





POST GRADUATE DEGREE PROGRAMME

MSC. CLINICAL EMBRYOLOGY

(2Year PG Degree)

CURRICULUM & SYLLABUS

REGULATION 2026

Choice Based Credit System (CBCS)

&

Learning Outcomes Based Curriculum Framework (LOCF)

Effective from the Academic Year

2026 -2027

DEPARTMENT OF CLINICAL EMBRYOLOGY

SCHOOL OF ALLIED HEALTH SCIENCES

CURRICULUM STRUCTURE

Total Credits: 92

SEMESTER 1

Sl. No.	Title of the Paper	Credit pattern			Total Credit
		L	T	P	
1	Basic Biology (I)	4	0	2	6
2	Basic Biology (II)	4	0	2	6
3	Basic Reproductive Biology	3	0	3	6
4	Andrology & Semen Technology	3	0	3	6
		14	0	8	24

SEMESTER 2

Sl. No.	Title of the Paper	Credit patter			Total Credits
		L	T	P	
1	ART Laboratory Design and Management	3	0	3	6
2	Cryobiology & Fertility Preservation	3	0	3	6
3	Research Methodology and Ethics	2	0	2	4
4	ART Clinical aspects and Embryology	3	0	3	6
		6	0	16	22

SEMESTER 3

Sl. No.	Title of the Paper	Credit patter			Total Credits
		L	T	P	
1	Reproductive Genetics & PGT	3	0	3	6
2	ART Legal Regulations and Surrogacy Act	3	0	3	6
3	Advance embryology	3	0	3	6
4	New developments in ART	0	0	6	6
		9	0	15	24

SEMESTER 4

Sl. No.	Title of the Paper	Credit patter			Total Credits
		L	T	P	
1	Advance ART Laboratory techniques	0	0	4	4
2	Dissertation	18	0	0	18
	Total	18	0	6	22

SEMESTER 1

BASIC BIOLOGY (I)

Course Objectives

The course aims to provide fundamental knowledge of cell biology, reproductive anatomy, embryology, endocrinology, biochemistry, and molecular biology related to reproductive sciences. It is designed to help students understand gametogenesis, fertilization, implantation, and early embryonic development along with the hormonal regulation of male and female reproductive systems. The course also introduces the principles of assisted reproductive technology (ART) and reproductive physiology applied in IVF practices. In addition, it enhances understanding of biochemical and molecular mechanisms involved in human reproduction and prepares students with a strong theoretical foundation for advanced studies and laboratory applications in Clinical Embryology.

UNIT I – Cell Biology and Reproductive Anatomy

The cell, cell structure and functions, organelles, plasma membrane, nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, ribosomes, cell cycle, cell cycle control, cyclins and CDKs, apoptosis, mitosis, meiosis, differences between mitosis and meiosis, anatomy of male reproductive system, testes, epididymis, vas deferens, seminal vesicles, prostate gland, penis, anatomy of female reproductive system, ovaries, fallopian tubes, uterus, cervix, vagina, anatomy of sperm, head, acrosome, midpiece, tail, anatomy of oocyte, zona pellucida, corona radiata.

UNIT II – Gametogenesis and Developmental Anatomy

Primordial germ cells, migration and differentiation, gonadogenesis, sex determination, development of testis, spermatogenesis, spermiogenesis, structure of spermatozoa, development of ovary, oogenesis, folliculogenesis, oocyte development, zygote formation, gamete transport, fertilization basics, cleavage, morula, blastocyst, early embryonic development, implantation, germ layers, organogenesis and development of various organs.

UNIT III – Endocrine and Reproductive Physiology

Hormone classification, physiology of endocrine glands, hypothalamus and pituitary hormones, thyroid and parathyroid hormones, adrenal gland physiology, pancreas and glucose regulation, physiology of puberty in male and female, male reproductive physiology, spermatogenesis, hormonal regulation by FSH, LH and testosterone, semen physiology, female reproductive physiology, oogenesis, ovarian cycle, menstrual cycle, hormonal regulation by estrogen and progesterone, fertilization physiology, sperm transport, capacitation, acrosome reaction, implantation basics.

UNIT IV – Applied Reproductive Physiology

Hormonal control in IVF, controlled ovarian stimulation, gonadotropins, GnRH agonists and antagonists, ovarian stimulation physiology, follicular growth and ovulation trigger, endometrial receptivity, implantation window period, embryo implantation, early pregnancy physiology, role of hCG, corpus luteum maintenance, placental hormonal support.

UNIT V – Biochemistry and Molecular Biology

Osmoregulation and osmotic balance, carbohydrates, definition, classification, properties and biological importance, lipids, classification and biological importance, fat metabolism, fatty acids, steroids, eicosanoids, cholesterol synthesis and derivatives, nucleic acids, structure and properties of DNA and RNA, nucleosides, nucleotides, double stranded DNA structure, types of RNA, mRNA, tRNA, rRNA, biological significance of nucleic acids and protein synthesis.

Course Outcomes

1. Explain the structure and function of cells, cell organelles, and mechanisms of cell division including mitosis and meiosis.
2. Describe the anatomy and physiology of the male and female reproductive systems and understand the structure and functions of gametes.
3. Illustrate the processes of gametogenesis, fertilization, implantation, and early embryonic development.
4. Understand endocrine regulation of reproduction, including hormonal control of spermatogenesis, oogenesis, menstrual cycle, and pregnancy.
5. Apply knowledge of reproductive physiology in assisted reproductive technology (ART) and IVF procedures.

