ADAMAS UNIVERSITY
KOLKATA
PURSUE EXCELLENCE

GDIFR

Program Name: Post Graduation in Clinical Embryology

Program Code: **RAE4203**

Offered jointly by Subhash Mukhopadhyay Centre for Stem Cell Biology and Regenerative Medicine, Department of Allied Health Sciences, School of Health and Medical Sciences, Adamas University

&

Ghosh Dastidar Institute for Fertility Research, Kolkata

Duration: 2 Years

Academic Year: 2026-28

Syllabus for MSc in Clinical Embryology

ADAMAS UNIVERSITY
SUBHASH MUKHOPADHYAY CENTRE FOR STEM CELL BIOLOGY AND REGENERATIVE MEDICINE

SEMESTER I

RAE401: BASICS IN MOLECULAR BIOLOGY (4 credits, 60 lecture hours)

Module I: Foundations of cellular life (8 hours)
Universal features of cells, chemical components of cells, energy, catalysis, and cellular metabolism; protein structure, folding, and function; introduction to genetic information flow.

Module II: Genome architecture and maintenance (16 hours)
DNA structure/function and chromatin organization; chromosome dynamics and genome evolution; DNA replication mechanisms (initiation, elongation, termination); DNA repair systems (direct repair, mismatch, nucleotide excision); homologous recombination; transposition; site-specific recombination.

Module III: Gene expression & regulation (14 hours)
Transcription mechanisms (prokaryotic/eukaryotic); RNA processing and post-transcriptional controls; translation machinery and protein synthesis; gene regulatory proteins and genetic switches; epigenetic regulation (chromatin remodelling, histone modifications).

Module IV: Methods in molecular and cellular analysis (10 hours)
Cell culture and isolation techniques; protein purification and analysis (SDS-PAGE, Western blot); DNA/RNA manipulation (PCR, sequencing, CRISPR); gene expression assays (qRT-PCR, reporter systems); microscopy (light, fluorescence, electron) theory and image acquisition techniques.

Module V: Cellular systems & dynamics (12 hours)
Membrane structure; ion transport (channels, transporters) mechanisms; organelle biogenesis/function (ER, Golgi, mitochondria, peroxisomes); cell signalling (GPCRs, enzyme-coupled receptors, proteolysis pathways); cytoskeleton, molecular motors, and cell motility; cell cycle regulation; mitosis; apoptosis; and homeostasis

Suggested textbooks:

1. Molecular Biology of the Cell (Fifth edition), Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Kate Roberts, Peter Walter. Garland Science (Taylor & Francis Group) 2008.
2. Biochemistry (Fourth Edition), Donald Voet & Judith G. Voet, Wiley (2011).

RAE402: HUMAN REPRODUCTION (4 credits, 60 lecture hours)

Module I: Fundamentals of germ cell biology and sexual reproduction (12 hours)
Evolutionary principles: competitive advantage of sexual reproduction, variation across species; meiosis & genetic diversity: mechanisms of meiotic entry, synaptonemal complex, crossing-over regulation and segregation anomalies; germline induction: human primordial germ cells (hPGCs) formation, migration, and conservation from model systems, epigenetic reprogramming: genome asymmetry, imprinting establishment, X-chromosome dynamics, and reprogramming triggers; germ cell pathology: origins and mechanisms of germ cell tumours.

Module II: Gametogenesis & gonadal development (14 hours)
Oogenesis: Molecular regulation of oocyte growth, size determinants, follicular atresia, and maturation; spermatogenesis: spermatogenic cycle, sperm morphology adaptations, and endocrine regulation; gonadal development: roadmap of gonad formation, sex determination pathways, and descent of testes/ovaries, meiotic sex differences: differential regulation in males (continuous) vs. females (arrested).

Module III: Reproductive system integration (14 hours)
Anatomy & neurovascular supply: male/female reproductive tract structures, vascularization, innervation; endocrinology: hypothalamic-pituitary-gonadal axis, hormone synthesis/regulation, feedback loops; physiology: menstrual/estrous cycles, spermatogenic waves, ejaculatory mechanisms; pathophysiology: hormonal disorders (e.g., PCOS, hypogonadism), cryptorchidism, implantation failure.

Module IV: Fertilization & early developmental transitions (10 hours)
Sperm maturation: capacitation, acrosome reaction, and sperm-zona pellucida interactions; fusion & activation: sperm-egg fusion mechanics, calcium signalling, cortical reaction, block to polyspermy; zygotic transformation: sperm contribution to zygote, totipotency acquisition, zygotic genome activation; epigenetic reset: post-fertilization reprogramming consequences.

Module V: Assisted reproduction & clinical applications (10 hours)

ART Techniques: IVF/ICSI workflows, gamete handling, embryo culture systems; preimplantation diagnostics: genetic screening (PGT) and epigenetic assessment, reproductive challenges: recurrent implantation failure, sperm dysfunction diagnostics; emerging technologies: mitochondrial replacement, genome editing ethics.

Suggested textbooks:

1. Molecular Biology of the Cell (Fifth edition). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Kate Roberts, Peter Walter. Garland Science (Taylor & Francis Group) 2008.
2. Human Physiology (Volume 1; twelfth edition). C C Chatterjee. CBS Publishers and Distributors 2018.
3. Textbook of Clinical Embryology. Kevin Coward and Dagan Wells. Cambridge University Press 2013.

RAE403: EMBRYOGENESIS (4 credits, 60 lecture hours)

Module I: Basics of pluripotency and early development (14 hours)

Pre-implantation Embryogenesis: Zygote, morula, blastocyst (ICM/trophectoderm specification); pluripotency states: naive vs. primed pluripotency; evolutionary conservation across species; stem cell derivation: embryonic stem cells (ESCs) from ICM; induced pluripotent stem cells (iPSCs); characterization & banking: key biomarkers, genomic stability assays, GMP-compliant cryopreservation.

Module II: Molecular control of stem cell states (12 hours)

Signalling Networks: LIF/STAT3, BMP/SMAD, WNT/NODAL in self-renewal vs. Differentiation; epigenetic regulation: DNA/histone modifications, X-chromosome dynamics, imprinting maintenance; culture systems: chemically defined media for naive/primed states; 3D matrices for state transitions (reset & capacitation); functional genomics for identification pluripotency determinants.

Module III: Modelling human embryogenesis (16 hours)

Pre-implantation Models: iBlastoids/EPS-blastoids (generation, validation & limitations) post-implantation systems: 3D epiblast models (BMP4-driven symmetry breaking), gastruloids for anteroposterior patterning, day-14 embryo models from naive ESCs; extraembryonic integration: trophoblast stem cells in blastocyst models and placental

interface reconstruction; validation tools: scRNA-seq and live imaging; ethical boundaries (ISSCR guidelines).

Module IV: Differentiation and organogenesis (10 hours)

Gastrulation dynamics: EMT, germ layer specification and axial organization; peri-gastruloid systems: Modelling early organogenesis; germline reconstitution: In vitro gametogenesis from PSCs; endometrial interactions: implantation cues, maternal-fetal signalling.

Module V: Translational applications and frontiers (8 hours)

Disease modelling: birth defects using patient-derived iPSCs, teratoma assays for developmental potential; regenerative strategies: organoid-based tissue engineering (hindgut, yolk sac), In vitro gametogenesis (IVG) for infertility; emerging technologies: AI-driven morphogenesis prediction, synthetic embryo models with bioengineered niches.

