DAY TWENTY SEVEN

Human Reproduction and Reproductive Health

Learning & Revision for the Day

- Human Reproduction
- Male Reproductive System
- Female Reproductive System
- Menstrual Cycle
- Gametogenesis
- Fertilisation
- Implantation
- Placenta
- Parturition
- Lactation
- Embryonic Development
- Reproductive Health
- Birth Control or Contraception
- Reproductive Techniques

Embryology is the branch of biology, which deals with the study of development of organisms. **Aristotle** is known as Father of Embryology, **von Baer** as Father of Modern Embryology, while **R Roux** is known as Father of Experimental Embryology.

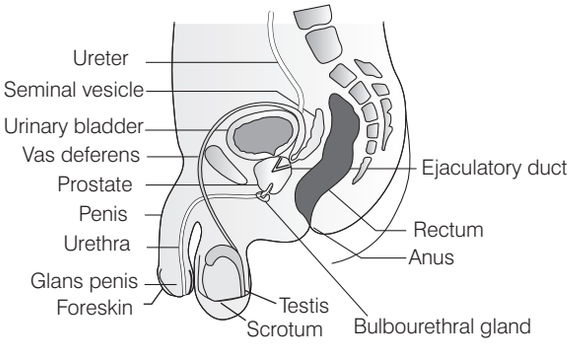
Human Reproduction

Humans are **unisexual** and **viviparous**, they give birth to young ones. The main characteristics of reproduction in humans are as follows

- The reproductive events in humans is a multistep process which includes
  - (i) Formation of gametes (gametogenesis).
  - (ii) Transfer of sperms into the female genital tract (insemination).
  - (iii) Fusion of male and female gametes (fertilisation).
  - (iv) Formation of zygote.
  - (v) Formation and development of blastocyst and its attachment to the uterine wall (implantation).
  - (vi) Embryonic development (gestation).
  - (vii) Delivery of the baby (parturition).
- Foetus develops inside uterus. In uterus, foetus is nourished by placenta.
- Menstrual cycle is completed in 28 days and oestrous cycle remains absent.
- Infants feed on mother's milk.
- **Accessory sex organs** are those organs, which form the gametes that are important in the process of reproduction.

Male Reproductive System

The male reproductive system is located in the pelvic region and mainly consists of a pair of testis (pl. testes), accessory ducts (rete testis, vasa efferentia, epididymis, ejaculatory duct, vas deferens and urethra), accessory glands (seminal vesicle, prostate gland and bulbourethral gland) and external genitalia (penis). The structure and location of these organs can be understood by the following labelled diagram:



Diagrammatic sectional view of male pelvis showing reproductive system

Testes

- These are the primary sex organs of males, located outside the abdominal cavity in a pouch called **scrotum**. This maintains the low temperature (2-2.5° C lower than the normal), essential for sperm formation.
- The scrotum communicates with abdominal cavity through the inguinal canal. Testis are oval in shape, with a length of 4-5 cm and width of 2-3 cm.
- The testis is covered by three protective coverings called tunicae. It is externally covered with tunica vaginalis, then white fibrous membrane called tunica albuginea and internal, tunica vasculosa.
- Each testis contain about 250 compartments called testicular lobules, each containing 1-3 highly coiled **seminiferous tubules**. The seminiferous tubule is lined on its inside by two types of cells
  - **Spermatogonia or Male germ cells** Undergo meiosis to form spermatozoa.
  - **Sertoli cells or Nurse cells** These are larger, tall columnar cells which provide nutrition to **Leydig cells** (i.e. between the tubules and produce the male sex hormone testosterone.).

Accessory Ducts

(i) **Rete testis** It comprises of anastomosing network of tubules, carrying sperms from seminiferous tubules to vasa efferentia.

(ii) **Vasa efferentia** (Sing. vas efferens) number of tubules arising from rete testis that conduct sperms to epididymis.

(iii) **Epididymis** It is tightly coiled structure, located on posterior surface of testis. It serves as site for sperm maturation and storage till their ejaculation.

(iv) **Vasa deferentia** (Sing. vas deferens) These are ducts arising from epididymis, ascending to the abdomen and loops over urinary bladder.

(v) **Ejaculatory duct** The vas deferens when pass over urinary bladder, receive a duct from seminal vesicle, thus forming the ejaculatory duct. It opens into urethra shortly after its origin from urinary bladder.

(vi) **Urethra** It originates from urinary bladder and extends through the penis to external opening, i.e. urethral meatus. It receives ducts of Cowper and prostate gland. It is called as urogenital duct as it provide exit for urine from bladder as well as semen from vasa deferentia.

External Genitalia

Penis is male external genitalia that comprises of vascular, spongy tissue that help in its erection to facilitate insemination. It serves as copulatory organ to transmit sperms into vagina of female during coitus.

The glans penis is the enlarged end of penis with a loose fold of skin called **foreskin** or **prepuce**.

Accessory Glands

These are of different types as follows

(i) **Seminal vesicles** (uterus masculinus) are situated behind the bladder. They are narrow, long pouches with muscular tissue on their wall.

- Uterus masculinus is situated at the junction of vas deferens and prostate gland. About 70% of the semen in seminal fluid is produced by seminal vesicles.
- Seminal fluid contains fructose (energy source for sperm), citrate, inositol, prostaglandins and several proteins.
- The product of the testes (spermatozoa) and prostate gland along with the fluid from the seminal vesicle are collectively known as **semen.**
- Seminal fluid has a pH of about 7.4.