Recommended books:

1.Gray's Anatomy for Students — Richard L. Drake, A. Wayne Vogl & Adam W.M. Mitchell — Elsevier/Churchill Livingstone, 5th Edition (2023)
2.Langman's Medical Embryology — T.W. Sadler — Lippincott Williams & Wilkins, 15th Edition (2023)
3.Guyton and Hall Textbook of Medical Physiology — John E. Hall — Elsevier, 15th Edition (2021)
4.Ganong's Review of Medical Physiology — Barrett, Barman, Brooks & Yuan — McGraw Hill Education, 26th Edition (2019)
5.Molecular Biology of the Cell — Bruce Alberts et al. — Garland Science, 7th Edition (2022)
6.Textbook of Assisted Reproductive Techniques — David K. Gardner, Ariel Weissman & Colin M. Howles — CRC Press, 6th Edition (2023)
7.Clinical Embryology — Ashok Agarwal — Academic Press/Elsevier, 1st Edition (2022)

BASIC BIOLOGY (II)

Course Objectives

The course aims to provide students with fundamental knowledge of general pathology, reproductive pathology, pharmacology, microbiology, and infection control related to reproductive medicine and assisted reproductive technology (ART). It is designed to help students understand pathological changes affecting male and female reproductive systems, infertility-related disorders, and laboratory diagnostic techniques. The course also introduces the principles of general and reproductive pharmacology, including drugs used in ovulation induction and IVF treatment protocols. In addition, it develops awareness regarding microbiological hazards, aseptic techniques, sterilization procedures, and infection control practices essential for maintaining quality and safety in ART laboratories.

UNIT I – General Pathology

Definition and scope of pathology, cell injury, reversible and irreversible injury, cell death, necrosis, apoptosis, inflammation, tissue repair, regeneration, healing mechanisms, cellular adaptations, pathological changes in tissues and organs.

UNIT II – Reproductive Pathology

Male reproductive pathology, testicular failure, varicocele, orchitis, testicular tumors, disorders of spermatogenesis, Johnsen scoring system, female reproductive pathology, PCOS, endometriosis, fibroids, ovarian cysts and tumors, endometrial disorders, reproductive neoplasms, infertility-related pathological conditions.

UNIT III – Laboratory Pathology and General Pharmacology

Histopathology basics, cytology, Pap smear, biopsy interpretation, semen abnormalities and pathological evaluation, pharmacokinetics, absorption, distribution, metabolism, excretion, pharmacodynamics, drug-receptor interactions, hormonal pharmacology, gonadotropins, FSH, LH, hCG, GnRH agonists and antagonists, estrogen, progesterone, oral contraceptives.

UNIT IV – Reproductive Pharmacology and ART Drugs

Ovulation induction drugs, clomiphene citrate, letrozole, drugs used in assisted reproductive technology (ART), controlled ovarian stimulation drugs, luteal phase support, trigger injections using hCG, progesterone supplementation, cryopreservation media components, hormonal protocols in IVF and fertility treatment.

UNIT V – Microbiology and Infection Control in ART Labs

Basics of microbiology, bacteria, viruses, fungi, parasites, virology, HIV, Hepatitis B and C, viral transmission in ART laboratories, screening methods, fungal contamination in IVF labs, parasitic infections affecting fertility, infection control in ART labs, aseptic techniques, PPE usage, laboratory contamination sources, air quality control, VOCs and particulates, culture media contamination prevention, cryostorage contamination risks, sterilization and disinfection methods, autoclaving, filtration, UV radiation, cleanroom concepts, laminar airflow systems.

Course Outcomes

1. Explain the basic concepts of pathology, including cell injury, inflammation, tissue repair, and healing mechanisms.
2. Describe pathological conditions affecting male and female reproductive systems and correlate them with infertility.

3. Understand laboratory pathology techniques such as histopathology, cytology, Pap smear, biopsy interpretation, and semen analysis.
4. Demonstrate knowledge of pharmacokinetics, pharmacodynamics, hormonal pharmacology, and drugs used in reproductive medicine and ART.
5. Identify and explain the role of ovulation induction agents, ovarian stimulation drugs, luteal phase support, and IVF hormonal protocols.
6. Understand the fundamentals of microbiology and the impact of bacterial, viral, fungal, and parasitic infections on fertility and ART laboratories.

Recommended books:

1.Robbins and Cotran Pathologic Basis of Disease — Vinay Kumar, Abul K. Abbas & Jon C. Aster — Elsevier, 11th Edition (2022)
2.Shaw's Textbook of Gynecology — V.G. Padubidri & Shirish N. Daftary — Elsevier, 18th Edition (2022)
3.Williams Gynecology — Barbara L. Hoffman et al. — McGraw Hill Education, 5th Edition (2023)
4.Goodman and Gilman's The Pharmacological Basis of Therapeutics — Laurence Brunton et al. — McGraw Hill Education, 14th Edition (2022)
5.Essentials of Medical Pharmacology — K.D. Tripathi — Jaypee Brothers Medical Publishers, 9th Edition (2023)
6.Textbook of Assisted Reproductive Techniques — David K. Gardner, Ariel Weissman & Colin M. Howles — CRC Press, 6th Edition (2023)
7.Clinical Embryology — Ashok Agarwal — Academic Press/Elsevier, 1st Edition (2022)

BASIC REPRODUCTIVE BIOLOGY

Course Objectives

The course aims to provide students with a strong foundation in basic cell biology, genetics, molecular biology, and chromosomal abnormalities relevant to reproductive sciences and clinical embryology. It is designed to help learners understand cellular structure and function, cell cycle regulation, cancer biology, and molecular mechanisms of inheritance. The course also introduces principles of human genetics, genetic disorders, and their role in infertility. In addition, it develops knowledge of molecular techniques, gene expression, and chromosomal analysis, enabling students to understand genetic influences on reproduction and apply this knowledge in reproductive medicine and assisted reproductive technologies.

UNIT I – Basic Concepts of Cell Biology

Diversity of cells, cell size and shape, cell theory, structure and organization of prokaryotic and eukaryotic cells, cellular composition, plasma membrane structure and function, cell communication and cell-to-cell interaction, primordial germ cells, gonadogenesis, basic cellular organization and functions.

UNIT II – Cell Cycle and Cancer Biology

Cell cycle and its phases, mitosis, meiosis, molecular regulation of cell cycle, cyclins and checkpoints, cell cycle checkpoints, programmed cell death, apoptosis and molecular mechanisms of apoptosis, introduction to signal transduction, cancer biology, properties and types of cancers, theories of cancer development, cellular transformation and tumor progression.

UNIT III – Basic and Reproductive Genetics

Introduction to genetics, Mendel's laws, genotype and phenotype, Mendelian inheritance patterns, genes and alleles, supplementary and complementary genes, epistasis, epigenetics, monogenic diseases, reproductive genetics, genetic disorders in infertility, pedigree analysis, genetic counseling, prenatal diagnosis and inheritance of genetic traits.