Suggested textbooks:

1. Molecular Biology of the Cell (Seventh edition). Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Kate Roberts, Peter Walter. W.W. Norton & Company 2022.
2. Handbook of Stem Cells (Volume 1). Robert Lonza, John Gearhart, Brigid Hogan, Doughlas Melton, Roger Pedersen, James Thomson, Michael West. Academic Press 2004.
3. In-Vitro Fertilization (Fourth edition) Kay Elder and Brian Dale. Cambridge University Press 2020.

Suggested articles:

1. Kinoshita, M., Barber, M., Mansfield, W., Cui, Y., Spindlow, D., Stirparo, G.G., Dietmann, S., Nichols, J., and Smith, A. (2021). Capture of mouse and human stem cells with features of formative pluripotency. *Cell Stem Cell* 28, 453–471.e8
2. Rostovskaya, M., Stirparo, G.G., and Smith, A. (2019). Capacitation of human naı¨ve pluripotent stem cells for multi-lineage differentiation. *Development* 146, dev172916.
3. Takahashi K, Yamanaka S. A decade of transcription factor-mediated reprogramming to pluripotency. *Nat Rev Mol Cell Biol.* 2016;17(3):183–93.
4. Liu, X. et al. Modelling human blastocysts by reprogramming fibroblasts into iBlastoids. *Nature* 591, 627–632 (2021).
5. Yu, L. et al. Blastocyst-like structures generated from human pluripotent stem cells. *Nature* 591, 620–626 (2021).

6. Kagawa, H. et al. Human blastoids model blastocyst development and implantation. *Nature* 601, 600–605 (2022).
7. Yanagida, A. et al. Naive stem cell blastocyst model captures human embryo lineage segregation. *Cell Stem Cell* 28, 1016–1022.e4 (2021).
8. Io, S. et al. Capturing human trophoblast development with naive pluripotent stem cells in vitro. *Cell Stem Cell* 28, 1023–1039.e13 (2021).
9. Guo, G. et al. Human naive epiblast cells possess unrestricted lineage potential. *Cell Stem Cell* 28, 1040–1056.e6 (2021).
10. Mazid, M. A. et al. Rolling back human pluripotent stem cells to an eight-cell embryo-like stage. *Nature* 605, 315–324 (2022).
11. Taubenschmid-Stowers, J. et al. 8C-like cells capture the human zygotic genome activation program in vitro. *Cell Stem Cell* 29, 449–459.e6 (2022).
12. Yu, L. et al. Large-scale production of human blastoids amenable to modeling blastocyst development and maternal-fetal cross talk. *Cell Stem Cell* 30, 1246–1261.e9 (2023).
13. Simunovic M, Metzger JJ, Etoc F, Yoney A, Ruzo A, Martyn I, Croft G, You DS, Brivanlou AH, Siggia ED. A 3D model of a human epiblast reveals BMP4-driven symmetry breaking. *Nat Cell Biol.* 2019 Jul;21(7):900-910.
14. Moris N, Anlas K, van den Brink SC, Alemany A, Schröder J, Ghimire S, Balayo T, van Oudenaarden A, Martinez Arias A. An in vitro model of early anteroposterior organization during human development. *Nature* 2020 Jun;582(7812):410-415.
15. Simunovic M, Siggia ED, Brivanlou AH. In vitro attachment and symmetry breaking of a human embryo model assembled from primed embryonic stem cells. *Cell Stem Cell* 2022 Jun 2;29(6):962-972.e4.
16. Weatherbee BAT, Gantner CW, Iwamoto-Stohl LK, Daza RM, Hamazaki N, Shendure J, Zernicka-Goetz M. Pluripotent stem cell-derived model of the post-implantation human embryo. *Nature* 2023 Oct;622(7983):584-593.
17. Oldak B, Wildschutz E, Bondarenko V, Comar MY, Zhao C, Aguilera-Castrejon A, Tarazi S, Viukov S, Pham TXA, Ashouokhi S, Lokshtanov D, Roncato F, Ariel E, Rose M, Livnat N, Shani T, Joubran C, Cohen R, Addadi Y, Chemla M, Kedmi M, Keren-Shaul H, Pasque V, Petropoulos S, Lanner F, Novershtern N, Hanna JH. Complete human day 14 post-implantation embryo models from naive ES cells. *Nature* 2023 Oct;622(7983):562-573.

MLT41105/MLT41109: DSE – INTRODUCTION TO QUALITY AND PATIENT SAFETY/PRINCIPLES OF MANAGEMENT WITH SPECIAL REFERENCE TO MEDICAL LABORATORY SCIENCE MANAGEMENT (4 credits, 60 lecture hours)

MLT41105: DSE– INTRODUCTION TO QUALITY AND PATIENT SAFETY

Module I: Quality assurance and management

Concepts of quality of care, Quality improvement approaches, standards and norms, Quality improvement tools, Introduction to NABH guidelines.

Module II: Basics of emergency care and life support skills

Vital signs and primary assessment, Basic emergency care – first aid and triage, Ventilations including use of bag-valve-masks (BVMs), Choking, rescue breathing methods, One- and Two-rescuer CPR, using an AED (Automated external defibrillator), Managing an emergency including moving a patient.

Module III: Bio medical waste management and environment safety

Definition of biomedical waste, waste minimization, BMW – Segregation, collection, transportation, treatment and disposal (including color coding), liquid BMW, radioactive waste, metals / chemicals / drug waste, BMW Management & methods of disinfection, modern technology for handling BMW, use of personal protective equipment (PPE), monitoring & controlling of cross infection (Protective devices).

Module IV: Infection prevention and control

Evidence-based infection control principles and practices [such as Sterilization, Disinfection, Effective hand hygiene and use of Personal Protective Equipment (PPE)], Prevention & control of common healthcare associated infections, Components of an effective infection control program, and Guidelines (NABH and JCI) for Hospital Infection Control.

Module V: Antibiotic Resistance

History of antibiotics, how resistance happens and spreads, types of resistance- intrinsic, acquired, passive, trends in drug resistance, actions to fight resistance, bacterial persistence, antibiotic sensitivity, consequences of antibiotic resistance, antimicrobial Stewardship – Barriers and opportunities, tools and models in hospitals.

Module VI: Disaster preparedness and management

Fundamentals of emergency management, psychological impact management, resource management, preparedness and risk reduction, key response functions (including public health,

logistics and governance, recovery, rehabilitation and reconstruction), information management, incident command and institutional mechanisms.

Suggested textbooks:

1. Textbook of Medical Laboratory Technology (Volume 1&2; fourth edition). Praful B. Godkar, Darshan P. Godkar. Bhalani publishers (2024).

MLT41109: DSE– PRINCIPLES OF MANAGEMENT WITH SPECIAL REFERENCE TO MEDICAL LABORATORY SCIENCE MANAGEMENT

Module I: Ethical Principles and standards for a clinical laboratory professional
Duty to the patient, duty to colleagues and other professionals, duty to the society.

Module II: Good Laboratory Practice (GLP) Regulations and Accreditation
Introduction to Basics of GLP and Accreditation, aims of GLP and Accreditation, advantages of accreditation, brief knowledge about national and international agencies for clinical laboratory accreditation.

