ART UNIT REGULATIONS

2017

MINISTRY OF HEALTH AND PREVENTION

Appendix

I. INTRODUCTION

DEFINITION/TERMINOLOGY

A few years ago, this field was often referred to as IVF, in vitro fertilization, but as the field has become more technologically advanced and an expanded number of services are offered, assisted reproductive technologies(ART) is the preferred term

ART facility means any premise which is involved in treatment and procedures that includes in vitro handling of human oocytes, spermatozoa and embryos for the purpose of establishing a pregnancy.

There are a number of ways to set up and operate a successful assisted reproductive technique (ART) laboratory: one set-up may have little in common with another but may prove to be equally successful. It is important that one remembers this before venturing into establishing a new clinic. Facilities for ART range from a make shift in vitro fertilization (IVF) laboratory with a minimum of equipment to a fully equipped laboratory specifically designed for ART and additional space dedicated to clinical care and research.

While the environment, physical plant, and equipment require special consideration in the design of an integrated gamete and embryo culture facility, it is the staff members who will carry out the procedures and are essential for the success of the entire operation. Successful clinical practice in general and ART in particular are almost entirely dependent on the experience level of medical and laboratory personnel. For the laboratory staff, enthusiasm is another key factor to success, especially because there are still few formal teaching and skills examination programs in place for a speciality in ART.

Setting up a new laboratory or thoroughly renovating an existing facility is very much an art as is the practice of ART itself.

Assisted reproductive technologies include the following:

- Infertility diagnosis prescreening
- Artificial insemination-large numbers of washed motile sperm are placed into the female reproductive tract, often the uterus
- Intrauterine insemination (IUI)-sperm are placed directly into the uterus
- Hormonal therapy to induce ovulation
- Reproductive laser surgery to treat endometriosis and other uterine or tubal problems that can affect fertility
- Ovulation induction with artificial insemination
- Gamete intrafallopian transfer (GIFT)-eggs and sperm are injected directly into the woman's fallopian tubes via laparoscopy
- Zygote intrafallopian transfer (ZIFT)-a zygote (newly fertilized egg) is inserted directly into the woman's fallopian tubes

- Intracytoplasmic sperm injection (ICSI)-using micromanipulation technology, a single sperm is injected into the center of the cytoplasm of the egg to achieve fertilization
- Testicular epididymal sperm aspiration (TESA)-sperms are retrieved using an open testicular biopsy technique
- In vitro fertilization (IVF)-eggs are retrieved from the ovary and fertilized by the man's sperm in the lab, several days later a number of fertilized embryos are transferred into the uterus the remaining embryos can be cryopreserved for use in subsequent cycles.
- Assisted hatching-micromanipulation of the embryo to increase implantation success
- Egg donation-women whose ovaries have been removed, or do not function normally, can receive donated eggs from another woman, these eggs are fertilized by the male's sperm in the lab and later implanted into the uterus
- Gestational surrogacy-transferring the embryo into another woman who carries the pregnancy to term;
- Traditional surrogacy –artificially inseminating a woman who carries a baby to term, the baby will then be raised by its genetic father and his partner
- Embryo cryopreservation-freezing and storage of embryos in liquid nitrogen
- Hysteroscopy with tubal canalization – visual examination of the interior of the uterus to check for abnormalities
- Laparoscopy-procedures using a fiber optic scope passed into the abdomen through a tiny incision below the navel
- Psychological services

II. REGULATORY ISSUES AND LICENSING

IVF Units (Fertilization Centers) in the UAE require licensing according to the Cabinet Decision No 36 of 2009 Implementing Regulation of Federal Law No (11) of 2008 Concerning the Licensing of Fertilization centers in United Arab Emirates. All IVF Units should comply with the requirements stated in the Cabinet Decision document.

III. FACILITY DESIGN CONSIDERATIONS:

General:

In the early days of IVF some clinics were built in remote areas, based on the premise that environmental factors such as stress could affect the patient and thereby the outcome of treatment. Today's laboratories are commonly placed in city centers and large metropolitan areas in order to service large populations. When designing the IVF laboratory, the most recent developments in facilities, equipment and procedures should be considered. Attention should be given to operator comfort to provide a safe working environment that minimizes the risk of distraction, fatigue and thereby making a mistake. Taking into account local, international occupational health and safety requirements, considerations should include bench height, adjustable chairs, adequate work space per person, microscope eye height, efficient use of space and surfaces, sufficient environmental lighting and air-conditioning with controlled humidity and temperature.

1. Site selection and environmental considerations.

The choice of a laboratory site is of great importance for a new program. The recent development of better assays for determining the baseline quality of the environment facilitates the site selection. There is now awareness that some buildings or building sites could be intrinsically harmful to cell tissue culture.

Before developing the basic design for a new laboratory, **environmental factors** must be considered. While the air quality in modern laboratories can be controlled to degree, it can never be fully protected from the exterior environment and adjoining building spaces. Designers should first determine whether the building or the surrounding site is scheduled to undergo renovations, demolition, or major changes of any kind in the foreseeable future. City planning should also be reviewed. Historical environmental data and trends, future construction, and the ability of maintenance staff to maintain and service the IVF laboratory need to be determined. Activity related to any type of construction can have a significant negative impact on any proposed laboratory. Prevalent wind direction, industrial hazards, and general pollution reports such as ozone measurements should also be determined. Even when these factors are all deemed acceptable, basic air sampling and determination of volatile organic compound (VOC)concentrations is necessary inside and outside the proposed building area.

Therefore, Prior to site selection the following internal and external environmental factors should be respected:

External:

1. Air quality
2. Noise control(traffic)

3. Adjacent sites (Constructions, factories)
4. Wind direction

Internal:

a-Natural light

Natural light is highly desirable where achievable, particularly for laboratory areas where staff will spend a majority of their time.

b-Privacy/acoustics:

Privacy is essential for confidential conversations and interviews and will minimize stress and discomfort for patients.

Confidential patient information is exchanged between patients and staff; therefore, the Interview, Consult, Collection and Treatment rooms should be acoustically treated to maximize privacy.

In acoustically treated rooms, return air grilles should be acoustically treated to avoid transfer of conversations to adjacent areas. Door grilles and undercuts to these areas should be avoided.

An ART unit may be developed as:

- A stand-alone unit.
- A dedicated unit within a hospital

2. Space efficiency and ergonomic considerations

Laboratory design should respect optimal work flow over minimal distances while handling reproductive cells during all treatment phases. Ideally, an embryologist should be able to finish one complete procedure without moving more than three meters in any direction; not only is this efficient but also it minimizes accidents in a busy laboratory. The number of modules can easily be determined by the expected number of cases and procedure types, the average number of eggs collected, and the number of embryologists expected to work simultaneously. Each person should be provided with sufficient workspace to perform all procedures without delay. Additional areas can contain simple gamete-handling stations or areas concentrating incubators.

Laboratories and storage areas shall be sized to suit the design requirements of the equipment to be used, to provide a safe working environment and to allow the effective movement of staff. Aspects for consideration will include height of benches and chairs, height of equipment in constant use such as microscopes and bio-safety cabinets.

3. Safety and security considerations

Designing for safety in an ART lab is of upmost importance.

When there are several options available to the laboratory designer supply and evacuation routes should be planned. One of the most susceptible aspects of ART is cryopreservation. In case of any emergency such as fire or power failure it may be necessary to relocate the liquid nitrogen filled dewars without using an elevator or to relocate the frozen samples using a temporary container. This may seem an extreme consideration especially in the larger laboratories that stock piles thousands of samples but plans should be made. It may be possible to keep a separate storage closet or space near the building exit where long term samples which usually provide the bulk of the storage can be kept. This would require a repeated checking of the facility that is not part of the facility. **Liquid nitrogen tank alarms** with remote notification capability should be installed on all dewars holding gametes and embryos. The route of delivery of liquid nitrogen and other gas cylinders must be relatively easy without stairways between the laboratory and the delivery truck and should be sensibly planned. Note that the flooring of this route is usually destroyed within months because of liquid nitrogen spills and were caused by delivery containers. So, the possibility of an alternative delivery corridor should be considered for these units

Placement of bulky and difficult pieces of equipment should be considered when designing doorways and electrical panels. Architects should be fully informed of all equipment specifications to avoid the truly classic door-width mistake. **Emergency generators** should always be installed, even where power supplies are usually reliable. The requirements can be determined by an electrical engineer. Thankfully, these units can be well removed from the laboratory, but must be placed in well-ventilated areas that are not prone to flooding. Additional battery "**uninterruptible power systems**" may be considered as well but are of very limited capability. Buildings should also be checked for placement of the main power inlets and distribution centers, especially because sharing power lines with other departments or companies may not be advisable. Circuit breakers should be easily assessible to embryologists or building maintenance staff. General knowledge of mechanical and electrical engineering of the building and the laboratory specifically will always be advantageous. Leaving all the building mechanics and other facilities to other individuals is often counterproductive. Embryologists need to be involved with facilities management and be updated with construction decisions in and outside the building in a timely manner.