UNIT IV – Molecular Biology and Inheritance

Molecular basis of inheritance, chromosomes, karyotype, DNA and RNA structure, DNA replication and repair, transcription, translation, gene expression, protein synthesis, recombinant DNA technology, primers and probes, regulation of gene expression and molecular mechanisms involved in heredity.

UNIT V – Chromosomal and Genetic Abnormalities

Chromosomal abnormalities, monosomy, trisomy, mutations, gene deletion, genomic imprinting, imprinting disorders, genetic abnormalities associated with infertility, chromosomal analysis techniques, introduction to Human Genome Project and its applications in medicine, diagnostics and reproductive biology.

Course Outcomes

1. Understand the basic structure and function of prokaryotic and eukaryotic cells, including cell organelles and membrane functions.
2. Explain the mechanisms of cell cycle regulation, mitosis, meiosis, apoptosis, and their relevance to growth and disease.
3. Apply fundamental concepts of genetics, including Mendelian inheritance, gene interactions, and pedigree analysis in reproductive biology.
4. Describe the molecular basis of inheritance, including DNA replication, transcription, translation, and gene expression.

5. Identify chromosomal abnormalities and genetic disorders and understand their impact on infertility and reproductive health.

Recommended books:

1.Molecular Biology of the Cell — Bruce Alberts et al. — Garland Science, 7th Edition (2022)
2.Principles of Genetics — D. Peter Snustad & Michael J. Simmons — Wiley, 8th Edition (2019)
3.Thompson & Thompson Genetics in Medicine — Robert L. Nussbaum et al. — Elsevier, 9th Edition (2023)
4.Lewin's Genes XII — Jocelyn E. Krebs et al. — Jones & Bartlett Learning, 12th Edition (2017)
5.Human Molecular Genetics — Tom Strachan & Andrew Read — Garland Science, 4th Edition (2018)

PRACTICALS IN BASIC REPRODUCTIVE BIOLOGY

1. Good Laboratory Practices (GLP) and guidelines
2. Biosafety levels and laboratory safety protocols
3. Equipment and disposables identification and handling
4. Sterilization techniques (autoclaving, UV, chemical sterilization)
5. Preparation of culture media (basic demonstration)
6. pH, temperature and osmolarity maintenance in lab
7. Documentation and record maintenance
8. Waste disposal and biomedical waste segregation

ANDROLOGY AND SEMEN TECHNOLOGY

Course Objectives

The course aims to provide basic knowledge of andrology and semen analysis. It helps students understand spermatogenesis, sperm structure, and male reproductive function. The course introduces routine semen analysis and interpretation of results in male infertility. It also covers sperm preparation techniques used in ART procedures like IUI, IVF, and ICSI. In addition, it gives an overview of sperm retrieval, cryopreservation, and basic laboratory practices used in andrology labs.

UNIT I – Basics of Andrology and Seminology

Introduction to andrology, spermatogenesis, structure and physiology of spermatozoa, hormonal regulation of spermatogenesis, seminology, nomenclature in semen analysis, general principles and characteristics of seminal fluid, male reproductive function and fertility assessment.

UNIT II – Routine Semen Analysis

Macroscopic examination of semen, appearance, volume, colour, viscosity, liquefaction time, odour and coagulation, chemical examination including pH, zinc, fructose, citric acid and acid phosphatase, microscopic examination including sperm concentration, motility, morphology, vitality, round cells, agglutination and debris, quality control and accuracy in semen assessment.

UNIT III – Sperm Assessment and Male Infertility

Assessment of spermatozoa, types and methodologies of sperm evaluation, advantages and disadvantages of assessment techniques, azoospermia, causes and types of azoospermia, genetic analysis in male infertility, management of azoospermia, clinical interpretation of semen abnormalities and male infertility evaluation.

UNIT IV – Semen Technology and Sperm Function Tests

Principles of semen preparation, semen preparation methods, culture media and clinical applications, sperm preparation for IUI, IVF, ICSI, IMSI and PICSI, swim-up technique, density gradient technique, simple wash and double density gradient methods, sperm function tests including hypo-osmotic swelling test, acrosome reaction, sperm capacitation, zona binding test, sperm mucus interaction test, antisperm antibody test and sperm DNA fragmentation test.

UNIT V – Sperm Retrieval, Cryopreservation and Laboratory Setup- (9 hours)

Sperm retrieval techniques including PESA, MESA, TESA, TESE and Micro-TESE, principles of cryopreservation, cryoprotectants and media, cryopreservation methods, cryopreservation of testicular tissue, setting up of andrology laboratory, laboratory safety, quality control, quality assurance and laboratory management practices.

Course Outcomes

1. Explain the fundamentals of andrology, spermatogenesis, sperm structure, and hormonal regulation of male reproductive function.
2. Perform and interpret routine semen analysis including macroscopic, microscopic, and biochemical evaluation of seminal fluid.
3. Assess sperm quality and understand the clinical significance of semen abnormalities in male infertility.
4. Demonstrate knowledge of semen processing techniques and sperm function tests used in ART procedures such as IUI, IVF, and ICSI.

Recommended books:
Textbook of Assisted Reproductive Techniques — David K. Gardner, Ariel Weissman & Colin M. Howles — CRC Press, 6th Edition (2023)
Clinical Andrology — E.S.E. Hafez — Elsevier, 3rd Edition (2017)

PRACTICALS IN BASICS OF ANDROLOGY AND SEMINOLOGY
1.Semen collection and handling procedures
2.Semen analysis (WHO guidelines)
3.Sperm concentration, motility and morphology assessment
4.Sperm preparation techniques (swim-up, DGC)
5.Hyperosmotic swelling test
6.Sperm vitality and viability tests
7.Fructose and biochemical tests of semen
8.Sperm DNA fragmentation assay (observation/demo)
9.Semen freezing and thawing protocols
10.Cryoprotectant preparation and usage
11.Sperm agglutination and antisperm antibody testing
12.Semen quality control and reporting

SEMESTER 2

ART LABORATORY DESIGN, EQUIPMENTS AND QUALITY CONTROL

Course Objectives

The course aims to provide fundamental knowledge of ART laboratory setup, design, and functioning. It helps students understand different types of ART laboratories, essential equipment, and workflow involved in IVF and related procedures. The course also introduces clean room design, air quality control, and laboratory environment management. In addition, it focuses on quality control, quality assurance, safety practices, and regulatory guidelines required for maintaining standards in ART laboratories. The course further develops awareness of proper handling of equipment, contamination prevention, and efficient laboratory management practices.

