jaypee.com, for detailed information on obstetrics & gynecology books, visit our website www.ejaypee.com, for detailed information on obstetrics & gynecology books





Journey to Inception of Life
Troubleshooting in ART Laboratory

Editors
Chandan Vijay Salunke
Shravani Kanakdas Parker

Foreword
Ameet A Naik

JAYPEE

Contents

SECTION 1: Foundations of Troubleshooting in Assisted Reproductive Technology

1. Introduction to Troubleshooting in Assisted Reproductive Technology 3

SECTION 2: Gamete Analysis and Preparation

2. Quality Control in Assisted Reproductive Technology Laboratory 11
3. Semen Analysis and Sperm Preparation 18
4. Sperm Retrieval and Handling (Percutaneous Epididymal Sperm Aspiration, Testicular Sperm Aspiration, and Testicular Sperm Extraction) 23
5. Oocyte Cumulus Complex Scanning 28
6. Oocyte Denudation 34
7. Oocyte Assessment 41

SECTION 3: Fertilization and Embryo Development

8. Intracytoplasmic Sperm Injection Troubleshooting 51
9. Fertilization Assessment 58
10. Embryo Assessment 65

SECTION 4: Culture, Cryopreservation, and Transfer

11. Culture Systems 77
12. Cryopreservation 86
13. Embryo Transfer 90

SECTION 5: Advanced Manipulations and Ethics

14. Laser-assisted Hatching and Biopsy Techniques 99
15. Consumables and Media Quality 104
16. Documentation and Sample Identity 108
17. Ethics, Regulations, and Legal Troubleshooting 112

Index *117*

SECTION

4

Culture, Cryopreservation, and Transfer

11. Culture Systems
12. Cryopreservation
13. Embryo Transfer

JAYPEE BROTHERS

JAYPEE BROTHERS

CHAPTER 11

Culture Systems

INTRODUCTION

In assisted reproductive technology (ART), culture systems are the cornerstone of success, as they provide the essential environment for gamete maturation, fertilization, and embryo development. These systems must be finely tuned to regulate factors such as temperature, pH, CO_2 levels, humidity, and media composition. Even minor deviations in these parameters can disrupt cellular processes, leading to problems such as slow cleavage, developmental arrest, increased fragmentation, or apoptosis. Moreover, maintaining sterility and preventing contamination are crucial to ensuring the quality and viability of embryos. This chapter covers the key components of ART culture systems, including media selection, environmental control, sterility management, and the use of specific substances such as oil overlays, hyaluronidase, and polyvinylpyrrolidone (PVP), along with troubleshooting strategies based on the latest scientific insights.

MEDIA TYPES AND COMPOSITION IN ASSISTED REPRODUCTIVE TECHNOLOGY CULTURE SYSTEMS

Culture media serve as the foundation of any ART culture system, providing the necessary nutrients, energy sources, and biochemical support for embryos as they transition from fertilization to blastocyst formation **(Table 1)**. The two most common types of media used in ART are sequential and one-step media, each designed to address different metabolic needs during various stages of development **(Table 2)**.

AMINO ACIDS, ETHYLENEDIAMINETETRAACETIC ACID, AND ANTIBIOTICS IN CULTURE MEDIA

- *Amino acids (AAs):* Amino acids serve as key metabolic substrates and regulators of embryo development. In early cleavage

TABLE 1: Amino acids (AAs) types in culture media and their functions.

Amino acid type	*Examples*	*Function in embryo culture*
Nonessential AAs	Alanine, glutamine, and glycine	Early cleavage support, osmotic regulation, and energy source
Essential AAs	Leucine, lysine, and methionine	Required for blastocyst development and protein synthesis
Glutamine	Glutamine and glutamate	Cell proliferation and antioxidant protection
Taurine and hypotaurine	Modified AA derivatives	ROS scavenging and membrane stability
EDTA	Chelating agent	Reduces ROS, and protects early embryos

(EDTA: ethylenediaminetetraacetic acid; ROS: reactive oxygen species)

JAYPEE BROTHERS

TABLE 2: Sequential versus one-step media.