Module III: Awareness / Safety in a clinical laboratory
General safety precautions, HIV: pre- and post-exposure guidelines, Hepatitis B & C: pre- and post-exposure guidelines, Drug Resistant Tuberculosis.

Module IV: Patient management
Patient management for clinical samples collection, transportation and preservation, sample accountability, purpose of accountability, methods of accountability.

Module V: Sample analysis
Introduction, factors affecting sample analysis

Module VI: Reporting results
Basic format of a test report, reported reference range, clinical alerts, abnormal results, turnaround time, results from referral laboratories, release of examination results, alteration in reports.

Module VII: Biomedical waste management in a clinical laboratory

Module VIII: Introduction and importance of calibration and Validation of Clinical Laboratory instruments

Module IX: Introduction to Laboratory Information system (LIS)
Hospital Information system (HIS) and financial management

Module X: Ethics in Medical laboratory Practice
Introduction, functions of a laboratory management system, standards for laboratory management system, introduction and awareness of financial management in a clinical laboratory, inventory control.

Suggested textbooks:

1. Medical Laboratories Management- Cost effective methods by Sangeeta Sharma, Rachna Agarwal, Sujata Chaturvedi and Rajiv Thakur. Viva Book Originals (2018).

RAE404: RESEARCH METHODOLOGY (OF EMBRYO CULTURE) (4 credits, 45 lecture hours and 15 training hours)

Module I: Facilities for embryo culture
General aspects of air quality in ART laboratory, hygiene, layout of the laboratory, laboratory storage, safety and security in ART laboratory, gas and electrical power. Incubator - types, installation, cleaning and preventing contamination, functioning, monitoring and quality control. Product development and validation for ART, quality control on medical devices for ART

Module II: Culture media and optimal handling techniques in human embryo culture
Synthetic oviduct fluid, sequential embryo culture, components of embryo culture - protein supplements, growth factors and hormones, vitamins, trace metals, lipids, hyaluronic acid, pH regulators, non-physiological additives, oxygen concentration and antioxidants, single vs group culture, Biocarbonate-buffered media, zwitterionic-buffered media, equilibration of media, temperature inside and outside incubator, osmolarity, light inside and outside incubator, air inside and outside incubator; culture conditions - oxygen, temperature, pH and osmolarity, humidity, air quality, performance indicators; culture medium, culture time, missing link between embryo culture and IVF offspring outcome.

Module III: From identification to witnessing
Witnessing procedure, equipment for witnessing, consumables used for or traced by witnessing.

Module IV: Timing of embryo culture
Embryo selection, single embryo transfer and reduction of multiple pregnancies, embryo-uterine synchronization, embryo biopsy for PGT, embryo cryopreservation, monitoring of

ovarian hyperstimulation syndrome, outcomes after cleavage-stage and blastocyst transfer, morula stage, embryo with slow or fast development.

Module V: Time-lapse technology

Time-lapse vs morphological selection, time-lapse prediction models, time-lapse and computer assisted technology/machine learning, types and characteristics of TLT devices – single vs combined embryo culture, integrated vs non-integrated systems, gas, dish preparation and handling, TLT for embryo assessment.

Suggested textbooks:

1. Textbook of Clinical Embryology. Kevin Coward and Dagan Wells. Cambridge University Press 2013.
2. Manual of Embryo Culture in Human Assisted Reproduction. Kersti Lundin, and Aisling Ahlström. Cambridge University Press 2021.

RAE405: FIELD PROJECT IN BIOCHEMISTRY AND MOLECULAR BIOLOGY LAB (2 credits, 90 practical hours)

A. Isolation of genomic DNA
B. Isolation of RNA and cDNA preparation
C. Amplify DNA by PCR
D. Agarose gel electrophoresis
E. Cloning of DNA into plasmid
F. Transformation of plasmid into bacteria
G. SDS-PAGE
H. Western Blotting
I. pH measurement and adjustments
J. Phase contrast microscopy
K. Bright-field & fluorescence microscopy
L. Immunocytochemistry
M. Enzyme linked Immuno Assay (ELISA)
N. Karyotyping
O. Fluorescent In Situ Hybridization (FISH)
P. Real-Time PCR

SEMESTER II

RAE501: FUNDAMENTALS OF ASSISTED REPRODUCTIVE TECHNOLOGY (ART) (4 credits, 60 lecture hours)

Module I: Basics of ART

Historical evolution: introduction and propagation of IVF, Indian IVF history & ethical frameworks; ovarian reserve assessment: biomarkers (AMH, AFC), genetic influences; basic procedures overview: IUI, IVF, GIFT/ZIFT; third-party reproduction: gamete donation and surrogacy legal models.

Module II: ART treatment protocols

Ovarian stimulation science: agonist/antagonist protocols, individualized dosing strategies; monitoring & retrieval: ultrasound-guided techniques, complication prevention (premature ovulation); sperm processing: surgical retrieval (PESA/TESA).

Module III: ART laboratory processes

Fertilization techniques: conventional IVF vs. ICSI mechanics; embryo culture systems: media formulations, environmental controls; cryopreservation principles & methods: vitrification vs. slow-freezing thermodynamics; tissue banking protocols.

Module IV: ART risks and outcomes

Clinical complications: OHSS pathophysiology, multiple pregnancy epidemiology; procedural risks: ectopic pregnancy, miscarriage rates, long-term health implications; success metrics: data interpretation, SART benchmarks.

Module V: Patent management in ART

Multidisciplinary counselling: psychological support frameworks, financial decision models; ethical considerations: informed consent protocols, emerging technology discussions (mitochondrial transfer).

Suggested textbooks:

1. Textbook of Clinical Embryology. Kevin Coward and Dagan Wells. Cambridge University Press 2013.

2. Principles of IVF Laboratory Practice - Laboratory Set-Up, Training and Daily Operation. Markus H. M. Montag and Dean E. Morbeck. Cambridge University Press 2023.
3. Principles of IVF Laboratory Practice - Optimizing Performance and Outcomes. Markus H. M. Montag and Dean E. Morbeck. Cambridge University Press 2017.
4. In-Vitro Fertilization (Fourth edition) Kay Elder and Brian Dale. Cambridge University Press 2020.
5. Human Assisted Reproductive Technology. David K. Gardner, Botros R. M. B. Rizk, Tommaso Falcone. Cambridge University Press 2011.
6. Manual of Intracytoplasmic Sperm Injection in Human Assisted Reproduction. Gianpiero D. Palermo and Zsolt Peter Nagy. Cambridge University Press 2021.
7. Single Embryo Transfer. Jan Gerris, G. David Adamson, Petra De Sutter, Catherine Racowsky. Cambridge University Press 2008.

RAE502: ANDROLOGY (4 credits, 60 lecture hours)

Module I: Spermatogenesis & Endocrine Regulation

Testicular architecture: seminiferous tubule dynamics, sertoli/germ cell interactions; sperm production pathways: Hormonal control (HPG axis), epigenetic programming; disruption mechanisms: genetic drivers, environmental toxins.

Module II: Sperm maturation and function

Epididymal maturation: surface remodeling, motility activation, role of seminal plasma; biochemical competence: capacitation biochemistry, acrosome reaction triggers; functional diagnostics: DNA fragmentation assays, oxidative stress biomarkers.

Module III: Pathologies & sexual health

Erectile physiology: NO/cGMP signaling, vascular pathologies; systemic disorders: diabetes/metabolic syndrome impacts; infectious threats: orchitis, post-infectious infertility.