UNIT I – Introduction to ART Laboratory

Definition and scope of ART laboratory, role of embryology laboratory in IVF outcomes, laboratory personnel and responsibilities, facility planning, budget and laboratory design, equipment and consumables used in ART laboratories, overview of IVF laboratory systems and workflow.

UNIT II – Types and Setup of ART Laboratories

Types of ART laboratories including IVF lab, ICSI lab, IVF operation theatre, andrology laboratory and cryopreservation unit, laboratory planning and layout, setting up of andrology laboratory, embryology laboratory and OT, clean room design, air quality management, laboratory interiors, utilities and support systems, cryopreservation laboratory design.

UNIT III – ART Laboratory Equipments

Laminar airflow workstation, incubators, stereo and inverted microscopes, laser systems, micromanipulator and micromanipulation mechanics, HEPA filters, positive pressure systems, VOC monitoring systems, air quality monitoring systems, ICSI micromanipulator setup, centrifuges, cryopreservation tanks, regulators, thermometers, heating blocks, refrigerators, CO_2 analyzers and gas cylinders.

UNIT IV – Quality Control and Quality Assurance in ART Labs

Quality control (QC), quality assurance (QA), QA and QC in IVF laboratories, precision in IVF procedures, laboratory maintenance protocols, calibration and maintenance of instruments, quality improvement techniques, troubleshooting in ART laboratories, roster of work, biomedical waste management, staff safety protocols, RFID systems, national regulations and laboratory guidelines.

UNIT V – Laboratory Environment and Safety

Laboratory environmental control, humidity regulation, air quality management, temperature control, volatile organic compounds (VOC) monitoring, contamination prevention, clean room standards, laboratory safety measures, infection control and maintenance of optimal laboratory conditions for ART procedures.

Course Outcomes

1. Understand the structure, scope, and functioning of ART laboratories and their role in IVF outcomes.
2. Identify different types of ART laboratories and explain their design, setup, and workflow.
3. Recognize and describe essential laboratory equipment used in IVF, ICSI, and cryopreservation units.
4. Apply principles of quality control, quality assurance, and laboratory maintenance in ART settings.
5. Understand laboratory safety measures, contamination prevention, and environmental control systems used in ART laboratories.

Recommended books:

1.Textbook of Assisted Reproductive Techniques — David K. Gardner, Ariel Weissman & Colin M. Howles — CRC Press, 6th Edition (2023)
2.Clinical Embryology — Ashok Agarwal — Elsevier/Academic Press, 1st Edition (2022)
3.Handbook of IVF Laboratory Technology — David K. Mortimer — CRC Press, Latest Edition

CRYOBIOLOGY & FERTILITY PRESERVATION

Course Objectives

The course aims to provide fundamental knowledge of cryobiology and its applications in assisted reproductive technology (ART). It helps students understand the principles of cryopreservation, cellular response to freezing and thawing, and the role of cryoprotectants. The course also introduces various cryobiology techniques such as vitrification and slow freezing used for gametes, embryos, and reproductive tissues. In addition, it focuses on cryostorage systems, laboratory handling procedures, safety measures, and quality control in cryopreservation. The course further develops understanding of fertility preservation, reproductive tissue banking, and clinical applications in modern reproductive medicine.

UNIT I – Introduction to Cryobiology

Introduction to cryobiology, history of cryopreservation, laboratory setup for cryopreservation, principles and physiology of cryobiology, cellular response to freezing and thawing, cryoprotectants, penetrating and non-penetrating cryoprotectants, role and mechanism of cryoprotectants, cryofreezers, factors affecting freezing and thawing, advantages and disadvantages of slow freezing, recent developments in cryobiology.

UNIT II – Cryobiology Techniques

Cryobiology techniques, vitrification, warming protocols, embryo freezing, slow freezing techniques, vitrification of gametes, oocyte and sperm vitrification methods, handling and storage procedures, troubleshooting in vitrification and cryopreservation procedures.

UNIT III – Cryopreservation in ART

Cryopreservation of embryos, gametes and reproductive tissues, storage systems, liquid nitrogen handling, cryostorage management, labeling and identification systems, safety precautions, contamination prevention, quality control in cryopreservation laboratories and transport of cryopreserved samples.

UNIT IV – Fertility Preservation

History and evolution of fertility preservation, principles of fertility preservation, indications and clinical applications, fertility preservation in cancer patients, reproductive tissue banking, ethical and clinical considerations in fertility preservation.

UNIT V – Reproductive Tissue Cryopreservation

Oocyte cryopreservation, cryopreservation of semen, freezing of ovarian tissue, freezing of testicular tissue, freezing of reproductive tissues and organs, preservation protocols, tissue handling techniques, post-thaw assessment and future applications of fertility preservation technologies.

Course Outcomes

Understand the basic principles, history, and scope of cryobiology in reproductive medicine.

1. Explain the mechanisms of cryoprotectants and cellular changes during freezing and thawing.
2. Describe cryopreservation techniques including slow freezing and vitrification for gametes and embryos.
3. Demonstrate knowledge of cryostorage systems, liquid nitrogen handling, labeling, and safety procedures.
4. Understand fertility preservation techniques, reproductive tissue cryopreservation, and their clinical applications.

Recommended books:

1.Clinical Embryology — Ashok Agarwal — Elsevier/Academic Press, 1st Edition (2022)
2.Cryopreservation and Freeze-Drying Protocols — Jennifer Day & Mark Stacey — Humana Press, Latest Edition
3.Principles of Cryobiology — Peter Mazur — Academic Press, Latest Edition

RESEARCH METHODOLOGY & ETHICS

Course Objectives

The course aims to provide students with a basic understanding of research methodology, biostatistics, epidemiology, and ethics in reproductive medicine and assisted reproductive technology (ART). It helps learners develop skills in designing research studies, collecting and analyzing data, and interpreting results using statistical tools. The course also introduces principles of epidemiology and their application in medical and infertility research. In addition, it focuses on ethical, legal, and regulatory aspects of ART practices, including informed consent, surrogacy laws, and guidelines governing reproductive technologies. The course further emphasizes national and international standards to ensure safe, ethical, and evidence-based practice in reproductive healthcare

UNIT I – Introduction to Research Methodology

Introduction to research methodology, types of research, basic concepts of scientific research, research approaches, quantitative and qualitative research methods, importance of research in medical and reproductive sciences.