Media type	*Description*	*Impact on ART outcomes*	*Solution*
Sequential media	Sequential media are designed to match the changing metabolic needs of embryos as they progress through different stages. One medium supports early cleavage stages, while another is used during the blastocyst stage	Sequential media provide optimal conditions for each developmental stage, mimicking the in vivo environment. However, the need for dish changes introduces risks such as handling errors, exposure to air, and contamination[1]	Minimize embryo handling by streamlining dish changes and reducing exposure time. Pre-equilibrate media thoroughly and maintain stable environmental conditions, including CO_2 and temperature, to avoid stress on the embryos during transitions[2]
One-step media	One-step media maintain embryos in a single culture medium from fertilization through to the blastocyst stage, containing nutrients, amino acids, and growth factors that support development throughout	One-step media reduce the need for handling, lowering the risk of contamination and embryo stress. However, pH and nutrient stability may become challenging during extended culture periods[3]	Use one-step media when minimal handling is required, such as in time-lapse incubators. Ensure that the media are fully equilibrated before use to maintain stable pH levels. Implement oil overlays to protect against evaporation and pH fluctuations[4]

stages, nonessential amino acids such as glycine, taurine, and alanine help to regulate osmolarity, support protein synthesis, and reduce ammonia accumulation. In contrast, essential amino acids such as glutamine, leucine, and isoleucine become more critical during the morula to blastocyst transition, where cellular proliferation and differentiation intensify. Amino acids also act as carbon and nitrogen sources, influencing energy metabolism and nucleic acid synthesis.[1]

- *Ethylenediaminetetraacetic acid (EDTA):* EDTA functions as a metal ion chelator, binding divalent cations like Fe^{2+} and Cu^{2+} to prevent the formation of reactive oxygen species (ROS). This protects preimplantation embryos from oxidative stress, especially during early cleavage stages when endogenous antioxidant systems are immature. EDTA also serves as a free radical scavenger, maintaining redox balance and aiding in the preservation of genomic integrity.[3]
- *Antibiotics:* Antibiotics such as gentamicin and streptomycin are included to prevent bacterial contamination, especially during long-term culture. However, their presence must be tightly regulated, as high concentrations may interfere with mitochondrial translation, protein synthesis, and cellular respiration. Overuse can inadvertently suppress beneficial microbiota or compromise embryo metabolism. Therefore, batch validation and sterility assurance of media is crucial to limit antibiotic reliance while maintaining contamination-free environments.[5]
- *Buffers and pH regulators:* Most culture media use a bicarbonate buffer system in conjunction with controlled CO_2 atmospheres to maintain physiological pH (7.2–7.4). 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (HEPES) or 3-(N-morpholino) propanesulfonic acid (MOPS) buffers are also employed in handling media outside CO_2 incubators, offering pH stability during procedures like

JAYPEE BROTHERS

intracytoplasmic sperm injection (ICSI) or embryo transfer.

- *Hormones and growth factors:* Although not always included in standard IVF media, some advanced media formulations contain epidermal growth factor (EGF), insulin, or recombinant gonadotropins to mimic in vivo signaling pathways. These factors may enhance metabolic activation, compaction, and blastocyst formation when supplemented appropriately.
- *Scavengers and antioxidants:* In addition to EDTA, media may be supplemented with glutathione, vitamin C, vitamin E, or melatonin, which serve as ROS scavengers to reduce oxidative injury during in vitro development. These agents help to stabilize mitochondrial function, protect lipids and DNA, and promote healthier embryonic development under in vitro conditions.