Module IV: Surgical andrology & oncology

Microsurgical techniques: vasectomy reversal patency rates, varicocelectomy outcomes sperm retrieval: microTESE vs. conventional TESA; testicular cancer: germ cell tumor subtypes, fertility-sparing strategies; onco-TESE protocols.

Module V: Fertility preservation & therapeutics
Cryobiology: sperm preservation, limitation in retrieval process ethical guidelines for cryobank maintenance; medical interventions: hormonal stimulation protocols; emerging tech: stem cell-derived gametes, artificial spermatogenesis.

Suggested textbooks:

1. A Practical Guide to Basic Laboratory Andrology. David Mortimer, Lars Björndahl, Christopher L. R. Barratt, José Antonio Castilla, Roelof Menkveld, Ulrik Kvist, Juan G. Alvarez, Trine B. Haugen. Cambridge University Press 2022.

RAE503: ETHICS IN ART (4 credits, 45 lecture hours and 15 training hours)

Module I: Regulatory Foundations & National Frameworks (10 lectures + 3 training hours)
Core legislation: comparative analysis of ART Act 2021 vs. Surrogacy Act 2021; PCPNDT Act's intersection with ART; governance Architecture: structure and powers of NARI/State ART Boards; clinic registration workflows (digital simulations); training: document-based case studies on registration compliance.

Module II: Gamete/Embryo Ethics & Accountability (9 lectures + 4 training hours)
Donor systems: anonymity vs. identity-release models (global comparisons), genetic screening thresholds (ACMG guidelines); embryo stewardship: consent frameworks for embryo disposition, research use protocols (14-day rule evolution); training: Donor-recipient matching simulations.

Module III: Controversial Applications & Boundary Technologies (10 lectures + 3 training hours)
Contentious practices: age-based access algorithms (fertility decline curves), non-medical sex selection prohibition ethics, emerging tech governance: mitochondrial replacement therapy (3-parent baby) risk matrices, CRISPR embryo editing oversight protocols, training: ethics committee role-play on PGT-A expansion requests.

Module IV: Surrogacy Ecosystems & Clinical Integrity (8 lectures + 3 training hours)
Surrogacy justice: Compensation models (altruistic vs. commercial), cross-border regulatory

arbitrage risks; clinic operations: embryologist certification standards (ESHRE benchmarks), chain-of-custody protocols for gametes; training: surrogate consent documentation audits.

Module V: Violation Management & Future Governance (8 lectures + 2 training hours)
Compliance enforcement: penalty classification systems (minor/major violations), whistleblower protection mechanisms; horizon scanning: artificial womb technology ethics, AI-driven fertility prediction regulatory gaps; training: offence scenario response drills.

Suggested textbooks:

1. Textbook of Clinical Embryology. Kevin Coward and Dagan Wells. Cambridge University Press 2013.

MLT41108/MLT41104: DSE-BASIC CLINICAL BIOCHEMISTRY/BASIC HAEMATOLOGY (4 credits, 180 practical hours)

MLT41108: DSE-BASIC CLINICAL BIOCHEMISTRY

Module I: Introduction to Medical Laboratory Technology
Introduction to medical lab. technology, role of medical lab technologist, ethics and responsibility, safety measures, first aid, cleaning and care of general laboratory glass ware and equipment, steps involved in cleaning soda lime glass, steps involved in cleaning borosilicate glass, preparation of chromic acid solution, storage, distilled water - method of preparation of distilled water, type of water distillation plants, storage of distilled water.

Module II: Use of Glassware and Pipettes
Units of Measurement - S. I unit and CGS units & conversion, strength, molecular weight, equivalent weight, Normality, Molarity, Molality, Numerical, Calibration of volumetric apparatus – flask, pipettes, burettes, cylinders, analytical balance – principle, working & maintenance.

Module III: Concept of pH
Concept of pH, Definition, Henderson Hassel batch equation, Pka value, pH indicator, Methods of measurement of pH - pH paper & pH meter, principle, working, maintenance and calibration of pH meter.

Module IV: Volumetric Analysis
Volumetric analysis, normal and molar solutions, standard solutions, preparation of reagents, storage of chemicals, Osmosis – definition, types of osmosis, factors affecting osmotic pressure, Vant Hoff 's equation, applications of osmosis, dialysis.

MLT41104: DSE-BASIC HAEMATOLOGY

Module I: Introduction to Haematology
Introduction to Haematology, definition, importance, important equipment used, laboratory organization and safety measures in Haematology Laboratory, introduction to blood, its composition, function and normal cellular components, anticoagulants: types, mode of action and preference of anticoagulants for different haematological studies, collection and preservation of blood sample for various haematological investigations.

Module II: Formation of blood cells
Formation of cellular components of blood (Haemopoiesis) – Erythropoiesis, Leucopoiesis, Thrombopoiesis, Haemoglobin - definition, types, structure, synthesis and degradation

Module III: Morphology of blood cells
Morphology of normal blood cells, normal haemostasis & physiological properties of coagulation factors.

Module IV: Introduction to abnormal morphology of red blood cells
Red cell abnormalities: anisocytosis, poikilocytosis, hypochromia, inclusions (Howell-Jolly bodies); white cell abnormalities: toxic granulation, döhle bodies, blast cells, platelet; abnormalities: giant platelets, platelet clumping.

Suggested textbooks:

1. Practical Clinical Biochemistry (fourth edition) by Harold Varley. CBS Publishers & Distributors 2005.

BME11008/BME11010: BIOMEDICAL SIGNAL ACQUISITION & PROCESSING/BIOMATERIALS (4 credits, 180 practical hours)

BME11008: BIOMEDICAL SIGNAL ACQUISITION & PROCESSING

Module I: Introduction to Digital Signal Processing
Types of signal and systems, Origins of bio-signals: EMG, ECG, EEG, EOG, PCG; Sources of noise, application of DSP in biomedical engineering.

Module II: Frequency Domain Analysis of Discrete Time Signals and Systems
Z-transform, Z-transform properties, Inverse z-transform, System analysis using Z transform, Discrete Fourier analysis, Discrete-Time Fourier Transform (DTFT), Inverse DTFT. Discrete Fourier Transform (DFT), Inverse DFT. Fast Fourier Transform, Types of FFT, N-point Radix-2 FFT, Inverse FFT.

Module III: Structures of Discrete-Time Systems
Realization of discrete-time systems, FIR systems: Direct, Cascade, Frequency Sampling and Lattice structures. Structures for IIR systems: Direct, Signal Flow Graphs and Transposed, Cascade, Parallel, Lattice and Lattice-Ladder structures. State space system analysis and structures.

Module IV: FIR Filter Design
Symmetric and Anti-symmetric FIR filters, FIR Filter design by window method (Rectangular, Bartlett, Hamming, Hanning, Blackman and Kaiser window), Frequency Sampling method, Optimum approximation of FIR filters, Design of FIR differentiators, Design of Hilbert transformers.

Module V: IIR Filter Design
Design of Discrete-time IIR filters from Continuous-time Filters: Filter design by Impulse invariant and bilinear transformation method: Butterworth, Chebyshev and Elliptic approximation Filter, Frequency transformation.