UNIT II – Research Design and Statistical Analysis

Research design, planning and structure of research studies, formulation of research problems and hypotheses, review of literature, data collection methods, statistical analysis, mean, median and mode, standard deviation, Student's t-test, interpretation of data and applications of biostatistics in medical research.

UNIT III – Epidemiology and Medical Research Applications

Basics of epidemiology, uses of epidemiology in healthcare and reproductive medicine, study designs in medical research, observational and experimental studies, application of epidemiological methods in ART and infertility research, evidence-based medical practice.

UNIT IV – Ethics and Legal Aspects in ART

Introduction and history of ethics, ethical principles in healthcare, current legislation and regulations in ART in India, licensing, accreditation and approval requirements for ART clinics, national guidelines for accreditation of ART clinics in India, ethical considerations, policies and legal issues in ART, surrogacy laws and ethical aspects, informed consent, use of gametes and embryos for research, abandoned embryos, third-party reproduction and patient rights.

UNIT V – National and International ART Guidelines

ART guidelines and regulatory bodies, ICMR (Indian Council of Medical Research), ASRM (American Society for Reproductive Medicine), SART (Society for Assisted Reproductive Technology), ESHRE (European Society of Human Reproduction and Embryology), HFEA (Human Fertilisation and Embryology Authority), NICE (National Institute for Health and Care Excellence), role of guidelines in standardization, ethics, safety and quality assurance in ART practice.

Course Outcomes

1. Understand the basics of research methodology, types of research, and their importance in medical and reproductive sciences.
2. Design research studies and apply basic statistical tools for data analysis and interpretation.
3. Apply epidemiological concepts in infertility research and evidence-based reproductive medicine.
4. Understand ethical principles, legal regulations, and policies related to ART practices in India.
5. Recognize the role of national and international guidelines in ensuring quality, safety, and ethical standards in ART.

Recommended books:

1.Textbook of Assisted Reproductive Techniques — David K. Gardner, Ariel Weissman & Colin M. Howles — CRC Press, 6th Edition (2023)
2.Clinical Embryology — Ashok Agarwal — Elsevier/Academic Press, 1st Edition (2022)

PRACTICALS IN RESEARCH METHODOLOGY & ETHICS

1. Good Laboratory Practice (GLP) in research
2. Research problem identification
3. Literature review and referencing methods
4. Data collection techniques (observation-based)
5. Preparation of questionnaire/case sheet
6. Basic biostatistics (mean, SD, t-test – demonstration)
7. Ethical committee documentation format
8. Informed consent forms preparation
9. Confidentiality and patient data protection
10. Case study presentation
11. Plagiarism and research misconduct awareness

ART CLINICAL ASPECTS AND CLINICAL EMBRYOLOGY

Course Objectives

The course aims to provide comprehensive knowledge of assisted reproductive technology (ART), infertility management, and clinical embryology. It helps students understand the causes, diagnosis, and management of infertility in both males and females. The course introduces ART procedures including ovarian stimulation, oocyte retrieval, and luteal phase support. It also focuses on complications associated with ART and management of high-risk pregnancies. In addition, it develops understanding of gametogenesis, fertilization, early embryonic development, and implantation processes, along with their clinical applications in reproductive medicine.

UNIT I – Introduction to ART and Infertility Management

Introduction to Assisted Reproductive Technology (ART), definition, history and evolution of ART, indications and overview of ART procedures, patient counselling, infertility assessment, female assessment, male assessment, causes of infertility, fertility evaluation and management approaches.

UNIT II – ART Procedures and Ovarian Stimulation

Indications for ART, role of ultrasound in ART, ovarian stimulation protocols, natural cycle, folliculogenesis, physiology of ovulation, ovulation trigger, oocyte retrieval techniques, luteal phase support, pregnancy diagnosis and monitoring of ART patients.

UNIT III – Complications and High-Risk Pregnancy Management in ART

Complications in ART, ovarian hyperstimulation syndrome (OHSS), early pregnancy management, miscarriage, ectopic pregnancy, multiple gestation, heterotopic pregnancies, monitoring and management of high-risk ART pregnancies.

UNIT IV – Basics of Clinical Embryology and Gametogenesis

Introduction to clinical embryology, history and concepts of embryology, evolution of embryology, gametogenesis, oogenesis, spermatogenesis and clinical applications, folliculogenesis, parthenogenesis and reproductive developmental biology.

UNIT V – Early Embryonic Development and Implantation (9 hours)

Fertilization, syngamy, pronucleus formation, zygote development, cleavage stage embryo, blastocyst formation, gene expression in early embryos, implantation and stages of implantation, immunology of implantation and fetal development, embryo–maternal interaction and early developmental processes.

Course Outcomes

1. Understand the fundamentals of ART, infertility causes, and methods of fertility evaluation in males and females.
2. Describe ART procedures including ovarian stimulation, ovulation trigger, oocyte retrieval, and pregnancy monitoring.
3. .Identify complications in ART such as OHSS, ectopic pregnancy, and multiple pregnancies and understand their management.