Security and Alarm Systems

Laboratory security sometimes involves video cameras. Depending on the number of people who have access to the lab, a finger print or retinal identification system and/or magnetic card reader may be required. Alarm systems monitor incubators, gas and liquid nitrogen tanks, and cryotank monitors, relaying a message when equipment malfunctions. Thermo Scientific makes the Sensaphone telephone dialing system that interfaces with an alarm to automatically dial several sequential

telephone numbers of laboratory staff if something is amiss at the lab. This device can monitor power failures, listen to the sound of smoke detectors, monitor temperature or water on the floor, humidity and the operation of numerous pieces of laboratory equipment.

4. HVAC design considerations

Procedures involving gamete or embryo manipulation should be performed in a **controlled environment**. Maintaining the sterile conditions of some specific spaces is of utmost importance. Therefore, the HVAC system design should respect differential pressurization which in turn can't be achieved without respecting proper architectural adjacencies.

5. Infection control considerations

All assisted reproductive technologies (ART) involve handling of biological material, and pose a potential hazard of transmitting diseases to personnel and to other patients' biological material (cross-contamination)

Designing for infection control is very important. A list of critical measures should be strictly applied and permanently inspected. The following are to be respected:

1. To ensure adequate safety measures, the treatment of viral-positive patients should be only performed in IVF laboratories with dedicated areas and equipment. Alternatively, such patient treatments could be allocated to specific time slots provided processing of their biological materials is followed by a thorough disinfection of the allocated areas and equipment.

2. Whenever biological material is imported into the IVF laboratory from another clinic, full screening results should be obtained in advance. If any transported material is viral-positive, a dedicated dry shipper may be needed, depending on international regulations.

3. Procedures to ensure personnel safety and prevent cross-contamination should be established, taking International safety standards into consideration. Therefore:

- Vaccination of all personnel against hepatitis B or other viral diseases, for which a vaccine is available, is recommended.
- Patients must be screened for infectious diseases according to national and international regulations.
- Staff must be informed when a viral-positive patient is to be treated and be aware of the risks of handling infected biological material.

Moreover, the following points should be respected:

1. Hand basins for staff handwashing in all patient areas and laboratories

2. Use of laboratory clothing in laboratories
3. Use of theatre clothing in procedure rooms
4. Use of laminar flow biosafety cabinets in laboratories (a class 2 cabinet should be available for handling of contaminated samples)
5. Sharps containers and clinical waste collection and removal.

6. Process/patient flow/functional relationship considerations.

The initial visit starts with a comprehensive physical and gynecological exam, a review of family and social history, and a review of male-related infertility issues. This initial interview and examination may take 45 to 50 minutes. Because the reasons for infertility problems are so diverse, the number of procedures to address these problems is similarly diverse. To give some idea of what is involved, consider two of the most frequent procedures, egg retrieval and egg transfer. In addition to taking hormones, the woman will take a medication at home and within a specified period of time-generally 35 hours-must come to the office for the egg retrieval. This is an ultrasound-guided needle aspiration procedure that is typically done under conscious sedation. Patients are understandably very nervous prior to this procedure. Afterward, the patient is transferred on a gurney to the recovery room where she remains for approximately an hour. Eggs and embryos are kept inside an incubator while in the embryology lab except when they are removed to be inseminated, changed to a new culture medium, or prepared for transfer to the uterus. The IVF lab acts as a temporary womb to support fragile gametes (eggs and sperm) and nurtures newly formed embryos until they are transferred to the uterus; therefore, the environment has to be very carefully controlled.

The IVF laboratory must have adequate functionalities to minimize any damaging effects upon reproductive cells, and ensure good laboratory practice. The laboratory should be adjacent to the operating room where clinical procedures are performed.

The IVF unit may have a close working relationship with:

Externally:

- Pathology laboratories
- Pharmacy
- Medical imaging

The IVF unit should be ideally located on the ground floor. if located on an upper floor, there must be a stretcher carrying lift available.

Internally:

Within the IVF unit the following relationships are significant:

- Laboratory areas should be located with a direct adjacent relationship to the Operating rooms for egg collection and re-implantation

- Laboratories should be located in a separate zone away from the outpatient/ consultation area and secured.
- Sperm Collection rooms have a close functional relationship with the Andrology Laboratory; specimens require rapid transfer to the laboratory to avoid deterioration.
- Office areas should be separate from the treatment and laboratory zone.
- Cryopreservation and storage facilities are often located in a separate space, although this is not strictly necessary; if separated, these areas should always be adjacent to the main laboratory. Another separate laboratory or module may contain an area for culture medium preparation, sterilization, and water treatment.

More specifically the following design criteria should be respected**:**

a. A separate laboratory with a safety fume hood should be provided for analyses using fixatives and other toxic reagents.

b. The area for cleaning and sterilization of materials, if present, should be separate from the laboratory.

c. Laboratory design should ensure optimal workflow over minimal distances while handling reproductive cells during all treatment phases.

d. Laboratory access should be restricted to authorized personnel.

e. A system for clean access of personnel and materials to the laboratory is highly recommended.

f. Rooms for changing clothes should be separate from the laboratory.

g. Hand-washing facilities should be placed outside or directly at the entry of the laboratory.

h. Separate office space for administrative work should be available outside the laboratory.

7. Considerations related to selection of construction material and finishes

Materials used in laboratory construction, painting, flooring and furniture should be appropriate for clean room standards, minimizing Volatile Organic Compounds (VOC) release and embryo toxicity.

Construction and renovation can introduce a variety of compounds into the environment of the ART laboratory, either temporarily or permanently. **Both can have major adverse effects** on the outcome of operations. The impact of the exterior environment on IVF success has been demonstrated. Pollutants can have a significant negative effect on success in an IVF laboratory. These effects can range from delayed or abnormal embryonic development, reduced or failed fertilization, and reduced implantation rates to failure of a treatment cycle.

Many of the damaging materials are organic chemicals that are released or out gassed by paint, adhesives from flooring, cabinets, and general building materials as well as from laboratory equipment and procedures.

It is important to realize that the actual construction phase of the laboratory can cause permanent problems. Furthermore, any subsequent adjacent renovation can also cause similar, or even greater problems. Moreover, new construction immediately outside the building is considerably more problematic.

Measures and precautions to be considered when renovating a new lab

For construction of a new laboratory or if changes are to be made to areas adjacent to the IVF facility, the following guidelines should be followed:

First, the area to be demolished and reconstructed needs to be physically isolated from the IVF laboratory (if this is not the new IVF laboratory itself). The degree of isolation should be equivalent to an **asbestos or lead abatement project**.

The isolation should be done through:

1. Physical barriers, consisting of poly-sheeting supported by studding where needed.
2. Limited access to the construction area and the use of an access passageway with two doors in series.
3. Removal of all construction waste via an exterior opening or proper containment of waste before using an interior exit;
4. Negative air pressure in the construction area, exhausting to the exterior, far removed from the laboratory's air intake, and properly located with regard to the prevailing winds and exterior airflow
5. Extra interior fans during any painting or the use of adhesives to maximize removal of noxious fumes
6. Compiling and logging of material safety data sheets for all paints, solvents, and adhesives in use.

The negative pressurization of the laboratory space requires continuous visual confirmation via a ball and tube pressure indicator or simply paper strips. Periodic sampling for particulates, aldehydes and organics could be done outside the demolition and construction site, provided this is economically feasible.

Alternatively, tracer gas studies can be done to verify containment. The general contractor of the demolition and construction should be briefed in detail on the need to protect the IVF facility and techniques to accomplish this. When possible, the actual members of the construction crew should be selected and briefed in detail. Large filter units using filter pellets of carbon and permanganate can be placed strategically. Uptake of organics can be assayed, but the frequency of routine filter changes should be increased during periods of construction activity.

Many materials release significant amounts of VOCs and a typical list includes paints, adhesives, glues, sealants, and caulking materials, which release alkanes, aromatics, alcohols, aldehydes, ketones, and other classes of organic materials. Strict measures should be taken in order to reduce these out-gassing chemicals. Any and all interior painting throughout the facility should only be done on prepared surfaces with water -based paint formulated for low VOC potential.

During any painting, auxiliary ventilation should be provided using large industrial construction fans, with exhaust vented to the exterior. Paints that can significantly influence air quality should be emission tested**. Material safety data sheets** are generally available for construction materials. Suppliers should submit testing reports for potential emission. **Interior paints must be water-based, low -volatile paints with acrylic, vinyl acrylic, alkyd, or acrylic latex polymers.** Paints meeting this specification can also contain certain inorganic materials. Paints with low volatiles may still contain low concentrations of certain organics. **No interior paint should contain formaldehyde, acetaldehyde, isocyanates, reactive amines, phenols and other water-soluble volatile organics. Adhesive glues, sealants, and calking materials present some of the same problems as paints. None of these materials used in the interior should contain formaldehyde, benzaldehyde, phenol, and like substances. Silicone materials** are preferred whenever possible, particularly for sealant and caulking works.

iv. ART UNIT ARCHITECTURAL COMPONENTS

ART unit may consist of a number of functional zones.