Suggested textbooks:

1. Digital Signal Processing – Principles and Applications. Thomas Holton, Cambridge University Press 2021.
2. Discrete Time Signal Processing by A.V. Oppenheim, R. W. Schafer, & John R. Buck, , 2nd Edition, Prentice Hall, 1999.

BME11010: BIOMATERIALS

Module I: Classification of biomaterials
Natural and synthetic materials - Properties of biomaterials - Bulk and surface properties – Biocompatibility – Assessment of biocompatibility of biomaterials. Various classes of biomaterials - Metals, Ceramics, Polymers and Composites – Implantable biomaterials – Temporary or permanent implants – Bio-degradable and non-biodegradable materials.

Module II: Cell-biomaterial interactions

Interactions between human tissue and biomaterials - Wound healing – Foreign-Body response - Pathological response to implants.

Module III: Blood-material interactions

Evaluation of blood material interactions – Hemocompatibility – *In Vivo* testing and histocompatibility assessment.

Module IV: Applications of biomaterials in medicine

Soft and hard tissue replacements - Dental implants - Intraocular lens – Metallic hip joint.

Suggested textbooks:

1. Biomaterials science: an introduction to materials in medicine. Buddy D. Ratner.
2. Christiansen-Biomaterials Science and Biocompatibility. Frederick H. Silver, David L. Springer-Verlag New York (1999).
3. Advances in Biomaterials Science and Biomedical Applications. Pignatello R.
4. Biomaterials for Implants and Scaffolds. Qing Li, Yiu-Wing Mai (eds.) - Springer-Verlag Berlin Heidelberg (2017).

RAE504: FIELD PROJECT ON STEM CELL AND GERM CELL BIOLOGY LAB (2 credits, 90 practical hours)

A. Cell line culture & maintenance
B. Transfection of cell line
C. Thawing and harvesting
D. Selection of media conditions
E. Selection of cell culture matrix
F. EB formation
G. *In vitro* differentiation

SEMESTER III

RAE505: IVF, CRYOPRSERVATION TECHNIQUES & ICSI (4 credits, 60 lecture hours)

Module I: IVF Protocol

History of IVF, Introduction to culture media, handling and culture techniques, preparation of media and buffer, sequential culture media, co-culture, normal embryo development, abnormal embryo development, metabolism of embryo, grading of oocyte, embryo selection and grading, Blastocyst culture, embryo transfer technique, USG-guided embryo transfer, Embryo Reduction, anaesthesia, instrumentation in IVF procedure.

Module II: Fundamentals of cryopreservation

History of cryopreservation, principles of cryobiology, cryoprotectants and cryofreezers, factors affecting freezing, cryopreservation protocols, storage of cryopreserved samples and its safety, Vitrification devices, freeze all strategy.

Module III: Cryopreservation of gametes and embryo

Oocyte cryopreservation: history, indications, method of cryopreservation of mature and immature oocytes, current status of oocyte vitrification, ovarian tissue cryopreservation; importance of embryo cryopreservation, embryo cryopreservation, slow freezing and thawing method, penetrating and nonpenetrating cryoprotectant, slow freezing method for embryos, vitrification and warming of embryos, Frozen embryo transfer cycles.

Module IV: Processing of ovarian tissue

In vitro culture of ovarian tissue, ovarian tissue transplantation and outcome.

Module V: Background and protocol of ICSI

Historical aspect and Indication for ICSI, introduction to micromanipulator, physics of micromanipulation, various equipment required to perform ICSI; sperm immobilization, selection of sperm, preparation of sperm for ICSI from ejaculates and testicular biopsies, various medias required to perform ICSI, denuding of oocyte, micropipette handling, ICSI procedure, indication and contraindication of ICSI procedure, obstructive, azoospermia and ICSI, PESA, TESA, TESE and ICSI, intracytoplasmic morphologically selected sperm injection (IMSI), identification of abnormal sperm, identification of immature sperm, sperm separation from testicular biopsy, identification of spermatids - spermatocytes and other cells, assessment of fertilization (ferti-check), risk of anomalies in ICSI.

Suggested textbooks:

1. Textbook of Clinical Embryology. Kevin Coward and Dagan Wells. Cambridge University Press 2013.
2. Principles of IVF Laboratory Practice - Laboratory Set-Up, Training and Daily Operation. Markus H. M. Montag and Dean E. Morbeck. Cambridge University Press 2023.
3. Principles of IVF Laboratory Practice - Optimizing Performance and Outcomes. Markus H. M. Montag and Dean E. Morbeck. Cambridge University Press 2017.
4. In-Vitro Fertilization (Fourth edition) Kay Elder and Brian Dale. Cambridge University Press 2020.
5. Human Assisted Reproductive Technology. David K. Gardner, Botros R. M. B. Rizk, Tommaso Falcone. Cambridge University Press 2011.
6. Manual of Intracytoplasmic Sperm Injection in Human Assisted Reproduction. Gianpiero D. Palermo and Zsolt Peter Nagy. Cambridge University Press 2021.
7. Single Embryo Transfer. Jan Gerris, G. David Adamson, Petra De Sutter, Catherine Racowsky. Cambridge University Press 2008.

RAE506: CYTOGENETICS, QUALITY ASSURANCE AND CONTROL IN ART (4 credits, 60 lecture hours)

Module I: Cytogenetics in Infertility

Role of genetics in infertility, chromosomal and genetic analysis in IVF, genetic techniques, preparation of blastomeres for FISH, embryo biopsy, karyotyping, role of genetics in OATS, genes and RPL (Recurrent pregnancy losses).

Module II: Quality control and analysis in ART

Set up of IVF lab, QA and AC for IVF lab, QA and QC practices, infection control in lab, precision of IVF procedure, record keeping with documentation, lab maintenance protocol, introduction and maintenance of all instruments in IVF lab, calibration of all instruments, quality improvement techniques, review national and international guidelines, trouble shooting and its solution.

Module III: Birth defects caused by genetically altered gametes

Origins of genetic alterations in gametes: parental germline mutations: heritable disorders (e.g., cystic fibrosis, Huntington's), de novo mutations: sporadic errors in meiosis (e.g., aneuploidy, microdeletions), environmental mutagens: radiation, chemotherapy, toxins affecting gamete DNA, ART-Induced Risks: ICSI, ovarian stimulation, in vitro culture impacting epigenetic imprinting. mechanisms of gametic damage: meiotic nondisjunction, DNA repair deficiencies

mutations in *BRCA1/2*, epigenetic dysregulation: altered imprinting (e.g., Angelman/Prader-Willi syndromes).

Module IV: Diagnostic & prevention strategies

Preimplantation genetic testing (PGT): PGT-A, PGT-M, PGT-SR; preconception counselling: genetic carrier screening (expanded panels), lifestyle mitigation (toxin avoidance).

Suggested textbooks:

1. Textbook of Clinical Embryology. Kevin Coward and Dagan Wells. Cambridge University Press 2013.

RAE507: REPRODUCTIVE DISORDERS (4 credits, 60 lecture hours)

Module I: Reproductive Disorders

Sexual differentiation & developmental abnormalities – male & female, menstrual disorders – precocious or delayed or absent puberty, amenorrhea fertility disorders – sexual dysfunction, Endocrine disorders – hyperprolactinemia autoimmune disorders genetic disorders, cancers and biomarkers – testicular prostate ovarian endometrial cervical breast.