Recommended Books

1.Clinical Embryology — Ashok Agarwal — Elsevier/Academic Press, 1st Edition (2022)
2.Human Embryology and Developmental Biology — Bruce M. Carlson — Elsevier, 6th Edition (2021)

PRACTICALS IN ART CLINICAL ASPECTS AND CLINICAL EMBRYOLOGY

1.IVF laboratory layout and workflow observation
2.Basic ultrasound follicular tracking
3.Follicular monitoring and ovulation prediction
4.Male infertility investigation observation
5.Semen analysis correlation with clinical cases
6.ART patient counseling observation
7.Oocyte retrieval procedure observation
8.IVF and ICSI procedure observation
9.Embryo culture systems setup
10.Embryo grading (Day 2, Day 3, blastocyst)
11.Embryo transfer observation
12.Cryopreservation and thawing (embryo/oocyte)
13.Incubator monitoring and CO_2 regulation
14.Air quality monitoring (VOC, HEPA systems)
15.Laboratory troubleshooting cases
16.Media preparation and storage systems

SEMESTER 3

REPRODUCTIVE GENETICS & PGT

Course Objectives

The course aims to provide students with a strong foundation in reproductive genetics and preimplantation genetic testing (PGT). It helps learners understand basic genetic principles, chromosomal structure, gene expression, and molecular mechanisms of inheritance. The course also introduces human cytogenetics, molecular genetic techniques, and their applications in reproductive medicine. In addition, it focuses on genetic causes of infertility, prenatal and postnatal diagnostic methods, and genetic counselling. The course further develops knowledge of PGT techniques, embryo biopsy methods, and modern genetic screening tools used in assisted reproductive technology to improve clinical outcomes.

UNIT I – Basics of Genetics

Introduction to genetics, nucleic acids, DNA and RNA structure and function, genes, genome and chromosomes, mutation and polymorphism, gene expression and regulation, principles of heredity and molecular basis of inheritance.

UNIT II – Human Cytogenetics and Molecular Genetics

Structure and classification of chromosomes, karyotyping, numerical and structural chromosomal abnormalities, mosaicism and chimerism, molecular genetics techniques including PCR, gel electrophoresis, DNA sequencing, microarray technology and SNP analysis.

UNIT III – Reproductive Genetics

Genetic causes of male and female infertility, Y-chromosome microdeletion, CFTR gene mutations, recurrent pregnancy loss, genetic aspects of endometriosis and PCOS, inheritance patterns in reproductive disorders and genetic counselling in infertility management.

UNIT IV – Prenatal and Postnatal Genetics

Prenatal and postnatal genetic diagnosis, amniocentesis, chorionic villus sampling (CVS), non-invasive prenatal testing (NIPT), indications and applications of prenatal testing, screening and diagnosis of genetic abnormalities during pregnancy.

UNIT V – Preimplantation Genetic Testing (PGT)

Overview and indications of PGT, sex-linked disorders, single gene defects, chromosomal disorders, embryo biopsy techniques, instrumentation and laboratory preparation, polar body biopsy, cleavage stage biopsy, blastocyst biopsy, tubing techniques and clinical applications, FISH, NGS, preimplantation genetic haplotyping, preimplantation genetic screening and aneuploidy screening.

Course Outcomes

1. Understand basic principles of genetics, including DNA structure, gene expression, mutation, and inheritance patterns.
2. Explain human cytogenetics, karyotyping techniques, and chromosomal abnormalities associated with reproductive disorders.
3. Identify genetic causes of male and female infertility and apply concepts of genetic counselling in clinical practice.
4. Describe prenatal and postnatal diagnostic techniques such as amniocentesis, CVS, and NIPT.
5. Understand principles and applications of preimplantation genetic testing (PGT), including embryo biopsy and molecular screening methods.

Recommended Books

1.Thompson & Thompson Genetics in Medicine — Robert L. Nussbaum et al. — Elsevier, 9th Edition (2023)
2.Human Molecular Genetics — Tom Strachan & Andrew Read — Garland Science, 4th Edition (2018)
3.Principles of Genetics — D. Peter Snustad & Michael J. Simmons — Wiley, 8th Edition (2019)
4.Medical Genetics at a Glance — Dorian J. Pritchard & Bruce R. Korf — Wiley-Blackwell, 4th Edition (2020)
5.Textbook of Assisted Reproductive Techniques — David K. Gardner, Ariel Weissman & Colin M. Howles — CRC Press, 6th Edition (2023)

ART LEGAL REGULATIONS AND SURROGACY ACT

Course Objectives

The course aims to provide students with knowledge of legal, ethical, and regulatory frameworks governing assisted reproductive technology (ART) and surrogacy practices in India. It helps learners understand the provisions of the ART Act 2021 and Surrogacy (Regulation) Act 2021, along with rules for clinic registration and standardization. The course also focuses on informed consent, confidentiality, patient rights, and ethical responsibilities in reproductive medicine. In addition, it introduces national guidelines, regulatory authorities, and compliance requirements in ART practice. The course further develops awareness of advanced ethical issues related to modern reproductive technologies and their social and legal implications.

UNIT I – ART and Surrogacy Laws in India

Assisted Reproductive Technology (ART) Act 2021, Surrogacy (Regulation) Act 2021, objectives and scope of the Acts, legal framework governing ART practices in India, regulation of surrogacy arrangements, protection of rights of patients, donors and children.

UNIT II – Regulation, Registration and Standardization

Mandatory registration of ART clinics and gamete banks, standardization of ART laboratories and clinics, regulation of gamete donation and storage, rules governing operation of fertility clinics, prohibition of illegal practices, prevention of commercialization and exploitation in reproductive medicine.

UNIT III – Consent, Confidentiality and Clinical Practice Ethics

Informed consent in ART procedures, confidentiality of patient and donor data, ethical counselling in ART, patient rights in fertility treatment, donor anonymity and legal considerations, ethical responsibilities in clinical IVF practice.

UNIT IV – National Guidelines and Regulatory Framework

ICMR guidelines for ART practices, PCPNDT Act and its relevance in reproductive medicine, regulation of gamete banks and gamete donors, relevant regulatory bodies in India, compliance with national and international standards, monitoring and enforcement mechanisms in ART practice.

UNIT V – Advanced Ethical Issues in Reproductive Medicine

Ethics and regulation of embryo editing, ethics of three-parent babies, regulation of PGT and PGT-A, ethics of preimplantation genetic testing, third-party reproduction ethics, posthumous reproduction, social and ethical responsibilities in patient care, implications of modern reproductive technologies on society and law.

Course Outcomes

1. Understand the provisions, scope, and objectives of the ART Act 2021 and Surrogacy (Regulation) Act 2021.
2. Explain the regulatory requirements for registration, standardization, and functioning of ART clinics and gamete banks.
3. Apply ethical principles related to informed consent, confidentiality, and patient rights in clinical practice.
4. Describe national guidelines such as ICMR recommendations and related regulatory frameworks governing ART practice in India.
5. Analyze advanced ethical and legal issues in reproductive medicine including PGT, surrogacy, and emerging reproductive technologies.