A. UNIT COMPONENTS

1. Reception/Administration:

- Waiting room
- Reception
- Business office (insurance, billing,)
- Conference room
- Staff lounge
- Staff toilets
- Storage
- Office manager
- Donor program coordinator
- Lab director
- OR nurse
- IVF coordinator
- Psychologist
- Resource library/patient education

2. Clinical Areas:

- Exam rooms
- Nurse stations
- Blood draw
- Collection room
- Toilets
- Consultation rooms

3. **Laboratory Zone**:

a. Andrology lab
b. Genetics lab
c. Embryology lab, includes:

- ❖ Micromanipulation area
- ❖ Cryopreservation prep and storage
- ❖ Male /female gowning lockers
- ❖ Storage Med gases and supplies
- ❖ Media preparation area

5. Patient Procedural area:

1. Gowned waiting
2. Operation room
3. Procedure room
4. Scrub
5. Clean utility
6. Soiled utility
7. Central supply
8. Toilet/staff dressing
9. Recovery areas
10. Janitor closet
11. Storage

Miscellaneous (Bio hazardous storage, medical gas storage, vacuum, and generator

B. SCHEDULE OF ACCOMODATION

The following program is based on an embryology lab equipped to process around 600 retrievals per year.

RECEPTION/ADMINISTRATION AREA		
ROOM SPACE	QTY * m2	**CONSIDERATIONS**
RECEPTION	15	
STORE/PHOTOCOPY/FILE	8	
WAITING MALE /FEMALE	2 * 10	
ACCESSIBLE VISITORS TOILET	2*6	
FAMILY WAITING AREA	1 * 25	
MEETING/INTERVIEW	1 * 12	
BUSINESS OFFICE	50	
CONFERENCE ROOM	28	
STAFF LOUNGE	13	
STAFF TOILETS	2 * 6	
STORAGE	7.5	
OFFICE MANAGER	11	
DONOR PROGRAM COORDINATOR	7.5	
LAB DIRECTOR	11	
OR NURSE	7.5	
IVF COORDINATOR	7.5	
PSYCHOLOGIST	11	
RESOURCE LIBRARY/PATIENT EDUCATION	11	

CLINICAL AREAS		
ROOM SPACE	QTY * m2	**CONSIDERATIONS**
EXAM/ULTRASOUND ROOMS	(4-6) * 10	
NURSE STATIONS	2 * 18	
BLOOD DRAW	5	
COLLECTION ROOM	2 * 10	
SHOWER/TOILETS	5	
CONSULTATION ROOMS	3 * 12	

LABORATORY AREAS			
ROOM SPACE		QTY * m2	**CONSIDERATIONS**
ANDROLOGY LAB		30	**SIZE IS RELATED TO SERVICE PLAN**
GENETIC LAB		15	
EMBRYOLOGY LAB	**MICROMANIPULATION AREA**	40	**SIZE IS RELATED TO SERVICE PLAN**
	CRYOPRESERVATION STORE		
	MALE/FEMALE GOWNING LOCKERS		
	STORAGE MED GASES AND SUPPLIES		
	MEDIA PREPARATION AREA		

PATIENT PROCEDURAL AREA		
ROOM SPACE	QTY * m2	**CONSIDERATIONS**
GOWNED WAITING	9	
OPERATION ROOM	37	
PROCEDURE ROOM	21	
SCRUB	2.5	
CLEAN UTILITY	7.5	
SOILED UTILITY	7.5	
CENTRAL SUPPLY	15	
TOILET/STAFF DRESSING	2 * 6	
RECOVERY AREAS	3 * 9	
HOUSKEEPING	3	
STORAGE	4	

V. DESCRIPTION, FUNCTIONAL ADJACENCIES, TECHNICAL DETAILS OF ART UNIT COMPONENTS

Before detailing the architectural components of an ART unit, design should respect the following requirements:

1. **Public corridors** should have a minimum width of 152 cm
2. Where patients are transported on stretchers or beds, at least one corridor that connects **operation room** and the **recovery area** to an **exit** shall have a minimum width of 183 cm.
3. The corridor connecting the **operation room** and the **recovery area** shall have a minimum width of 244cm to accommodate transport of patient between pre-operative, procedure, and recovery area.
4. **Staff only** corridors shall be permitted to be a minimum of 112 cm wide.
5. **Door** openings serving occupiable spaces shall have a minimum clear width of 87 cm, door openings requiring stretcher access should have a minimum width of 1.12 m.

1.EMBRYOLOGY /IVF LAB

Embryology lab includes or should be in direct relation:

a. Cryopreservation prep and storage
b. Micromanipulation area
c. Media preparation area
d. Storage Med gases and supplies

A. Description
B. Functional adjacencies
C. Technical considerations

Description

The embryology laboratory provides facilities for the handling, preparation, culture and storage of human gametes (sperm and oocytes). Due to the sensitive nature of its functions, the embryology laboratory should be located in a secure and sterile area away from the outpatient/ clinic facilities but in close proximity to the procedure room where the oocytes (eggs) are collected. The laboratory is responsible for identifying oocytes in ovarian fluid, culturing these eggs with the partner's sperm, and embryo examination prior to embryo implantation into the patient.

The ICSI (Intracytoplasmic Sperm Injection) laboratory involves the process of injecting a single sperm into the nucleus of the egg using a microscopic needle without affecting the viability of the egg. The zygote (fertilized egg) is then monitored until it starts to divide forming a small cluster of cells known as the blastocyst (in approximately 5 days in the lab) which is then replanted to form an embryo.

IVF LAB main components:

a. Cryopreservation store

One of the most susceptible aspects of ART is cryopreservation. The cryopreservation store area should be located within or in close proximity to the laboratory area and should have controlled access.

Cryopreservation store is a room where liquid nitrogen tanks containing frozen gamete are being stored. nitrogen tanks should be stored in an enclosed and well-ventilated space in case of any nitrogen leakage.
In case of any emergency such as fire or power failure it may be necessary to relocate the liquid nitrogen filled dewars without using an elevator or to relocate the frozen samples using a temporary container. This may seem an extreme consideration especially in the larger laboratories that stock piles thousands of samples but plans should be made.it may be possible to keep a separate storage closet or space near the building exit where long term samples which usually provide the bulk of the storage can be kept. This would require a repeated checking of the facility that is not part of the facility. Liquid nitrogen tank alarms with remote notification capability should be installed on all dewars holding gametes and embryos. The route of delivery of liquid nitrogen and other gas cylinders must be relatively easy without stairways between the laboratory and the delivery truck and should be sensibly planned in advance.

Cryopreservation area includes:

1. Laminar-flow hood,
2. Planar cell freezer,
3. Heat sealer
4. Stereo dissecting microscope,
5. Liquid nitrogen tanks.
6. Computerized semen analyzer

Microscopes need to be at sit-down workstations and must be at a comfortable height for the embryologist. This can differ depending on whether that individual is short or tall, which can sometimes be accommodated by adjusting the chair height. The selection of a task chair for this position is also very important as individual comfort and ergonomic features matter.
There should not be overhead cabinets above the balance table in the micromanipulation area, the computerized semen analyzer, the cryopreservation counters, or the autoclave area.

Areas under the cryopreservation countertop should be open to accommodate liquid nitrogen tanks on wheels.C02 lines should be centrally piped to the workbenches where it is needed. If space is limited, the endocrine analyzer can be located outside the lab.

Monitoring system for high levels of nitrogen in the air is required.

Strict cryopreservation protocols are required and will include:

- Infection control (minimizing the risk of cross contamination of frozen gametes, zygotes and embryos).
- Labelling, packaging and documentation of tissue frozen.

b. Embryology micromanipulation area

Includes air suspension table (to minimize vibration); inverted microscope; video camera, monitor, and recorder; stage warmer. The video camera and monitor enable the embryologist to perform the procedure at magnification on the monitor, rather than looking through the microscope. It also shows (if the OR has a large monitor) the embryo being loaded into the syringe just prior to the transfer procedure. A laser is used to aid in assisted hatching. It is attached to the micromanipulation system.

Micromanipulation area is a part of embryology lab

c. Media preparation area

Various culture media are prepared in this room. It can be within the IVF lab or adjacent to it.

d. Lab storage and supplies

If an adequate water purification system is not centrally installed, there will be a need to store quantities of ultra-pure water, which is delivered in large bottles. There are also many chemicals that need to be stored to support the lab functions.

Functional adjacencies

Ideally, IVF lab is contiguous with the procedure rooms. If the distance to the place of egg retrieval or embryo transfer (The procedure room) exceeds 10 m, then the use of an infant isolette or other method of maintaining temperature and PH for the eggs and embryos must be employed.
A pass-through hatch from the laboratory to each operating room is recommended. Staff change and hand wash areas should be located at the laboratory entry.