ENVIRONMENTAL CONTROL IN CULTURE SYSTEMS

Maintaining precise environmental conditions is essential for optimal oocyte and embryo development. Critical parameters such as pH (ideally 7.2–7.4), CO_2 concentration (5–6% for bicarbonate-buffered media), humidity (≥95%), and temperature (37°C) must be tightly regulated to prevent cellular stress and developmental arrest. Oocytes, particularly during the metaphase II stage, are highly sensitive to temperature fluctuations and pH shifts, which can compromise spindle integrity and cytoplasmic maturation. During the precompaction stage (Days 1–3), embryos rely on low oxygen conditions (5% O_2) and benefit from media supplemented with nonessential amino acids and EDTA to support cleavage without premature differentiation. In contrast, postcompaction embryos (Days 4–6) exhibit increased metabolic demands and require essential amino acids, antioxidants, and higher glucose concentrations to support blastocyst expansion and lineage specification. Ensuring a stable and embryo-safe environment throughout these transitions is crucial for maintaining viability, minimizing ROS, and supporting successful implantation.

CO_2 LEVELS AND pH STABILITY

CO_2 plays a vital role in maintaining the pH balance of bicarbonate-buffered culture media. Fluctuations in CO_2 levels can lead to pH instability, which adversely affects metabolic functions, protein synthesis, and cell division **(Table 3)**.

HUMIDITY AND TEMPERATURE CONTROL

Humidity and temperature must remain stable to prevent cellular stress and media evaporation. Any fluctuations in temperature can result in thermal shock, which can damage the meiotic spindle of oocytes and disrupt mitotic divisions in embryos. Similarly, low humidity can cause evaporation of culture media, leading to changes in osmolarity and pH, ultimately compromising embryo viability. External factors such as altitude and geographical location can influence ambient pressure and humidity levels, necessitating site-specific adjustments in incubator calibration and room design. The use of dehumidifiers, air conditioning systems, or room heaters must be carefully balanced, as they can inadvertently reduce room humidity or cause temperature fluctuations if not properly maintained or calibrated. Therefore, maintaining a controlled laboratory environment with continuous monitoring, sealed equipment, minimal air turbulence, and appropriate insulation is essential to preserve the stability of embryo culture conditions and ensure optimal outcomes **(Table 4)**.

JAYPEE BROTHERS

TABLE 3: Gas and pH control parameters in embryo culture systems.

Parameter	*Description*	*Impact on ART outcomes*	*Solution*
CO_2 concentration	CO_2 levels typically range from 5 to 6% in ART culture systems, regulating pH in bicarbonate-buffered media. Incubator malfunctions or inconsistencies in gas supply can cause CO_2 fluctuations	CO_2 variations lead to pH imbalances, affecting enzyme activity, mitochondrial function, and nutrient transport. This can result in slow cleavage, increased fragmentation, and developmental arrest[2]	Regularly calibrate CO_2 incubators to ensure proper functioning. Use external sensors to monitor CO_2 levels continuously. Use sealed culture dishes with oil overlays to protect against pH fluctuations caused by air exposure[3]
pH variation	pH is sensitive to environmental changes, and small variations in CO_2 levels or prolonged exposure to air can disrupt pH balance in culture media. The optimal pH for embryo culture is 7.2–7.4	pH fluctuations increase oxidative stress, disrupt mitochondrial activity, and impair nutrient uptake, leading to poor blastocyst formation and increased apoptosis[5]	Use oil overlays to stabilize pH and minimize exposure to ambient air. Monitor pH regularly using microelectrodes or dyes to detect deviations early. Pre-equilibrate media in incubators to maintain stable pH levels[4]

TABLE 4: Humidity and temperature regulation in embryo culture systems.

Parameter	*Description*	*Impact on ART outcomes*	*Solution*
Humidity control	Maintaining humidity at 95% helps to prevent evaporation of culture media, which maintains stable osmolarity and nutrient concentrations	Low humidity leads to evaporation, which alters media composition and osmotic balance, causing osmotic stress to embryos and increasing the risk of fragmentation[2]	Ensure that incubators have humidity control systems. Use oil overlays to protect media from evaporation. Regularly check the osmolarity of culture media to ensure it remains consistent, adjusting humidity settings as necessary[5]
Temperature control	Embryos require a constant temperature of 37°C for optimal cellular function. Deviations can disrupt metabolic and genetic processes	Temperature fluctuations result in cellular damage, reduced cleavage rates, and an increase in apoptosis. Improper temperature control can lead to failed embryo development[6]	Use temperature-controlled workstations and prewarmed media to avoid thermal shock. Regularly calibrate incubators and heating blocks to maintain consistent temperature. Monitor temperature with real-time sensors to detect and correct deviations promptly[1]