Module II: Female infertility

Physiology of ovulation, folliculogenesis, various stimulation protocols, ovarian hyperstimulation syndrome (OHSS), complication of stimulation, and monitoring, reproductive function and causes of subfertility, reproduction at advanced maternal age, diminished ovarian reserve (DOR), miscarriage.

Module III: Male infertility

Causes of male subfertility – pretesticular (endocrine disorders, hypogonadism), testicular (primary testicular failure, varicocele, cryptorchidism, infections, trauma, genetic disorders – Klinefelter, Y-microdeletions, CFTR), post-testicular (obstructive azoospermia, ejaculatory dysfunction – retrograde/anejaculation, infections); semen analysis: CASA, WHO criteria, sperm DNA fragmentation, sperm morphological defects; impact of environmental factors, lifestyle & aging; testicular cancer & fertility preservation.

Module IV: Clinical Management

Infertility and its management, ultrasound, ectopic pregnancies, multiple gestation, heterotrophic pregnancies, oocyte donation programme, surrogacy, male infertility- medical & surgical management – hormone therapy, varicocele repair, sperm retrieval techniques (TESE, microTESE).

Suggested textbooks:

1. Textbook of Clinical Embryology. Kevin Coward and Dagan Wells. Cambridge University Press 2013.
2. Principles of IVF Laboratory Practice. Markus H. M. Montag and Dean E. Morbeck. Cambridge University Press 2023.
3. In-Vitro Fertilization (Fourth edition) Kay Elder and Brian Dale. Cambridge University Press 2020.
4. Manual of Intracytoplasmic Sperm Injection in Human Assisted Reproduction. Gianpiero D. Palermo and Zsolt Peter Nagy. Cambridge University Press 2021.
5. Human Physiology (Volume 1; twelfth edition). C C Chatterjee. CBS Publishers and Distributors 2018.

MLT42107/MLT42105: DSE - FUNDAMENTALS OF HISTOLOGY/BIOCHEMICAL METABOLISM (4 credits, 60 lecture hours)

MLT42107: DSE-FUNDAMENTALS OF HISTOLOGY

Module I: Introduction to Histology

Alimentary System: Diseases of mouth, Diseases of Esophagus- Esophageal varices, Digestive System: Gastritis, Peptic ulceration, Appendicitis microbial diseases, food poisoning, hernia, Intestinal obstructions & mal absorption.

Module II: Introduction to reproductive histopathology

Normal histology of reproductive organs: male: testes (seminiferous tubules, Leydig cells), epididymis, vas deferens. Accessory glands: Prostate, seminal vesicles, bulbourethral glands; female: ovaries (follicles, corpus luteum), fallopian tubes, uterus (endometrium, myometrium, cervix), vagina `nx mammary gland tissue; histopathological techniques & terminology: tissue processing, staining (H&E, PAS), microscopy. Disorders: Hyperplasia, metaplasia, dysplasia, neoplasia.

Module III: Disease related to GI, Circulatory and Respiratory system

Accessory Digestive glands: Salivary glands- mumps, Liver – hepatitis, liver failure, cirrhosis, Pancreas- pancreatitis, Gall Bladder- Gall stones, jaundice and cardiovascular diseases, Circulatory System: Diseases of Blood vessels- Atheroma, Arteriosclerosis, heart block & Disorders of Blood Pressure-Hyper & Hypotension, Respiratory System: Upper respiratory tract infection, Bronchi, Asthma, Pneumonia, Lung abscess, Tuberculosis, Lung Collapse.

Module IV: Disease related to Urinary system, Nervous system and Endocrine system

Urinary System: Glomerulonephritis, Nephrotic syndrome, renal failure, renal calculi, Urinary obstruction, Urinary tract infection, Reproductive system: Sexually transmitted diseases, Pelvic inflammatory disease, disorder of cervix (CIN), Disease of ovaries, ectopic pregnancy, prostatitis, Infertility, Nervous System: Neuronal damage, ICP, Cerebral Infarction, head injury, Alzheimer ‘s Disease, dementia. Endocrine System: Pituitary: Hyper & Hypo secretions, Thyroid: Goiter, Adrenal: Cushing Syndrome, Addison Disease, Pancreas: Diabetes, Sense Organs - Ear: Otitis, Eye: Cataract.

Suggested textbooks:

1. Anatomy &Physiology – Ross and Wilson
2. Human Anatomy and Physiology by Pearce
3. Di Fiore ‘s Atlas of Histology
4. Text book of Pathology by Robbins

MLT42105: DSE-BIOCHEMICAL METABOLISM

Module I: Introduction to Carbohydrate Metabolism

Carbohydrate Metabolism - Introduction, Importance and Classification, Digestion and Absorption, Metabolism: - Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogenolysis, Glycogenesis, disorders of carbohydrate metabolism.

Module II: Introduction to Protein Metabolism

Protein Metabolism - Introduction, Importance and classification, important properties of proteins, digestion & absorption of Proteins, protein synthesis, metabolism of proteins, disorders of protein metabolism and Urea Cycle.

Module III: Introduction to Lipid Metabolism

Lipid, Introduction & classification, digestion & absorption of fats, lipoproteins, fatty acid biosynthesis & fatty acid oxidation

Module IV: introduction to Nucleic Acid Metabolism
Nucleic Acid – introduction, functions of Nucleic acid, functions of energy carriers.

Module V: Enzymes
Enzymes, introductions, importance & classifications, properties of enzymes, mechanism of enzyme action, factors affecting enzyme action, enzyme kinetics & enzyme inhibiters.

Suggested textbooks:

1. Biochemistry (Fourth Edition), Donald Voet & Judith G. Voet, Wiley (2011).

ECE11029/MLT43101: INTRODUCTION TO ARTIFICIAL INTELLIGENCE/IMMUNOLOGY AND BACTERIAL SEROLOGY (4 credits, 60 lecture hours)

ECE11029: INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Module I: Introduction to AI
Intelligent agents, problem-solving agents, automated problem solving- State Space, Problem Reduction, Game Playing, Constraint Satisfaction.

Module II: Automated Reasoning
Proposition and first order logic, inference and deduction, resolution refutation, answer extraction, knowledge-based systems, logic programming, and constrained logic programming, non-monotonic reasoning.

Module III: Planning
State-space, plan space and partial order planning, planning algorithms.

Module IV: Reasoning under uncertainty
Probabilistic reasoning, belief networks.

Module V: Learning
Inductive learning, decision trees, logical approaches, computational learning theory, neural networks, reinforcement learning, Intelligent agents, natural language understanding and Applications, case studies on AI: Robotics and automation/ Speech and audio processing/ Signal processing and pattern recognition/Internet of Things (IoT) applications/ wireless communication and networking/ embedded systems and edge computing/ circuit design and optimization/ energy efficiency and power management/healthcare.

Suggested textbooks:

1. Artificial Intelligence : A Modern Approach (Paperpack). Stuart Russell and Peter Norvig. Pearson; 3 edition. 2010
2. Fundamentals of the New Artificial Intelligence. Toshinori Munakata. Springer Science & Business Media.
3. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
4. Artificial Intelligence (Third Edition).Elaine Rich,Kevin Knight,Shivashankar B. Nair. Tata McGraw-Hill Education Pvt. Ltd. 2008.
5. Reinforcement Learning: An Introduction. Richard S. Sutton Andrew G. Barto . MIT Press, 2017.