Embryology lab contains or is usually directly adjacent to the following areas:

a. **Cryopreservation prep and storage**
b. **Micromanipulation area**
c. **Media preparation area**
d. **Storage Med gases and supplies**

Technical considerations

- **Security**

- **Safety**
- **Communication**
- **Electrical requirements**
- **Lighting**
- **Plumbing**
- **Medical gases**
- **HVAC requirements**
- **Finishing materials**
- **Equipment and fitting**

- **Security:**

Security is of utmost importance to maintain the **sterile** conditions of the space as well as to protect the specimens.
The laboratory should be in a low traffic, secured area with access limited to the embryologist and techs who work in the lab. video camera (CCTV) should be provided. A finger print or retinal identification system or magnetic card reader is required.

- **Safety:**

An Alarm system for monitoring incubators, gas and liquid nitrogen tanks, and cryotank monitors, relaying a message when equipment malfunctions. It is highly recommended to use the Sensaphone telephone dialing system that interfaces with an alarm to automatically dial several sequential telephone numbers of laboratory staff if something is amiss at the lab. This device can monitor power failures, listen to the sound of smoke detectors, monitor temperature or water on the floor, humidity and the operation of numerous pieces of laboratory equipment.

- **Communication:**

Intercom communication is recommended if direct communication is not possible.

- **Electrical requirements:**

- Uninterrupted power source for incubators is of utmost importance in the labs alarm systems, and monitors.
- A backup power system is required.
- surge protection is needed for electrical and electronic equipment.
- Emergency generators should always be installed, even where power supplies are usually reliable and must be placed in well- ventilated areas that are not prone to flooding
- Sharing power lines with other departments is not acceptable.
- Circuit breakers should be easily assessible to embryologists or building -- maintenance staff.

- **Lighting**

- Lighting in each section of the lab should be individually dimmable.
- Lighting must be an **incandescent** source as fluorescents generate a frequency that may affect cellular developments of the embryos.
- Room lighting needs to be placed to avoid glare on monitors.

- **Plumbing**

- Sinks must be precisely located at the entry of the laboratory areas.
- Some pieces of equipment may need to be connected to water and drain
- Non-corrosive piping must be used and sinks should be stainless steel
- Eyewash diverters must be plumbed separately.
- No floor drains should be allowed in lab area

- **Medical gases**

- The IVF culture area and micromanipulation area require vacuum and CO2.
- The cryopreservation area requires liquid nitrogen and vacuum.
- Media preparation area requires CO2 and vacuum.

- **HVAC requirements**

To avoid disruption of the sterile field and to minimize cooling effect on lab equipment's, preparing a detailed layout and assessment of all laboratory furniture and equipment is essential prior to designing an IVF lab HVAC system.

Background and processing air quality should comply with International guidelines, (international organization for standardization, 2001) and should be regularly monitored and the following requirements should be respected:

1. The clean room embryology lab has two ceiling HEPA filter air diffusers and two walls mounted HEPA filter diffusers that provide horizontal unidirectional laminar air flow to workstations for incoming oocytes and outgoing embryos and micromanipulation. Four vents at the floor level return the air to the main air handling ventilation unit. Access to the clean room is made through an anteroom equipped with two ceiling HEPA filter air diffusers that draw cleanroom air and provide vertical unidirectional laminar air flow to the entire anteroom. (the anteroom has a clean closet to store face masks, safety glasses, hoods, coveralls, boots and disposable laboratory supplies and can be used as a gowning room).

2. The standard for an embryology lab Air filter **is Class 100 air** quality. This Class number is the maximum allowable number of particles (0.5 micron) and larger per cubic foot of air. ISO class 1 is the cleanest.

3. The lab will have several laminar flow hoods for carrying out certain procedures. **The room should have a four stage HEPA filtration** system that purifies the air

of the entire lab. In addition, a portable Coda Aero Tower made specifically for IVF labs may be used to filter the air.

4. The **lab must have individual temperature, humidity and velocity controls** and there must **be access to overhead ducts for periodic cleaning and changing of air filters**. This room must maintain **positive air pressure**.

5. **Air intake** must not be near any source of contamination and air from the hoods needs to be **ducted directly to the outdoors**, due to the chemicals used.

6. **Basic air sampling and determination of volatile organic compound** (VOC) concentrations is necessary inside and outside the proposed lab area. The outcome of these tests will determine which design requirements are needed to remove VOCs from the laboratory area.

7. In most cases an **over-pressured laboratory** (at least 0.10-0.20 inches of water) that uses a high number (7-15) of fresh air changes per hour (FACH) is the best solution, because it provides for proper medical hygiene.

8. **The laboratory walls and ceiling** should have the absolute minimum number of penetrations. This generally requires a **solid ceiling, Sealed lighting,** and **airtight utility connections**, commercial suspended ceilings using double -sided tape and clips are not ideal.

9. **Doors** will require seals and sweeps, and should be lockable.

10. **Ducts** and equipment must be laid out in such a way that routine and emergency maintenance and repair work can be performed outside the laboratory with minimal disruption to the laboratory.

11. **Air handling** must not use an open plenum design. In the ideal case, 100% outside air with chemical and physical filtration will be used with sealed supply and return ducts. **While providing cleaner air, 100% outside air sourcing will maximize the life of a chemical filter and will provide lower concentration of VOC in the IVF laboratory's air**. **In climates where temperatures routinely exceed 32-degree C with 85% plus relative humidity,100% outside air could result in an unacceptable level of humidity (>60%), which could allow mold growth**. In these cases, the use of limited return air from the lab is acceptable. **A 50% outside air system with 15-30 total air changes per hour does work well and the relative humidity becomes very controllab**le.

12. **Humidity** must also be completely controlled according to climate and seasonal variation. The system must be capable of supplying the space with air with a temperature as high **as 30-35-degree c** at less **than 40% relative humidity.** At normal circumstances controlled humidity should be 20% and control temperature between 22-24-degree C.

13. **Air inlets and outlets should be carefully spaced to avoid drafts that can change local "spot" temperatures,** or expose certain equipment to relatively poor air or changes in air quality.

14. **Laminar flow hoods and micromanipulation workstations** should not be located too close to air supply fixtures to avoid disruption of the sterile field and to minimize cooling on the microscope stage. A detailed layout and assessment of

all laboratory furniture and equipment is therefore essential prior to construction and has many other benefit.

15. **Maintaining the HVAC system is crucial**. The heating, ventilation, and air conditioning(HVAC) will require filter changes, coil cleaning, replacement of drive belts, and chemical purification media. The most prevalent failure concerns the initial particulate filter. These are inexpensive filters designed to keep out large particles, plant debris, insects, etc. if such filters are not replaced promptly and regularly, they will fail, allowing the HVAC unit to become contaminated. The HEPA filters and chemical media also require inspection and periodic replacement. Maintenance staff should report their findings to the IVF laboratory.

FIG.2

ISO Clean room classifications

ISO standards for controlled environments

Adoption of ISO standards makes national standards such as AS 1386 redundant. The ISO standards shown below are complemented by ISO-14698, dealing with bio-contamination control and monitoring.

ISO-14644-1 Classification by Airborne Particles
ISO-14644-2 Monitoring for Compliance
ISO-14644-3 Measurement & Testing
ISO-14644-4 Design, Construction and Start-up
ISO-14644-5 Cleanroom Operations
ISO-14644-6 Terms, Definitions & Units
ISO-14644-7 Separative Enclosures
ISO-14644-8 Molecular Contamination

ISO air cleanliness classifications – Class limits (particles/m^3)

Classification number (N)	Maximum concentration limits (particles/m^3) for particles ≥ particle sizes shown					
	0.1 µm	0.2 µm	0.3 µm	0.5 µm	1 µm	5 µm
ISO Class 1	10	2				
ISO Class 2	100	24	10	4		
ISO Class 3	1000	237	102	35	8	
ISO Class 4	10000	2370	1020	352	83	
ISO Class 5	100000	23700	10200	3520	832	29
ISO Class 6	1000000	237000	102000	35200	8320	293
ISO Class 7				352000	83200	2930
ISO Class 8				3520000	832000	29300
ISO Class 9				35200000	8320000	293000

Note: Uncertainties related to the measurement process require that data with no more than three (3) significant figures be used in determining the classification level.

EU CGMP classifications

Grade	Maximum concentration limits (particles/m^3) for particles ≥ sizes shown			
	At rest (b)		In operation	
	≥ 0.5µm	≥ 5.0µm	≥ 0.5µm	≥ 5.0 µm
A	3500	0	3500	0
B (a)	3500	0	350000	2000
C (a)	350000	2000	3500000	20000
D (a)	3500000	20000	not defined (c)	not defined (c)

Notes:
(a) For B, C and D, the number of air changes should be related to the size of the room and the equipment and personnel present. The HVAC system should be provided with appropriate filters, e.g. HEPA for Grades A, B and C.
(b)The maximum permitted number of particles in the "at rest" condition correspond approximately to the US Federal Standard 209E & the ISO classifications as follows: Grades A and B = Class 100, M 3.5, ISO 5; grade C = Class 10 000, M 5.5, ISO 7 and Grade D = Class 100 000, M 6.5, ISO 8.
(c) The requirement and classification limit for the area will depend on the nature of the operations carried out.