STERILITY AND CONTAMINATION CONTROL IN ASSISTED REPRODUCTIVE TECHNOLOGY CULTURE SYSTEMS

Ensuring sterility in ART culture systems is fundamental to preserving embryo viability, as any form of contamination whether microbial, particulate like cotton fibers, or chemical such as endotoxins can severely disrupt the delicate in vitro environment. The quality of consumables plays a pivotal role, and only medical-grade, embryo-tested plastics with appropriate transparency or minimal opacity should be used

JAYPEE BROTHERS

to ensure both sterility and visual clarity during micromanipulation. Improperly manufactured or stored consumables can leach toxic substances or harbor residual contaminants, posing a serious threat to gamete and embryo health. Sterility must be validated not just by manufacturer certifications such as gamma irradiation, but also through in-laboratory disinfection practices and using sterile packaging within designated clean zones. Additionally, culture media and consumables must be lot-tested prior to use, since variations even between batches can affect embryo development. Decontamination workflows should include the use of incubators with HEPA filters, aseptic workstation design, validated entry protocols, and scheduled sterility monitoring. Maintaining sterility is thus a dynamic and proactive process, requiring continuous vigilance, standardized protocols, and consistent quality checks across all stages of the IVF workflow **(Table 5)**.

OILS, HYALURONIDASE, AND POLYVINYLPYRROLIDONE IN ASSISTED REPRODUCTIVE TECHNOLOGY CULTURE SYSTEMS

In addition to media, specific substances like oil overlays **(Table 6)**, hyaluronidase (hylase) **(Table 7)**, and PVP **(Table 8)** play crucial roles in protecting media, facilitating sperm selection, and aiding in oocyte denudation during ART procedures **(Table 9)**.

MONITORING EMBRYO DEVELOPMENT: CLEAVAGE, FRAGMENTATION, AND APOPTOSIS

Embryo development must be closely monitored throughout the culture period to assess the health of the embryos and identify potential issues such as abnormal cleavage, fragmentation, and apoptosis **(Table 10)**. These indicators are critical for selecting high-quality embryos for transfer.

TABLE 5: Contamination from particulates and inadequate sterilization in assisted reproductive technology (ART) laboratories.

Source of contamination	*Description*	*Impact on ART outcomes*	*Solution*
Cotton fibers and particulates	Cotton fibers, dust, and other particulates can enter culture dishes during handling, introducing contaminants that interfere with media composition and embryo development	Physical contaminants can damage embryos, disrupt sperm-oocyte interactions, and introduce microbial organisms that affect fertilization and embryo quality[7]	Use lint-free materials in the laboratory, and avoid cotton-based laboratory coats and towels. Implement strict gowning protocols, and inspect culture dishes for visible contaminants before use. Use filtered pipette tips and sterile workstations to prevent contamination[6]
Disinfection and sterilization protocols	Inadequate sterilization of media, dishes, and tools introduces microbial contaminants that compromise embryo health. Even trace amounts of endotoxins can impair embryo development	Contaminated media lead to increased apoptosis, poor-quality embryos, and failed implantation. Endotoxins disrupt normal cellular processes, leading to developmental arrest[7]	Use sterile, single-use culture dishes and autoclave reusable tools. Conduct regular microbiological testing, such as endotoxin assays, to validate the sterility of culture media and tools. Employ UV sterilization of incubators and workstations to maintain contamination-free environments[5]

JAYPEE BROTHERS

TABLE 6: Comparative assessment of oil types used in ART culture systems.