MLT43101: IMMUNOLOGY AND BACTERIAL SEROLOGY

Module I: Basic concept of Immunity

History and introduction to immunology, innate immunity, acquired immunity, basic concepts about the mechanisms of innate and acquired immunity, definition, types of antigens and determinants of antigenicity

Module II: Antigen-antibody reaction and different tests in Medical Microbiology

Definition, types, structure and properties of immunoglobulin, antigen-antibody reactions - definition, classification, general features and mechanisms, applications of various antigen antibody reactions, principle, procedure and applications of under mentioned in medical microbiology: complement fixation test, immuno- fluorescence, ELISA, SDS-PAGE, Western blotting.

Module III: Complement system and immune response

Principle, procedure and interpretation of various serological tests: Widal, VDRL, ASO, CRP, Brucella tube agglutination, Rose-Waaler, complement system: definition basic concepts about its components, complement activation pathways, immune response: introduction, basic concepts of humoral and cellular immune responses.

Module IV: Automation in serology and Vaccines

Hypersensitivity: definition, types of hypersensitivity reactions, basic concepts of autoimmunity and brief knowledge about autoimmune diseases, automation in diagnostic serology, Vaccines: definition, types, vaccination schedule, brief knowledge about 'Extended programme of immunization'(EPI) in India.

Suggested textbooks:

1. Practical Medical Microbiology by Mackie & McCartney Volume 1 and 2
2. Medical Laboratory manual for tropical countries Vol II Microbiology by Monica Cheesbrough
3. Immunology by Riot
4. Basic & Clinical Immunology by P. Daniel Fudenberg. H. Hugh and Stites

RAE508: FIELD PROJECT ON ART (2 credits, 90 practical hours)

A. Ovum pick up and transfer
B. The sperm sample – preparation methods for IUI/IVF/ICSI
C. *In Vitro* Fertilization & ICSI
D. Embryo Scoring
E. Embryo transfer
F. Embryo Biopsy
G. Cryopreservation programme & quality assurance
H. Sperm freezing/thawing
I. Oocyte vitrfication/warming
J. Embryo vitrification/warming
K. Ovarian vitrificaion/warming
L. Testicular freezing/thawing
M. Frozen Embryo Transfer
N. Innovative techniques in human embryo viability assessment
O. Dynamic embryo culture
P. Time Lapse incubator

SEMESTER IV

RAE509: BIOINFORMATICS AND BIOSTATISTICS (4 credits, 60 lecture hours)

Module I: Bioinformatics & Multi-omics fundamentals

Introduction to Bioinformatics: databases and genome browser: NCBI, ClinVar, UniProt, Ensembl; Sequence alignment (BLAST) for spermatogenic cell marker, fertility and infertility-related genes; multi-omics technologies (based on case studies): genomics: WES/WGS in preimplantation genetic testing (PGT-A/PGT-M); transcriptomics: from cDNA library to FASTQ file preparation. e.g. RNA-seq of cumulus cells for oocyte quality prediction; proteomics: Mass spectrometry of embryonic secretome; epigenomics: DNA methylation analysis in imprinting disorders (e.g., Angelman syndrome), data formats & Tools: FASTQ, BAM, VCF files; R/Bioconductor for omics data.

Module II: Foundations of biostatistics

Introduction to biostatistics in reproductive medicine: role of statistics in clinical embryology research; data types: nominal, ordinal, interval, ratio (e.g., embryo grading scores, hormone levels); data collection & presentation: design of data collection forms for ART (Assisted Reproductive Technology); summary tables, graphs (bar, pie, scatter plots), and error bars for clinical data; descriptive statistics: measures of central tendency (mean, median) and dispersion (SD, IQR, SEM); applications: analyzing embryo morphokinetic parameters, patient BMI, or hormone assay variability; probability & distributions: binomial, poisson, and normal distributions; relevance: modelling IVF success rates, embryo implantation probability.

Module III: Statistical Inference & Hypothesis Testing (15 hours)

Sampling & estimation: analyze IVF dataset with R/SPSS (t-tests, regression); random sampling techniques in cohort studies (e.g., PCOS vs. non-PCOS patients); confidence intervals for ART success rates; tests of significance: parametric tests: t-tests (comparing embryo quality between two culture media); ANOVA (one-way/two-way): analysing multiple IVF protocol outcomes, F-test (variance in sperm motility assays); Non-parametric tests: chi-square (association between genetic variants and infertility), Mann-Whitney U/Wilcoxon correction (non-normal embryo development data); correlation & regression: Pearson/Spearman correlation (e.g., maternal age vs. blastocyst formation rate), linear regression: predicting IVF outcomes using biomarkers.

Module IV: Multi-omics Data Analysis in Embryology (10 hours)
Variant analysis: SNV/CNV detection in embryos (e.g., aneuploidy screening); Tools: GATK, PLINK; differential expression analysis: identifying dysregulated genes in endometriosis, non-obstructive azoospermia (NOA) (DESeq2, Seurat); pathway & network analysis: KEGG/GO enrichment for fertilization-related pathways (Encichr, g:Profiler); Protein-protein interaction networks (Expasy, STRING); integrative multi-omics: combining genomics, proteomics, and metabolomics for embryo viability scoring.

Module V: Advanced Applications & Research Design (5 hours)
Diagnostic statistics in embryology: sensitivity/specificity of PGT tests, ROC curves for embryo selection algorithms; clinical trial design: sample size calculation for ART studies; RCTs in comparing embryo culture conditions, ethical AI & Big Data, machine learning in embryo grading (time-lapse imaging); ethical guidelines for genomic data in infertility clinics.

Suggested textbooks:

1. Teaching statistics a bag of tricks. Andrew Gelman and Deborah Nolan. Oxford University Press, 2002.
2. Statistics for Engineers and Scientists" by William Navidi, published by McGraw-Hill Education.

MLT41102/MLT43108: DSE – GENERAL CLINICAL MICROBIOLOGY/CYTOPATHOLOGY (4 credits, 60 lecture hours)

MLT41102: DSE-GENERAL CLINICAL MICROBIOLOGY

Module I: Basics of Microbiology
Introduction to Medical Microbiology: definition, history, host - microbe relationship, safety measures in clinical microbiology, glassware used in clinical microbiology laboratory: introduction, care and handling of glassware, cleaning of glassware, equipment used in clinical Microbiology Laboratory: Introduction, care and maintenance including calibration

Module II: Elementary idea about Microscope

Microscopy: introduction and history, Types, principle and operation mechanism of following microscopes - light microscope, DGI, fluorescent, phase contrast, electron microscope: Transmission/ Scanning.

Module III: Sterilization and Disinfection

Sterilization – definition, types and principles of sterilization methods - heat (dry heat, moist heat with special Reference to autoclave), radiation, filtration, efficiency testing to various sterilizers, antiseptics and disinfectants – definition, types and properties, mode of action - uses of various disinfectants, precautions while using the disinfectants - Qualities of a good disinfectant, testing efficiency of various disinfectants, biomedical waste management in a medical microbiology laboratory: types of the waste generated – segregation – treatment – disposal, general characteristics & classification of Microbes: (Bacteria &fungi), classification of microbes with special reference to prokaryotes & eukaryotes, morphological classification of bacteria, bacterial anatomy (Bacterial cell structures).