Cross-reference to AS 1386 and other standards

Standard	Classification					
ISO 14644-1	3	4	5	6	7	8
AS 1386	0.035	0.35	3.5	35	350	3,500
BS 5295	C	D	E/F	G/H	J	K
Federal Standard 209E	1	10	100	1,000	10,000	100,000
EU CGMP	-	-	A/B	-	C	D

- **Finishing materials**

  Pollutants can have a significant negative effect on success in an IVF laboratory. These effects can range from delayed or abnormal embryonic development, reduced or failed fertilization, and reduced implantation rates to failure of a treatment cycle

  Many of the damaging materials are organic chemicals that are released or out gassed by paint, adhesives from flooring, cabinets, and general building materials as well as from laboratory equipment and procedures.

1. <u>Walls:</u>

   a. No penetrations should be seen.

b. Polyurethane based coatings should be used for walls.

c. No interior paint should contain formaldehyde, acetaldehyde, isocyanates, reactive amines, phenols and other water-soluble volatile organics.

d. Adhesive glues, sealants, and calking materials present some of the same problems as paints. None of these materials used in the interior should contain formaldehyde, benzaldehyde, phenol, and like substances.

2. Floors:

a. Floors should be made of antibacterial, anti-slip material with heat welded seams and a coved base.

b. Polyurethane based coatings should be used for floor finishes.

3. Ceilings:

a. **Ceiling** should have the absolute minimum number of penetrations.

b. Monolithic ceilings are highly recommended and this generally requires a solid ceiling.

c. The junctures of the ceiling to the walls should be coved

d. **Sealed lighting,** and **airtight utility connections**
e. Commercial suspended ceilings using double -sided tape and clips are not ideal.

- **Equipment and fitting**

A detailed list of equipment should be prepared and checked against the planned location of each item: it can later be used as the basis of maintenance logs. It is important to consider the inclusion of extra crucial equipment and spare tools in the laboratory design, to allow for unexpected malfunction. It is particularly important to have redundant elements of the cryopreservation system-including cryopreservation and storage equipment, similarly two or more spare incubators should not be seen as excessive; at least one spare follicle aspiration pump and micromanipulation station also be included. There are many other instruments and equipment pieces, the malfunction of which would jeopardize patient care, some spares should be continuously available to avoid any process disruption.
Furniture and equipment should be non-permeable, antibacterial, non-shedding, cleanable and resistant to frequent cleaning and disinfectant.

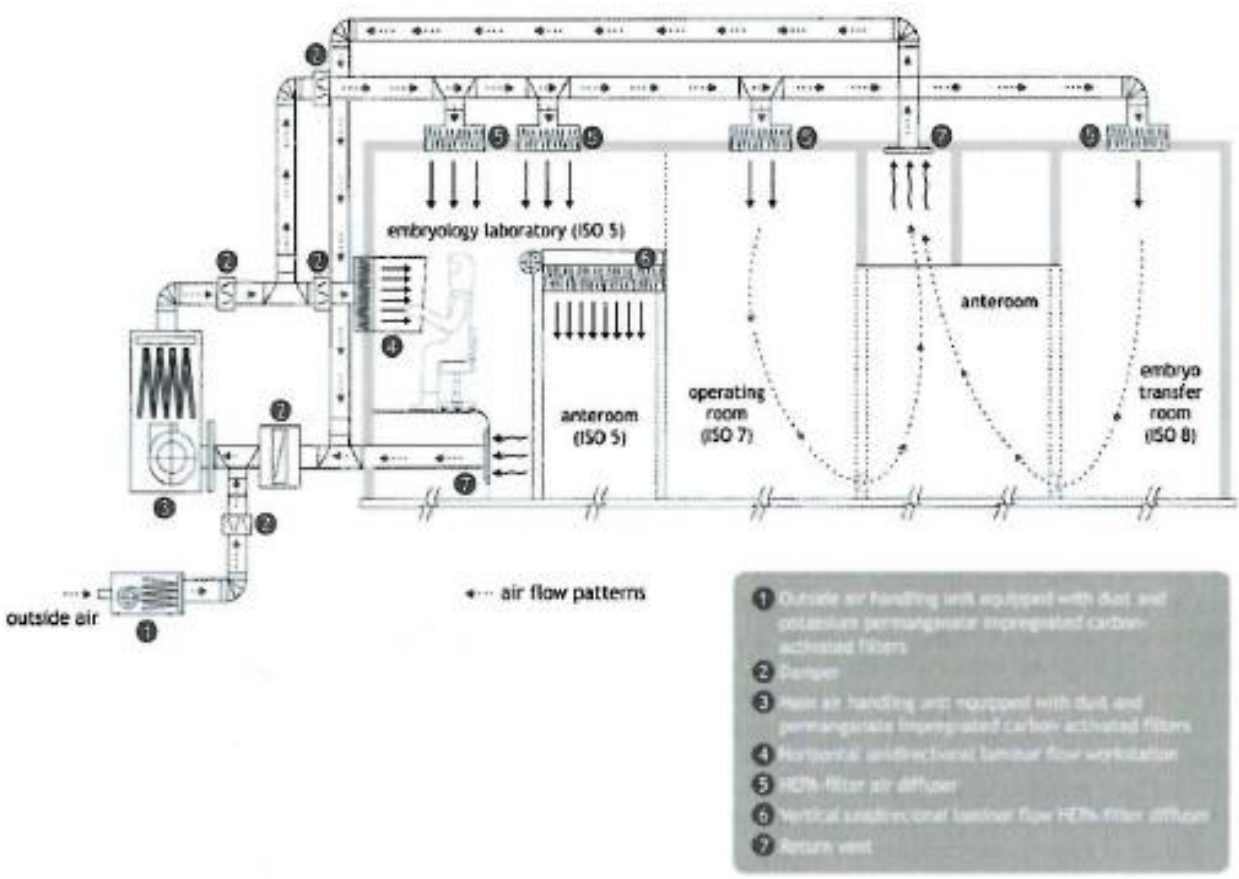
A list of equipments needed includes:

1. Laminar-flow hood
2. Stereo microscopes, bench top microscope, inverted microscope
3. Stage warmers
4. Centrifuges, large and small

5. Computers and printer
6. Incubators (tabletop model)
7. Water-jacketed CO2
8. High efficiency particulate air[HEPA]-filtered CO2)
9. Water purification system
10. Water line pressure pump and tank
11. Dry heat ovens.
12. Electrical pipets
13. Fyrite analyser(CO2 and O2 gas analyser)
14. Laboratory refrigerator
15. Eyewash diverter and emergency shower
16. Tele data service
17. Computer/printer

FIG.2

Schematic representation of a clean room embryology facility and its associated areas



2. ANDROLOGY LAB

A. **Description**
B. **Critical Functional adjacencies**
C. **Technical Considerations**

Description

The Andrology laboratory performs the evaluation, testing, preparation and storage specimens. Diagnostic procedures include:

- semen analysis determines sperm count, motility, viability and morphology,
- preparation of sperm for fertilization and Intrauterine Insemination (IUI) and thawing of frozen specimens

Critical Functional adjacencies

This is not a clean room (although sterile technique is used) and it needs to be adjacent to IVF lab and at close proximity of **collection room** as well.

Technical considerations

- **Security**
- **Safety**
- **Communication**
- **Electrical requirements**
- **Lighting**
- **Plumbing**
- **Medical gases**
- **HVAC requirements**
- **Finishing materials**
- **Equipment and fitting**

- **Security:**

Security is of utmost importance to maintain clean conditions of the space as well as to protect the specimens.
The laboratory should be in a low traffic, secured area with access limited to the embryologist and techs who work in the lab. video camera (CCTV) should be provided. A finger print or retinal identification system or magnetic card reader is required.

- **Safety:**

An Alarm system for monitoring incubators, gas and liquid nitrogen tanks, and cryotank monitors, relaying a message when equipment malfunctions. It is highly recommended to use the Sensaphone telephone dialing system that interfaces with an alarm to automatically dial several sequential telephone numbers of laboratory staff if something is amiss at the lab. This device can monitor power failures, listen to the sound of smoke detectors, monitor temperature or water on the floor, humidity and the operation of numerous pieces of laboratory equipment.

- **Communication:**

Intercom communication is recommended if direct communication is not possible.

- **Electrical requirements:**

- Uninterrupted power source for incubators is of utmost importance in the labs alarm systems, and monitors.
- A backup power system is required.
- surge protection is needed for electrical and electronic equipment.
- Emergency generators should always be installed, even where power supplies are usually reliable and must be placed in well- ventilated areas that are not prone to flooding
- Sharing power lines with other departments is not acceptable.
- Circuit breakers should be easily assessible to embryologists or building -- maintenance staff.