Recommended Books

1.Textbook of Assisted Reproductive Techniques — David K. Gardner, Ariel Weissman & Colin M. Howles — CRC Press, 6th Edition (2023)
2.Clinical Embryology — Ashok Agarwal — Elsevier/Academic Press, 1st Edition (2022)
3.Medical Law and Ethics in India — C.M. Francis — Jaypee Brothers Medical Publishers, Latest Edition

ADVANCE CLINICAL EMBRYOLOGY

Course Objectives

The course aims to provide advanced knowledge of clinical embryology and assisted reproductive technology (ART). It helps students understand gametogenesis, fertilization, and early embryonic development at the molecular and cellular level. The course also covers ovarian stimulation protocols, hormonal regulation, and management of ovarian response in ART cycles. In addition, it focuses on embryo culture systems, embryo grading, and evaluation techniques used in IVF laboratories. The course further introduces advanced ART procedures such as IVF, ICSI, embryo transfer methods, and sperm retrieval techniques, along with their clinical applications.

UNIT I – Gametogenesis and Fertilization Mechanism

Spermatogenesis, oogenesis, molecular mechanisms of gametogenesis, fertilization process, zona binding, acrosome reaction, sperm–oocyte interaction, molecular events in fertilization and early activation of oocyte.

UNIT II – Preimplantation Embryonic Development

Fertilization, syngamy, zygote formation, cleavage stage embryo, compaction, morula formation, early blastocyst and blastocyst development, embryonic cell differentiation, developmental milestones in preimplantation embryos.

UNIT III – Ovarian Stimulation and Hormonal Regulation

Types of stimulation protocols including natural cycle, GnRH agonist and antagonist protocols, individualized stimulation protocols, role of FSH, LH, progesterone (P4) and estradiol (E2) in ovarian stimulation, ovarian hyperstimulation syndrome (OHSS) and its pathophysiology.

UNIT IV – Embryo Evaluation and Culture Systems

Oocyte morphology and embryo grading, pronuclear (PN) check and scoring, syngamy, cleavage and blastocyst grading, patterns of embryonic development, blastocyst culture advantages and disadvantages, culture media composition, physiology, physical and chemical properties, effects of pH, temperature and osmolarity on embryo development.

Types of culture systems including single-step and sequential media, use of HTF, sperm isolation media, PBS, mineral oil, PVP, hyalase, pentoxifylline and embryo glue, laboratory handling of culture systems.

UNIT V – Assisted Reproduction Technologies and Clinical Applications

History and overview of assisted reproduction, gonadotrophins, ovarian reserve testing including AMH, AFC and CCCT, ovulation induction, IVF procedures, laparoscopy and transvaginal ultrasound guidance, oocyte retrieval, ART techniques including IUI, IVF, ICSI, IMSI and PICSI.

Embryo transfer techniques including single embryo transfer (SET), double embryo transfer (DET), frozen embryo transfer (FET), GIFT and ZIFT, benefits and risks of embryo transfer, sperm retrieval procedures including PESA, MESA, TESA and TESE, reproductive tourism, and financial and psychological counselling in ART.

Course Outcomes

1. Understand the molecular mechanisms of gametogenesis and fertilization in human reproduction.
2. Describe early embryonic development from zygote formation to blastocyst stage.
3. Explain ovarian stimulation protocols and hormonal regulation in assisted reproduction.
4. Evaluate embryo development using grading systems and understand embryo culture conditions.

5. Identify and describe advanced ART techniques including IVF, ICSI, embryo transfer, and sperm retrieval methods.

Recommended Books

1.Principles and Practice of Assisted Human Reproduction — Robert G. Edwards & David Gardner — Cambridge University Press
2.Human Embryology and Developmental Biology — Bruce M. Carlson — Elsevier
3.Handbook of IVF Laboratory Technology — David K. Mortimer — CRC Press

PRACTICALS IN ADVANCE CLINICAL EMBRYOLOGY

1.Micromanipulator setup, calibration and alignment
2.Advanced ICSI techniques
3.IMSI and PICSI demonstration
4.Laser-assisted hatching
5.Assisted oocyte activation (AOA) observation
6.Time-lapse embryo monitoring system (EmbryoScope)
7.Blastocyst grading and selection
8.Embryo biopsy techniques (polar body, trophectoderm)
9.Embryo vitrification and warming
10.Oocyte vitrification and thawing
11.Sperm immobilization and selection techniques
12.Embryo glue and implantation support media usage
13.Culture media comparison (single step vs sequential)
14.Embryo morphokinetic analysis
15.Advanced cryostorage tank management

NEW DEVELOPMENTS IN ART

Course Objectives

The course aims to provide students with updated knowledge of stem cell technology and recent advances in assisted reproductive technology (ART). It helps learners understand the basics of stem cells, their classification, and biological properties. The course also introduces regenerative medicine and the clinical applications of stem cells in reproductive and medical sciences. In addition, it focuses on new technologies in ART such as AI-based embryo selection, advanced cryopreservation, and genetic testing methods. The course further develops awareness of emerging reproductive technologies, mitochondrial genetics, and ethical issues in modern reproductive biotechnology.

UNIT I – Stem Cell Technology: Basics

Introduction to stem cell technology, history and origin, basic characteristics of stem cells, self-renewal and differentiation potential, classification and clinical significance, applications in modern medicine and reproductive biology.

UNIT II – Types of Stem Cells

Hemopoietic stem cells, testicular stem cells, embryonic stem cells, induced pluripotent stem cells (iPS cells), comparative features of different stem cell types, biological properties and regenerative potential of each type.

UNIT III – Stem Cells and Regenerative Medicine

Stem cell therapy, regenerative medicine applications, derivation of embryonic stem cells, isolation of inner cell mass (ICM), identification of stem cell colonies, differentiation pathways, stem cell markers, stem cell banking and storage, clinical translation of stem cell research.