Oil type	*Description*	*Impact on ART outcomes*	*Solution*
Liquid paraffin	Liquid paraffin is commonly used to overlay culture media to protect against evaporation and maintain stable temperature and pH	Liquid paraffin effectively stabilizes the culture environment, but poorly purified oil can introduce toxic compounds that harm embryos, such as peroxides and VOCs[1]	Use highly purified, sterile-filtered liquid paraffin and pre-equilibrate the oil in incubators before use. Regularly test oil for toxicity using mouse embryo assays (MEA) to ensure it supports normal embryo development[2]
Mineral oil	Mineral oil is another commonly used overlay with a higher viscosity, offering better protection for smaller culture droplets	Mineral oil maintains pH and temperature stability, but its higher viscosity can complicate handling during ICSI. Contaminated oil introduces risks of microbial contamination and VOC exposure[4]	Prewarm mineral oil and ensure it is fully sterile before use. Choose an oil with appropriate viscosity based on the size of the culture droplet and the procedure **(Fig. 1)**, such as ICSI or embryo culture[2]

(ART: assisted reproductive technology; ICSI: intracytoplasmic sperm injection; VOCs: volatile organic compounds)

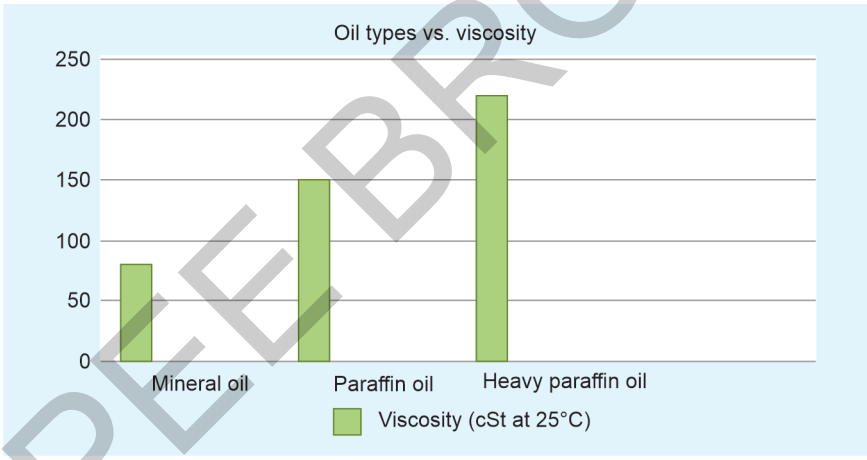

Fig. 1: Comparative viscosity of different oil types used in embryo culture systems.

TABLE 7: Hyaluronidase (Hylase) in oocyte denudation.

Substance	*Description*	*Impact on ART outcomes*	*Solution*
Hyaluronidase (Hylase)	Hyaluronidase is used to break down the extracellular matrix in cumulus cells surrounding oocytes, facilitating denudation prior to ICSI	Proper use of hyaluronidase aids in gentle and efficient removal of cumulus cells. Overexposure, however, can damage the oocyte's zona pellucida and cytoplasm, compromising fertilization rates[8]	Limit exposure time to hyaluronidase (1–2 minutes at 80 IU/mL is typical) and rinse oocytes thoroughly in fresh media after denudation. Minimize mechanical stress on oocytes during denudation to preserve cell viability[4]

(ART: assisted reproductive technology; ICSI: intracytoplasmic sperm injection)

JAYPEE BROTHERS

TABLE 8: Polyvinylpyrrolidone (PVP) in ICSI.

Substance	*Description*	*Impact on ART outcomes*	*Solution*
Polyvinylpyrrolidone	PVP is a viscous polymer solution used to immobilize sperm during ICSI, making sperm easier to select and inject. Concentrations of 7 and 10% PVP are commonly used depending on the viscosity required, with 10% offering more stable immobilization for precise handling. However, care must be taken during injection to avoid introducing excess PVP into the oocyte, as deposition of the polymer can affect ooplasmic integrity and disrupt fertilization	PVP facilitates sperm immobilization, but prolonged exposure can damage sperm DNA and reduce viability. Overexposure also increases the risk of sperm sticking to the pipette, complicating the injection process[6]	Use PVP with caution, limiting sperm exposure to only a few minutes before injection. Always ensure that PVP is prepared and tested for purity to avoid introducing contaminants during ICSI. Proper handling techniques should be used to minimize damage to the sperm[8]

(ART: assisted reproductive technology; ICSI: intracytoplasmic sperm injection)

TABLE 9: Oil types—viscosity, overlay behavior, and batch variability.