- **Lighting**

- Lighting in each section of the lab should be individually dimmable.
- Lighting must be an **incandescent** source as fluorescents generate a frequency that may affect cellular developments of the embryos.
- Room lighting needs to be placed to avoid glare on monitors.

- **Plumbing**

- Sinks must be precisely located outside or at the entry of the laboratory areas.
- Some pieces of equipment may need to be connected to water and drain.
- Non-corrosive piping must be used and sinks should be stainless steel
- Eyewash diverters must be plumbed separately.
- No floor drains should be allowed in lab area.

- **Medical gases**

- Andrology area should be provided with CO2 and vacuum outlets.

- **HVAC considerations**

Air quality is an important factor when trying to maintain process integrity. Testing reliability, results and personal protection can be affected by airborne contamination.

1. ISO class 1 air quality is the cleanest. The standard for an andrology lab **is Class 100 air** quality. This Class number is the maximum allowable number of particles (0.5 micron) and larger per cubic foot of air.

2. The lab will have several laminar flow hoods for carrying out certain procedures. **The room have a four stage HEPA filtration** system that purifies the air of the entire lab. In addition, a portable Coda Aero Tower made specifically for IVF labs may be used to filter the air.

3. The **lab must have individual temperature, humidity and velocity controls** and there must **be access to overhead ducts for periodic cleaning and changing of air filters**. This room must maintain **positive air pressure**.

4. **Air intake** must not be near any source of contamination and air from the hoods needs to be **ducted directly to the outdoors**, due to the chemicals used.

5. **Basic air sampling and determination of volatile organic compound** (VOC) concentrations is necessary inside and outside the proposed lab area. The outcome of these tests will determine which design requirements are needed to remove VOCs from the laboratory area.

6. In most cases an **over-pressured laboratory** (at least 0.10-0.20 inches of water) that uses a high number (7-15) of fresh air changes per hour (FACH) is the best solution, because it provides for proper medical hygiene.

7. **The laboratory walls and ceiling** should have the absolute minimum number of penetrations. This generally requires a **solid ceiling, Sealed lighting,** and **airtight utility connections**, commercial suspended ceilings using double -sided tape and clips are not ideal.

8. **Doors** will require seals and sweeps, and should be lockable.

9. **Ducts** and equipment must be laid out in such a way that routine and emergency maintenance and repair work can be performed outside the laboratory with minimal disruption to the laboratory.

10. **Air handling** must not use an open plenum design. In the ideal case, 100% outside air with chemical and physical filtration will be used with sealed supply and return ducts. **While providing cleaner air, 100% outside air sourcing will maximize the life of a chemical filter and will provide lower concentration of VOC in the IVF laboratory's air**. **In climates where temperatures routinely exceed 32-degree C with 85% plus relative humidity,100% outside air could result in an unacceptable level of humidity (>60%), which could allow mold growth**. In these cases, the use of limited return air from the lab is acceptable. **A 50% outside air system with 15-30 total air changes per hour does work well and the relative humidity becomes very controllab**le.

11. The andrology lab should have a roof top air handling unit that draws outside air through coarse and activated carbon filters before it enters the unique ceiling HEPA filter air diffuser that distributes filtered air to the laboratory under positive pressure.

12. **Humidity** must also be completely controlled according to climate and seasonal variation. The system must be capable of supplying the space with air with a temperature as high **as 30-35-degree c** at less **than 40% relative humidity.** At normal circumstances controlled humidity should be 20% and control temperature between 22-24-degree C.

13. **Air inlets and outlets should be carefully spaced to avoid drafts that can change local "spot" temperatures,** or expose certain equipment to relatively poor air or changes in air quality.

14. **Laminar flow hoods and micromanipulation workstations** should not be located too close to air supply fixtures to avoid disruption of the sterile field and to minimize cooling on the microscope stage. A detailed layout and assessment of all laboratory furniture and equipment is therefore essential prior to construction and has many other benefit.

15. **Maintaining the HVAC system is crucial**. The heating, ventilation, and air conditioning(HVAC) will require filter changes, coil cleaning, replacement of drive belts, and chemical purification media. The most prevalent failure concerns the initial particulate filter. These are inexpensive filters designed to keep out large particles, plant debris, insects, etc. if such filters are not replaced promptly and regularly, they will fail, allowing the HVAC unit to become contaminated. The HEPA filters and chemical media also require inspection and periodic replacement. Maintenance staff should report their findings to the IVF laboratory.

- **<u>Finishing materials</u>**

  Pollutants can have a significant negative effect on success in an andrology laboratory. These effects can range from delayed or abnormal sperm development, reduced or failed fertilization.

  Many of the damaging materials are organic chemicals that are released or out gassed by paint, adhesives from flooring, cabinets, and general building materials as well as from laboratory equipment and procedures.

  <u>Walls:</u>

  a. No penetrations should be seen.

  b. Wall surfaces should be covered with low odor epoxy-based paint

  c. No interior paint should contain formaldehyde, acetaldehyde, isocyanates, reactive amines, phenols and other water-soluble volatile organics.

d. Adhesive glues, sealants, and calking materials present some of the same problems as paints. None of these materials used in the interior should contain formaldehyde, benzaldehyde, phenol, and like substances.

Floors:

Floors should be made of monolithic vinyl antibacterial, anti-slip sheets with heat welded seams and a coved base.

Ceilings:

a. **Ceiling** should have the absolute minimum number of penetrations.

b. Monolithic ceilings are highly recommended and this generally requires a solid ceiling.

c. The junctures of the ceiling to the walls should be coved.

d. **Sealed lighting,** and **airtight utility connections.**

e. Commercial suspended ceilings using double -sided tape and clips are not ideal.

- **Equipment and fitting**

Includes:

1. laminar-flow hood
2. Refrigerator
3. Centrifuges both large and small
4. Phase microscope with fluorescence
5. Warming oven
6. Water jacketed C02 incubator
7. Dry shipper tanks.
8. Electrical pipettes
9. Variable pipettes.
10. Fyrite analyser(CO2 and O2 gas analyser)
11. Tele data service
12. Computer/printer

3. THE GENETICS LAB

A. Description
B. Critical functional adjacencies
C. Technical Considerations

Description

Genetics Laboratory undertakes cytogenetic studies of the embryo cells, particularly the nucleus which contains the chromosomes that carry genes and their DNA to determine the status of the embryo after IVF and before re-implantation, also referred to as Pre-implantation Genetic Diagnosis (PGD). This process can also identify and diagnose abnormalities and genetic diseases that may accompany the pregnancy by the use of sophisticated techniques such as Fluorescence In- Situ Hybridization (FISH) or Polymerase Chain Reaction (PCR).

Critical Functional adjacencies

Genetic lab should be in close proximity to IVF and andrology lab.

Technical considerations

- **Security**
- **Safety**
- **Communication**
- **Electrical requirements**
- **Lighting**
- **Plumbing**
- **HVAC requirements**
- **Finishing materials**
- **Equipment and fitting**

- **Security:**

Security is of utmost importance to maintain clean conditions of the space as well as to protect the specimens.
The laboratory should be in a low traffic, secured area with access limited to the embryologist and techs who work in the lab. video camera (CCTV) should be provided. A finger print or retinal identification system or magnetic card reader is required.

- **Safety:**

An Alarm system for monitoring incubators, gas and liquid nitrogen tanks, and cryotank monitors, relaying a message when equipment malfunctions. It is highly recommended to use the Sensaphone telephone dialing system that interfaces with an alarm to automatically dial several sequential telephone numbers of laboratory

staff if something is amiss at the lab. This device can monitor power failures, listen to the sound of smoke detectors, monitor temperature or water on the floor, humidity and the operation of numerous pieces of laboratory equipment.

- **Communication:**

Intercom communication is recommended if direct communication is not possible.

- **Electrical requirements:**

- Uninterrupted power source for incubators is of utmost importance in the labs alarm systems, and monitors.
- A backup power system is required.
- surge protection is needed for electrical and electronic equipment.
- Emergency generators should always be installed, even where power supplies are usually reliable and must be placed in well- ventilated areas that are not prone to flooding
- Sharing power lines with other departments is not acceptable.
- Circuit breakers should be easily assessible to embryologists or building -- maintenance staff.

- **Lighting**

- Lighting in the lab should be individually dimmable.
- Lighting must be an **incandescent** source as fluorescents generate a frequency that may affect cellular developments of the embryos.
- Room lighting needs to be placed to avoid glare on monitors.

- **Plumbing**

- Sinks must be precisely located at the entry of the laboratory areas.
- Some pieces of equipment may need to be connected to water and drain.
- Non-corrosive piping must be used and sinks should be stainless steel
- Eyewash diverters must be plumbed separately.
- No floor drains should be allowed in lab area.