UNIT IV – Advances in ART and Reproductive Biotechnology

New developments in ART including automated IVF laboratories, time-lapse imaging (EmbryoScope), AI-based embryo selection, advanced genetic testing (PGT and non-invasive PGT), improved cryopreservation techniques, enhanced embryo culture systems, PRP therapy in fertility, wearable and digital fertility tracking, regulatory and digital systems in ART, advanced sperm sorting techniques, micro-assisted fertilization, cloning concepts and gene editing (designer babies) with ethical considerations.

UNIT V – Mitochondrial Genetics and Emerging Reproductive Technologies

Mitochondrial DNA mutations and related diseases, prevention of mitochondrial disorders, oocyte reconstruction techniques, pronuclear transfer, spindle transfer, somatic cell nuclear transfer (SCNT), ethics of oocyte reconstruction, current research in proteomics and metabolomics, embryo editing, and future developments in mitochondrial and reproductive medicine.

Course Outcomes

1. Understand the basics of stem cell biology, including self-renewal and differentiation.
2. Identify different types of stem cells and their biological and clinical significance.
3. Explain applications of stem cells in regenerative medicine and reproductive biology.
4. Describe recent advances in ART such as AI-based embryo selection, time-lapse imaging, and advanced genetic testing.

Recommended Books

1.Textbook of Assisted Reproductive Techniques — David K. Gardner, Ariel Weissman & Colin M. Howles — CRC Press, 6th Edition (2023)

PRACTICALS IN NEW DEVELOPMENTS IN ART

1.AI-based embryo selection systems (demo/observation)
2.Microfluidic sperm sorting techniques
3.Non-invasive PGT (NIPGT) overview and observation
4.PGT-A, PGT-M and PGT-SR workflow observation
5.Advanced sperm selection (MACS, Zeta potential)
6.PRP therapy in reproductive medicine (overview)
7.Stem cell applications in fertility (observation/demo)
8.Gene editing techniques overview (CRISPR basics)
9.Mitochondrial transfer techniques (theoretical + demo)
10.Automated IVF laboratory systems
11.Digital tracking and ART lab software systems
12.Environmental monitoring (VOC, CO_2, humidity control)
13.Clean room validation and air handling systems
14.Cryobank management and sample tracking systems
15.Ethical case studies in embryo selection and genetics
16.Research project presentation in ART innovations
17.Quality audit and laboratory accreditation practice

SEMESTER 4

ADVANCE ART LABORATORY TECHNIQUES

Course Objectives
The objective of this course is to provide students with advanced knowledge of gamete preparation, sperm selection and retrieval, oocyte handling, ICSI, fertilization, embryo culture, grading, and manipulation techniques. It also aims to develop an understanding of cryopreservation, genetic testing, advanced ART laboratory instruments, quality control, laboratory safety, ethical practices, and regulatory requirements in assisted reproductive technology.

UNIT I – Advanced Gamete Preparation and Sperm Function Enhancement
Advanced semen preparation techniques including density gradient centrifugation (DGC), swim-up methods (direct and indirect), and advanced sperm sorting techniques. Sperm function enhancement using capacitation methods, pentoxifylline and calcium ionophore. Principles of sperm activation and functional optimization in ART.

UNIT II – Advanced Sperm Selection and Retrieval Techniques
Advanced sperm selection techniques including IMSI, PICSI, MACS and Zeta potential methods. Advanced sperm retrieval procedures such as PESA, TESA, TESE and micro-TESE. Clinical indications, procedural principles and applications in male infertility management.

UNIT III – Oocyte Handling, Activation and Fertilization Techniques
Oocyte retrieval techniques (TVOR principles), oocyte grading including COC assessment, nuclear and cytoplasmic maturity evaluation, oocyte denudation protocols. Oocyte activation techniques including chemical activation and artificial oocyte activation (AOA), oocyte cryopreservation by vitrification. Advanced ICSI techniques including micromanipulator use, microinjection procedures, IMSI, PICSI and rescue ICSI. Fertilization assessment including pronuclear (2PN) check and abnormalities in fertilization.

UNIT IV – Embryo Culture, Monitoring and Manipulation
Embryo culture systems including sequential and single-step media, advantages and limitations. Embryo developmental stages including cleavage stage and blastocyst culture. Time-lapse embryo monitoring systems (EmbryoScope). Embryo grading systems including Day 3 grading and blastocyst grading (ICM, TE, expansion). Embryo metabolism and viability markers. Advanced embryo manipulation techniques including assisted hatching (mechanical, chemical and laser methods). Embryo biopsy techniques including polar body biopsy, cleavage-stage biopsy, trophectoderm biopsy, embryo splitting and aggregation (research level applications).

UNIT V – Cryopreservation, Genetics, Laboratory Systems and Ethics
Cryopreservation principles including cryobiology, cryoprotectants, permeable and non-permeable agents, slow freezing and vitrification. Cryopreservation of sperm, oocytes, embryos (cleavage and blastocyst stages), warming techniques and survival assessment. Genetic and molecular techniques in ART including PGT-A, PGT-M, PGT-SR, non-invasive PGT, PCR, FISH and NGS. Genetic counselling and ethical considerations in ART. Advanced laboratory systems including micromanipulation setups, inverted microscopes, microinjectors, laser systems, time-lapse incubators, microfluidic devices and AI-based embryo selection. ART laboratory quality control and assurance including SOPs, calibration, validation, workflow and documentation. Air quality management including HEPA filtration, VOC control, temperature, CO_2 monitoring. Laboratory safety protocols including biohazard handling, cryostorage safety and regulatory compliance under ART Act 2021 and Surrogacy Act. Ethical issues in embryo handling and genetic selection in modern ART practice.

Course Outcomes

Perform and understand advanced sperm preparation and sperm selection techniques used in ART.

1. Explain advanced sperm retrieval procedures and their clinical applications in male infertility.
2. Describe oocyte handling, fertilization techniques, and embryo grading systems.
3. Understand embryo culture systems, time-lapse monitoring, and embryo manipulation techniques.
4. Apply knowledge of cryopreservation, genetic testing methods, laboratory systems, and ethical standards in ART practice.

Recommended Books

1.Handbook of IVF Laboratory Technology — David K. Mortimer — CRC Press, 2nd Edition (2018)

2.Principles and Practice of Assisted Human Reproduction — Robert G. Edwards & David Gardner — Cambridge University Press, 2nd Edition (2017)