Oil type	*Viscosity (cSt at 25°C)*	*Overlay behavior*	*Batch variability*	*Notes*
Mineral oil	65–100	Lighter, less dense, and faster spread	High (natural source)	Risk of peroxides; less commonly used today
Paraffin oil	120–200	Heavier and stable overlay	Low (synthetic source)	Preferred in IVF; undergoes filtration and QC
Heavy paraffin oil	>200	Slow spread, and minimal evaporation loss	Low	Used for long-term culture

(IVF: in-vitro fertilization; QC: quality control)

CONCLUSION

Culture systems in ART are essential for creating an optimal environment that supports gamete maturation, fertilization, and embryo development. Maintaining precise control over factors such as media composition, pH, CO_2 levels, temperature, and sterility is critical to ensuring successful outcomes. The selection of appropriate media, whether sequential or one-step, and the careful use of substances like hyaluronidase and PVP during procedures like ICSI, play a crucial role in minimizing stress on gametes and embryos. Environmental stability, including humidity and temperature control, is vital for preventing issues such as developmental arrest, fragmentation, or apoptosis. Troubleshooting culture systems involve constant monitoring and swift intervention to correct deviations, ultimately improving fertilization rates, embryo quality, and clinical success.

JAYPEE BROTHERS

TABLE 10: Embryo developmental kinetics and quality markers in assisted reproductive technology (ART).

Parameter	*Description*	*Impact on ART outcomes*	*Solution*
Cleavage rate	The cleavage rate refers to the timing of cell division in the developing embryo. Normal cleavage follows a consistent timeline (e.g., 2-cell at 24 hours, 8-cell at 72 hours)	Abnormally slow or fast cleavage can indicate metabolic stress, suboptimal culture conditions, or genetic abnormalities, which are associated with lower implantation rates and increased risk of miscarriage[2]	Monitor cleavage rates using time-lapse imaging to track real-time development and detect deviations early. Adjust culture media composition to provide necessary metabolic support. Ensure stable pH and temperature conditions throughout the culture period[4]
Fragmentation	Fragmentation involves the separation of small cytoplasmic pieces within the embryo. Low fragmentation (below 15%) is common, but higher levels (>25%) suggest significant developmental stress	High fragmentation is linked to chromosomal anomalies, poor embryo quality, and lower implantation rates. It may result from oxidative stress, improper media composition, or suboptimal environmental conditions[7]	Regularly monitor fragmentation levels and assess the cause of stress. Use antioxidant-supplemented media to reduce oxidative stress. Optimize culture conditions, including pH and temperature, and reduce handling times to minimize stress on developing embryos[1]
Apoptosis	Apoptosis is the process of programmed cell death. While it occurs naturally in developing embryos, excessive apoptosis is indicative of cellular damage or stress	High levels of apoptosis lead to poor-quality embryos, developmental arrest, and reduced implantation rates. Apoptosis may be triggered by oxidative stress, genetic mutations, or disruptions in culture conditions[6]	Use culture media with antioxidants, such as melatonin or vitamin C, to protect embryos from oxidative stress. Monitor environmental factors such as temperature, pH, and CO_2 levels to ensure stability. Genetic screening of embryos may help to identify underlying mutations that contribute to apoptosis[4]
Time-lapse monitoring	Time-lapse imaging tracks embryo development in real-time, allowing for detailed observation of cleavage, fragmentation, and abnormal cellular events without disturbing the culture environment	Time-lapse monitoring provides early detection of abnormal development patterns, allowing for better embryo selection. This leads to improved implantation rates and reduced miscarriage risk[4]	Implement time-lapse monitoring systems in the laboratory to continuously assess embryo development. Use the detailed data provided by these systems to guide embryo selection and optimize culture conditions[1]