- **HVAC considerations**

Air quality is an important factor when trying to maintain process integrity. Testing reliability, results and personal protection can be affected by airborne contamination.

1. ISO class 1 air quality is the cleanest. The standard for A genetic lab **is Class 100 air** quality. This Class number is the maximum allowable number of particles (0.5 micron) and larger per cubic foot of air.

2. The lab will have several laminar flow hoods for carrying out certain procedures. **The room have a four stage HEPA filtration** system that purifies the air of the

entire lab. In addition, a portable Coda Aero Tower made specifically for IVF labs may be used to filter the air.

3. The **lab must have individual temperature, humidity and velocity controls** and there must **be access to overhead ducts for periodic cleaning and changing of air filters**. This room must maintain **positive air pressure**.

4. **Air intake** must not be near any source of contamination and air from the hoods needs to be **ducted directly to the outdoors**, due to the chemicals used.

5. **Basic air sampling and determination of volatile organic compound** (VOC) concentrations is necessary inside and outside the proposed lab area. The outcome of these tests will determine which design requirements are needed to remove VOCs from the laboratory area.

6. In most cases an **over-pressured laboratory** (at least 0.10-0.20 inches of water) that uses a high number (7-15) of fresh air changes per hour (FACH) is the best solution, because it provides for proper medical hygiene.

7. **The laboratory walls and ceiling** should have the absolute minimum number of penetrations. This generally requires a **solid ceiling, Sealed lighting,** and **airtight utility connections**, commercial suspended ceilings using double -sided tape and clips are not ideal.

8. **Doors** will require seals and sweeps, and should be lockable.

9. **Ducts** and equipment must be laid out in such a way that routine and emergency maintenance and repair work can be performed outside the laboratory with minimal disruption to the laboratory.

10. **Air handling** must not use an open plenum design. In the ideal case, 100% outside air with chemical and physical filtration will be used with sealed supply and return ducts. **While providing cleaner air, 100% outside air sourcing will maximize the life of a chemical filter and will provide lower concentration of VOC in the lVF laboratory's air**. **In climates where temperatures routinely exceed 32-degree C with 85% plus relative humidity,100% outside air could result in an unacceptable level of humidity (>60%), which could allow mold growth**. In these cases, the use of limited return air from the lab is acceptable. **A 50% outside air system with 15-30 total air changes per hour does work well and the relative humidity becomes very controllab**le.

11. Genetic lab should have a roof top air handling unit that draws outside air through coarse and activated carbon filters before it enters the unique ceiling HEPA filter air diffuser that distributes filtered air to the laboratory under positive pressure.

12. **Humidity** must also be completely controlled according to climate and seasonal variation. The system must be capable of supplying the space with air with a temperature as high **as 30-35-degree c** at less **than 40% relative humidity.** At normal circumstances controlled humidity should be 20% and control temperature between 22-24-degree C.

13. **Air inlets and outlets should be carefully spaced to avoid drafts that can change local "spot" temperatures,** or expose certain equipment to relatively poor air or changes in air quality.

14. **Maintaining the HVAC system is crucial**. The heating, ventilation, and air conditioning(HVAC) will require filter changes, coil cleaning, replacement of drive belts, and chemical purification media. The most prevalent failure concerns the initial particulate filter. These are inexpensive filters designed to keep out large particles, plant debris, insects, etc. if such filters are not replaced promptly and regularly, they will fail, allowing the HVAC unit to become contaminated. The HEPA filters and chemical media also require inspection and periodic replacement. Maintenance staff should report their findings to the IVF laboratory.

- **Finishing materials**

  Many of the damaging materials are organic chemicals that are released or out gassed by paint, adhesives from flooring, cabinets, and general building materials as well as from laboratory equipment and procedures. These chemicals should be reduced to the maximum

  Walls:

  a. No penetrations should be seen.

  b. Wall surfaces should be covered with low odor epoxy-based paint

  c. No interior paint should contain formaldehyde, acetaldehyde, isocyanates, reactive amines, phenols and other water-soluble volatile organics.

  d. Adhesive glues, sealants, and calking materials present some of the same problems as paints. None of these materials used in the interior should contain formaldehyde, benzaldehyde, phenol, and like substances.

  Floors:

  Floors should be made of monolithic vinyl antibacterial, anti-slip sheets with heat welded seams and a coved base.

  Ceilings:

  a. **Ceiling** should have the absolute minimum number of penetrations.

  b. Monolithic ceilings are highly recommended and this generally requires a solid ceiling.

  c. The junctures of the ceiling to the walls should be coved.

  d. **Sealed lighting,** and **airtight utility connections.**

  e. Commercial suspended ceilings using double -sided tape and clips are not ideal.

- **Equipment and fitting**

  Includes:

  1. Refrigerator
  2. Deep Freezer (-86 o C)(NUAIRE)
  3. Elektroforesis System (UVP)
  4. Magnetic Stirrer & Vortex (IKA)
  5. Gel Documentation System (UVP7)
  6. Autoclave
  7. Refrigerated Centrifuge (Hettich
  8. Thermal Cycler (Agilent)
  9. Tele data service
  10. Computer/printer

4. COLLECTION ROOM

A. Description
B. Critical functional adjacencies

Description:

Some thought should go into planning the semen collection area. This room should be at the end of a hallway, preferably with its own exit; it should be sound proofed, not too large, with a sink and shower. Clear instructions of how to collect semen for ART should be provided in the room. The room should be adjacent to the semen preparation laboratory, preferably with a double door pass through for samples. This pass-through should have a signaling device so the patient can inform the embryologist that sample is ready; it also permits male patients to leave the area without having to carry a specimen container.

The room should include as well.

- Comfortable seating
- TV, DVD player.
- Shower\washbasin
- Locker

Critical Functional adjacencies

This is best located in a quiet area of the suite and should be reasonably close to the andrology lab where semen is analyzed and sperm undergo the capacitation process.

5. OPERATING/PROCEDURE ROOM

A. Description
B. Critical functional adjacencies
C. Technical Considerations

Description

Operating rooms will include equipment and facilities for egg collection and embryo transfer, under local anesthetic. Operating rooms will require adjacent Patient and Staff Change Rooms, scrub sink and patient toilet facilities

1. There should be sufficient space to accommodate all necessary equipment and personnel and to allow for expeditious access to patients and all monitoring equipment.

2. Space requirements for **operation rooms** shall be at least 37 sq. m with a minimum clear dimension 6.10 m. between fixed cabinets. Where renovation works is undertaken and it is not possible to meet the above standards, each room should have a minimum clear floor area of 33.5sqm with a minimum clear dimension of 5.50 m.

3. Space requirements for **procedure room** shall be at least 24 sq. m with a minimum clear dimension 4.6 m. between fixed cabinets.

4. Operation room entrance door should be about 2.13 m width.

.

Critical Functional adjacencies

Operating room should be located in close proximity to andrology lab and recovery area, and should be directly adjacent to embryology lab. It should be away from the outpatient clinic facilities in a secure and private area.

Technical considerations

- **Security**
- **Communication**
- **Electrical requirements**
- **Lighting**
- **Plumbing**
- **Medical gases**
- **HVAC requirements**
- **Finishing materials**
- **Equipment and fitting**

- **Security:**

Operation room should be located in the restricted area.

- **Communication:**

Emergency nurse call communication system is recommended.

- **Electrical requirements:**

- Uninterrupted power source should be provided
- A backup power system is required.
- surge protection is needed for electrical and electronic equipment.
- Emergency generators should always be installed, even where power supplies are usually reliable and must be placed in well- ventilated areas that are not prone to flooding
- Sharing power lines with other departments is not acceptable.
- The number of single electrical receptacles should be 24. (16 convenient to table placement)

- **Lighting**

- In large procedure rooms, a ceiling mounted surgical light is required
- Lighting should be individually dimmable during ultrasound guided procedures.
- Room lighting needs to be placed to avoid glare on monitors.

- **Plumbing**

- Scrub Sinks must be precisely located at the entry of the operation room.
- Non-corrosive piping must be used for scrub sink and sink should be St. Steel
- No floor drains should be allowed in this area.

- **Medical gases**

  Operating room should be provided with two oxygen outlets, five vacuum outlets and one medical air outlet.

- **HVAC considerations**

Air quality is an important factor when trying to maintain process integrity. Testing reliability, results and personal protection can be affected by airborne contamination.

1. The **operation room must have individual temperature, humidity and velocity controls** and there must **be access to overhead ducts for periodic cleaning and changing of air filters**.

2. Adequate ventilation and air exchanges with recommended 15 air changes per hour (acceptable range is 12-20 air changes per hour as per American Society of Heating, Refrigerating and Air -conditioning Engineers(ASHRAE) shall be maintained in the operation room (operating theatre should be at positive pressure relative to the adjacent preparation areas).

3. Minimum of two air supply inlets with proper High Efficiency Particulate air (HEPA) filters (delivered at or near the ceiling and should not be directed over the surgery table) and minimum of two exhaust outlets (located near floor level, bottom exhaust outlets should be at least45 cm above the floor).

