 out of 16) – 14 × 2 = 28 ◦ PART - C ◦ Short Essays - (8 out of 10) – 8 × 4 = 32

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Suggested Readings

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