JAYPEE BROTHERS

REFERENCES

1. Gardner DK, Lane M. Embryo culture systems: Role of media, gas environment, and temperature. Fertil Steril. 2013;99(4):856-62.
2. Gardner DK, Kelley RL. Embryo culture systems: Optimization for ART outcomes. Reprod BioMed Online. 2018;36(4):387-96.
3. Biggers JD, Summers MC. Choosing a culture medium: Making informed decisions. Fertil Steril. 2008;90(2):473-83.
4. Esfandiari N, Nazemian Z. Impact of culture systems on in vitro fertilization outcomes. J Assist Reprod Genetics. 2017;34(10):1345-54.
5. Menezo Y, Dale B. Embryo environment and quality: The importance of the microenvironment. Reprod BioMed Online. 2013;27(5):402-11.
6. Van den Bergh M, Overwater C. Influence of PVP on sperm DNA integrity during ICSI. Reprod Biomed Online. 2016;32(4):398-404.
7. Vermesh M, Samo M, Saadat P. Reducing contamination in ART: Air quality and microbiological monitoring. Fertil Steril. 2020;113(3):519-29.
8. Swain JE, Lai D, Takayama S, Smith GD. Thinking big by thinking small: Application of microfluidic technology to improve ART. Lab on a Chip. 2012;12(7):1214-20.

JAYPEE BROTHERS

for detailed information on obstetrics & gynecology books, visit our website www.ejaypee.com, for detailed information on obstetrics & gynecology books, visit our web

Journey to Inception of Life

Troubleshooting in ART Laboratory

Every embryo has a story, and every assisted reproductive technology (ART) success begins with precise laboratory work. This book brings together scientific reasoning, hands-on troubleshooting, and compassionate practice in one volume.

It explores challenges from semen preparation to embryo transfer, offering practical solutions to issues such as abnormal fertilization, embryo collapse, or culture-media errors. Dedicated chapters on regulatory compliance and ethical documentation round out this essential reference.

Whether you are refining your technique or training the next generation, this book offers clarity in a complex and deeply human field.

Salient Features

- *Stepwise troubleshooting:* Covers real-world ART challenges—semen preparation, intracytoplasmic sperm injection (ICSI), culture, transfer—with structured solutions
- *Scientific and practical insights:* Integrates cellular biology, laboratory protocols, and evidence-based reasoning behind each fix
- *Laboratory quality and compliance:* Focus on VOCs, media validation, traceability, ISO standards, and ART Act/SR Act alignment
- *Visual aids and case learning:* Includes tables, flowcharts, and real-case illustrations for enhanced understanding
- *All-round utility:* Designed for embryologists, clinicians, students, and IVF laboratory quality assurance teams.

Chandan Vijay Salunke PhD is a practicing Clinical Embryologist with 20+ years' experience, IVF Consultant, and Founder of Kasturi ReproAssist Concepts, Panjim, Goa, India. With a strong foundation in embryology laboratory operations, training, and quality systems, he has worked extensively across ART clinics to standardize laboratory protocols and improve success rates. Known for his analytical approach and commitment to ethical, evidence-based practices, he has trained numerous embryologists and authored various academic modules. His vision is to make embryology education more structured, accessible, and grounded in scientific rigor.

Shravani Kanakdas Parker holds an MSc in Clinical Embryology from Kasturba Medical College, Manipal, Karnataka, India and brings a meticulous and research-oriented approach to laboratory practice. She is an Executive Director, Kasturi ReproAssist Concepts LLP, Panjim, Goa, India. She specializes in micromanipulation techniques, cryopreservation protocols, and hands-on training. With a keen eye for detail and a passion for protocol optimization, she contributes to both the scientific and practical aspects of the book. Her work reflects a balance between academic insight and real-world ART experience, making her a valued contributor to the field and this publication.

Shelving Recommendations
OBSTETRICS & GYNECOLOGY

ISBN 978-93-7202-526-2

9 789372 025262

Buy from ejaypee

JAYPEE BROTHERS