4. The temperature and relative humidity set points should be adjustable. Differential pressure indicating device, humidity indicator, and thermometers should be installed and should be located for easy observation.

5. **Humidity** must also be completely controlled according to climate and seasonal variation. The system must be capable of supplying the space with air with a temperature as high **as 30-35-degree c** at less **than 40% relative humidity.** At normal circumstances controlled humidity should be 20% and control temperature between 22-24-degree C.

6. High efficiency filters should be installed in the air handling system, with adequate facilities provided for maintenance, without introducing contamination to the delivery system or area served).

7. **Air intake** must not be near any source of contamination

8. **The operation room walls and ceiling** should have the absolute minimum number of penetrations. This generally requires a **solid wall and ceiling, Sealed lighting,** and **airtight utility connections**, commercial suspended ceilings using double -sided tape and clips are not ideal.

9. **Ducts** and equipment must be laid out in such a way that routine and emergency maintenance and repair work can be performed outside the laboratory with minimal disruption to the laboratory.

10. **Maintaining the HVAC system is crucial**. The heating, ventilation, and air conditioning(HVAC) will require filter changes, coil cleaning, replacement of drive belts, and chemical purification media. The most prevalent failure concerns the initial particulate filter. These are inexpensive filters designed to keep out large particles, plant debris, insects, etc. if such filters are not replaced promptly and regularly, they will fail, allowing the HVAC unit to become contaminated. The HEPA filters and chemical media also require inspection and periodic replacement.

- **Finishing materials**

  Many of the damaging materials are organic chemicals that are released or out gassed by paint, adhesives from flooring, cabinets, and general building materials as well as these chemicals should be reduced to the maximum

  Walls:

  a. No penetrations should be seen.

  b. Wall surfaces should be covered with low odor epoxy-based paint.

  c. No interior paint should contain formaldehyde, acetaldehyde, isocyanates, reactive amines, phenols and other water-soluble volatile organics.

  d. Adhesive glues, sealants, and calking materials present some of the same problems as paints. None of these materials used in the interior should contain formaldehyde, benzaldehyde, phenol, and like substances.

  Floors:

  Floors should be made of monolithic vinyl antibacterial, anti-slip sheets with heat welded seams and a coved base.

  Ceilings:

  a. **Ceiling** should have the absolute minimum number of penetrations.

  b. Monolithic ceilings are highly recommended and this generally requires a solid ceiling.

  c. The junctures of the ceiling to the walls should be coved

  d. **Sealed lighting,** and **airtight utility connections**

  e. Commercial suspended ceilings using double -sided tape and clips are not ideal

- **Equipment and fitting for procedure room**

  1. Defibrillator
  2. Double tourniquets if the practice performs bier blocks
  3. Pulse oximeter
  4. Electrocardiographic(ECG) monitor
  5. Temperature monitoring system for procedures lasting more than 30 minutes
  6. Blood pressure apparatus
  7. Emergency crash cart

8. A refrigerator for pharmaceuticals and double -locked storage for controlled substances

- **Equipment and fitting for operating room**

1. Multipurpose operation table with patient straps.
2. Anesthesia machine with adequate vital sign monitors
3. Adequate medical gases supply
4. X-ray viewer
5. Cauterization equipment
6. ECG monitor
7. Emergency cart shall be available with defibrillator, necessary drugs and other CPR equipment.
8. Suction machine
9. Pulse oximeter
10. Emergency call system

6. RECOVERY AREA

A. Description
B. Critical functional adjacencies
C. Technical considerations

Description

When designing a recovery area and determining the number of recovery positions required, minimum consideration should be given to the type of procedures performed, types of anesthesia used, average recovery periods for patients and anticipated staffing level

Recovery area is an unrestricted area. It should be under direct supervision of nurse station. Provisions for patient's privacy should be made. Hand washing stations should be available. Nurse call system should be available. Patient toilet should be provided for the exclusive use of the patient. Recovery area shall be equipped to meet the patient need (minimum of one bed for each operation room). The average recovery time for an IVF patient is one hour.

Critical functional adjacencies

This area should be close to the surgery area in a small practice, it may be just two beds immediately outside the surgery room.

Technical considerations

- **Communication**
- **Electrical requirements**
- **Medical gases**
- **HVAC requirements**
- **Finishing materials**
- **Equipment and fitting**

- **Communication**

  Nurse call system should be available.

- **Electrical requirements**

  - The number of Electrical receptacles should be at least four. conveniently fixed near the stretcher or chair
  - Single, duplex, or fourplex receptacles or a combination of these shall be permitted.
  - Consideration shall be given to providing some outlets on emergency power and some on normal power in case of transfer switch failure.

- An additional outlet should be provided for a monitor if one is furnished in the room.

- **HVAC considerations**

Recovery area air pressure should be kept at balanced pressure with respect to any adjoining area and should have minimum 6 air changes per hour. Relative humidity should be maintained at 45% to 55%. High efficiency filters should be installed in the air handling system, with adequate facilities provided for maintenance, without introducing contamination to the delivery system or the area served. Toilets air pressure should be kept negative pressure with respect to any adjoining areas and should have minimum 10 air changes per hour.

- **Finishing materials**

Walls:

a. No penetrations should be seen.
b. Wall surfaces should be covered with low odor epoxy-based paint
c. No interior paint should contain formaldehyde, acetaldehyde, isocyanates, reactive amines, phenols and other water-soluble volatile organics.
d. Adhesive glues, sealants, and calking materials present some of the same problems as paints. None of these materials used in the interior should contain formaldehyde, benzaldehyde, phenol, and like substances.

Floors:

Floors should be made of monolithic vinyl antibacterial, anti-slip sheets with heat welded seams and a coved base.

Ceilings:

Ceiling should stand chemical washing and should have the absolute minimum number of penetrations.

- **Medical gases**

Reliable source of oxygen should be provided(1/bed) suction, vacuum should be provided as well. (3/bed)

- **Equipment and fittings**

1. Crash cart for resuscitation
2. Emergency drugs
3. Stretcher
4. IV holder
5. Wash basin

7. STERILISING/ PACKING

A. Description
B. Critical functional adjacencies
C. Technical Considerations

Description

An area where cleaned and dried instruments are sorted, assembled into sets, packaged, and then sterilized in an autoclave.

Ongoing use of an autoclave is not a problem as long as the released steam is rapidly exhausted to the outside. This keeps the relative humidity in the facility to controllable limits. The use of cold sterilizing agents is not advised. Aldehydes such as glutaraldehyde and ortho-phthaladehyde from the autoclave can be transported inside the IVF laboratory.

General:

1. The sterile processing room shall consist of a decontamination area and a clean work area
2. Location.
   The sterile processing room shall be designed to provide a one-way traffic pattern of contaminated materials/instruments to clean materials/instruments to the sterilizer equipment.

   a. Entrance to the contaminated side of the sterile processing room shall be from the semi-restricted area.
   b. Exit from the clean side of the sterile processing room to the semi-restricted area or to an operating room shall be permitted.

3. The sterile processing room shall be permitted to be shared between two or more operating rooms.

Decontamination area

1. The decontamination area shall be equipped with the following:

   a. Countertop
   b. Hand-washing station separate from the instrument-washing sink
   c. Sink for washing instruments
   d. Storage for supplies.

2. To avoid splash, the decontamination sink shall be separated from the clean work area by either a 4-foot distance from the edge of the sink or a separating wall or screen. If a screen is used, it shall extend a minimum of 4 feet (cm) above the sink rim.

Clean work area

The clean work area shall be equipped with the following:

1. Countertop
2. Sterilizer as required for the services provided
3. Hand washing station
4. Built-in storage for supplies.

Critical Functional adjacencies

The Sterilizing/ Packing Room will be located in an area close to operation /procedure room adjacent to the Clean-up Room where the instruments are cleaned and decontaminated

The room requires a defined unidirectional workflow for instruments from clean to sterile and then to sterile store. Sterile stock should not be stored in this room to avoid the potential for mixing unsterilized instrument sets with sterile sets

Technical considerations

- **HVAC considerations**

1. Autoclaves should not be placed on the IVF laboratory's HVAC system, but rather in a room that is built using tight construction.
2. Room air should be exhausted directly outside of the building

- **Equipment and fittings**

Fittings and Equipment located in this room will include

1. Hand basin
2. Benches and cupboards
3. Instrument packing table
4. Heat sealing device
5. Autoclave
6. Cooling trolleys

REFERENCES

1. **Medical and Dental Space Planning: A Comprehensive Guide to Design, Equipment, and Clinical Procedures, 4,Jain Malkin, 2014 edition**

2. **Guidlines for design and construction of HOSPITALS AND OUTPATIENT FACILITIES,2014 edition**

3. **Guidline of the European Society of human reproduction and embryology.(Revised guidelines for good practice in IVF LABORATORIES ,2015)**