Module IV: Growth and Culture of Microbes

Growth and Nutrition of Microbes: general nutritional & other requirements of the bacteria, classification of bacteria on the basis of their nutritional requirements, physical conditions required for growth, normal growth cycle of bacteria (growth curve), types of microbial cultures: Synchronous, Static, continuous culture, culture media: introduction, classification of culture media (Example & Uses) solid media, liquid media, semisolid, media, routine/synthetic/defined media, basal media, enriched, enrichment, Selective differential media, sugar fermentation media, transport media, preservation media and anaerobic culture media, quality control in culture media, automation in culture media preparation.

Module V: Aerobic and Anaerobic Culture

Aerobic & anaerobic culture methods: concepts, methods Used for aerobic cultures, methods used for anaerobic cultures, introductions to Immunology, immunity, antigens and antibodies, care & handling of laboratory animals: introduction, general care & handling, ethics & legality in use of laboratory animals.

Suggested textbooks:

1. Practical Medical Microbiology by Mackie and McCartney

MLT43108: DSE-CYTOPATHOLOGY

Module I: Cryostat sectioning & enzyme cytochemistry

Cryostat sectioning, its applications in diagnostic cytopathology, enzyme cytochemistry: diagnostic applications, demonstration of phosphatases, dehydrogenases, oxidases & peroxidases, vital staining for sex chromatin.

Module II: Aspiration & exfoliative cytology and automation in cytology

Aspiration cytology: principle, indications & utility of the technique with special emphasis on role of cytotechnologist in FNAC clinics, exfoliative cytology (Papanicolaou technique for the staining of cervical smears), cervical cytology, fluid cytology: urine, CSF & Body Fluids (Pleural, Pericardial, Ascitic), automation in cytology, liquid based cytology: principles and preparation, cytocentrifuge, molecular cytology, cell block and Immune-cytochemistry.

Module III: Gamete Cytology (Male/Female)

Sperm Cytology & Automated Analysis: Morphological assessment (Papanicolaou/Diff-Quik/HALO reagent staining), CASA (Computer-Aided Sperm Analysis): Statistical validation of motility parameters (mean ± SD, CV%), outlier detection. Use of t-tests/ANOVA to compare sperm quality across patient cohorts; Oocyte Cytology & Viability Assessment: Vital staining for oocyte maturity (mitochondrial activity, cortical granules), Genetic Anomalies in Gametes: FISH for aneuploidy screening (sperm/oocytes).

Module IV: Cytopathology of the Male/Female Reproductive Tract

Testicular cytopathology: FNAC for azoospermia: distinguishing obstructive vs. non-obstructive causes, Johnsen scoring system to assess spermatogenesis and detection criteria for Sertoli cell only STs, accessory gland cytology cervical-endometrial cytopathology, ovarian cytology & fluid analysis.

Suggested textbooks:

1. Handbook of Histopathological Techniques by C F A Culling
2. Medical Lab technology by Lynch
3. An Introduction to Medical Lab Technology by F J Baker and Silverton
4. Bancroft ‘s Theory and Practice of Histopathological Techniques by John D Bancroft
5. Diagnostic Cytology by Koss Volume - II

MLT42106/MLT41106: ANALYTICAL CLINICAL BIOCHEMISTRY/HUMAN ANATOMY AND PHYSIOLOGY (4 credits, 60 lecture hours)

MLT42106: ANALYTICAL CLINICAL BIOCHEMISTRY

Module I: Spectrophotometry and Colorimetry

Introduction, theory of spectrophotometry and colorimetry, Lambert`s law and Beer`s law, applications of colorimetry and spectrophotometry

Module II: Photometry

Introduction, general principles of flame photometry, limitations of flame photometry, instrumentation, applications of flame photometry, atomic absorption spectroscopy – Principle & applications

Module III: Chromatography

Introduction, types of chromatography, paper Chromatography: Introduction, principle, types, details for qualitative and quantitative analysis, application; thin layer chromatography: introduction, experimental techniques, application of TLC, limitations, High performance thin layer chromatography; column chromatography: introduction, principle column efficiency, application of column chromatography; gas chromatography: introduction principle, instrumentation, application; ion exchange chromatography: introduction, Definition and principle, cation and anion exchangers, application; gel chromatography: introduction, principle and method, application and advantages

Module IV: Electrophoresis

Introduction, principle, instrumentation, applications, types of electrophoresis, paper electrophoresis, gel electrophoresis

Suggested textbooks:

1. Practical Clinical Biochemistry by Harold Varley
2. Text book of Medical Laboratory Technology by P. B. Godker
3. Medical Laboratory Technology by Mukherjee
4. Principal of Biochemistry by Lehninger
5. Biochemistry by Voet &Voet
6. Biochemistry by Stryer

MLT41106: HUMAN ANATOMY AND PHYSIOLOGY

Module I: Introduction to human anatomy and physiology

Tissues: definition, classification with structure and functions; epithelial tissues, connective tissues, muscular tissues, nervous tissue

Module II: Blood, respiration and cardiovascular system

Blood: composition, function of blood; muscular skeletal system: introduction, classification, structure and function of skeletal system, muscles and joints, various movements of body; Respiratory system: introduction, structure, function, mechanism of breathing and respiration; various terms involved in respiratory system: vital capacity, total volume, reserve volume, total lung capacity; cardiovascular system: anatomy and physiology of heart, blood circulation, arteries and veins, conductive system of heart, cardiac cycle, introduction to ECG

Module III: Lymphatic system and body fluid

Lymphatic system: introduction, structure and function, lymph nodes, spleen, thymus gland, tonsils; structure and function of sense organ: eye, ear, nose, tongue; body fluids and their significance: Important terms, types of body fluid, total body water, avenues by which water leaves and enters body, general principles for fluid balance, cardinal principle, how body fluids maintain Homeostasis, Electrolytes & ions Function of electrolytes, how electrolyte imbalance leads to fluid imbalance.

Module IV: Digestive System

Digestive system: Organization; accessory organs; structure & function (Mouth, Tongue, Teeth, Esophagus, Pharynx, Stomach, Intestine, Rectum, Anus); Digestive glands; physiology of digestion of carbohydrates, lipids & proteins; Liver: structure and function.

Module V: Urinary and Genital System

Urinary system: Main parts, Structure &function of kidney, structure of nephron, physiology of excretion & urine formation, urine, additional excretory organs; genital system: Structure of male and female reproductive system, Gametogenesis in male & female, menstrual cycle. placenta and extra embryonic membranes; nervous system: parts, function & structure; brain, spinal cord, spinal & cranial nerves; all & none principle, role of neurotransmitters in transmission of nerve impulse; endocrine system: endocrine & exocrine glands, their location, structure & functions.

Suggested textbooks:

1. Anatomy & Physiology- Ross and Wilson
2. Anatomy and Physiology: Understanding the Human Body by Clark
3. Anatomy and Physiology for nurses by Evelyn Pearce
4. Anatomy and Physiology for nurses by Sears
5. Anatomy and Physiology for nurses by Pearson
6. Anatomy and Physiology by N Murges

RAE510: ENTERPRENEURSHIP IN ART (4 credits, 45 lecture hours and 15 training hours)

This will be conducted at the E-YUVA Incubation Centre (Supported by BIRAC, Government of India).

RAE511: RESEARCH PROJECT (6 credits, 270 practical hours)

Apprenticeship will be conducted at GDIFR