(ii) **Prostate gland** is a single large gland with the size of a golf ball and is spongy in texture. Prostate gland is a collection of 30-40 tubuloalveolar glands.

- Prostate is situated around the first part of the urethra.
- It contains prostatic utricle and acini and covered by a capsule.

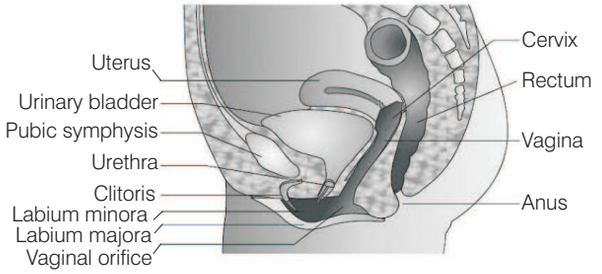
- Prostate gland secretes a thin, milky fluid that contains calcium citrate ion, phosphate ion, a clotting enzyme and a profibrinolysin called as **semen**.
- Enlargement of prostate results in prostatitis, in which urination is difficult or impossible.

NOTE
- BPH (Benign Prostatic Hypertrophy) is a medical condition, which occurs due to the increase in size of the prostatic gland.
- Untreated BPH may lead to the cancer of prostate.

(iii) **Cowper's gland** also called as **bulbourethral glands,** are two in number and situated beneath bladder and behind the urethra.
- These are present in male mammals. It opens into urethra before entering into penis.
- These are yellow in colour. Their secretion is slightly alkaline and is produced during sexual stimulation.
- Its secretion acts as a lubricant for the glans penis. It also neutralises any urine in urethra.
- The seminal vesicles, the prostate and Cowper's glands constitute the accessory genital glands.

Female Reproductive System

The female reproductive system is located in pelvic region and comprises of a **pair of ovaries**, **external genitalia**, **accessory ducts** (Fallopian tubes, uterus, cervix and vagina), **accessory glands** (vestibular glands and mammary glands). All these collectively support the process of ovulation, fertilisation, pregnancy, childbirth, lactation, etc. The structure and location of female reproductive organ can be understood by the diagram.



Diagrammatic view of female pelvis showing reproductive system

Ovary and its Anatomy

- These are two in number, 3 cm long, 2 cm wide and 1 cm thick, almond-shaped female gonads. The ovary remains attached to the abdominal wall by a ligament called **mesovarium**. Each ovary is a compact or solid organ consisting of an outer cortex and inner medulla.
- The stroma of the cortical region is composed of spindle-shaped fibroblasts.
- Cortex is covered by tunica albuginea (dense connective tissue layer), which imparts the whitish colour to the ovary.
- Surface of the ovary is covered by germinal epithelium, which is formed of simple squamous or cuboidal epithelial cells.
- The fluid of the antrum is called **liquor folliculi.**
- Maturing oocyte connects to wall of follicle through cumulus oophorus, which is formed by granulosa cells and remains suspended in the liquor folliculi. The oocyte of mammal is enclosed in a perforated membrane called **zona pellucida**. Next to zona pellucida, cells of inner margin of discus proliferous (cumulus) present a characteristic radial arrangement and is termed as **corona radiata.**
- Follicle itself have three layers, i.e. outer theca externa, middle theca interna and inner membranous granulosa.
- Generally, only one ovum is liberated in each menstrual cycle by alternate ovaries. Average duration of menstrual cycle is 28 days.
- A woman produces about 450 ova in her entire reproductive lifespan. Reproductive life of a girl begins from **menarche** (first menstrual flow about 10-16 years age) and ends by **menopause** (about 40-50 years of age).
- If fertilisation takes place, corpus luteum persists and enlarges by influence of Luteinising Hormone (LH). If fertilisation does not occur then corpus luteum will degenerate and endometrium will separate from uterus.

Accessory Ducts

Following parts constitute the accessory duct system of the female reproductive tract:

(i) **Fallopian tubes** (Oviducts) A pair of long (about 10-12 cm) ciliated, muscular and tubular structures, extending from each ovary to uterus. It helps in conduction of zygote or ovum to uterus.

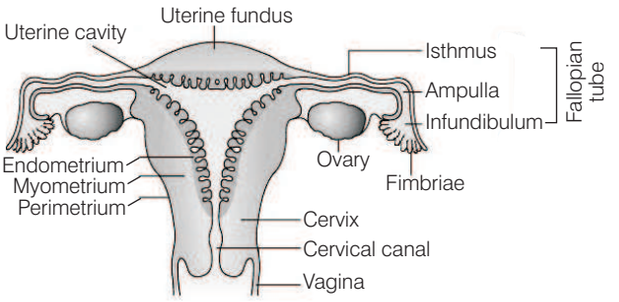
These are also called as **Mullerian ducts**. It consists of **infundibulum** (funnel-shaped part closer to ovary and possess **fimbriae** which helps in ova collection after ovulation), **ampulla** (wider part of oviduct) opens into the third region called **isthmus** (narrow part of duct that links uterus and acts as a fertilisation site, i.e. ampullary isthmic junction).

(ii) **Uterus** (Womb) It is a single, hollow muscular, inverted pear-shaped organ, located in the pelvic region between bladder and rectum and suspended by ligaments called mesometrium.
- It serves as site of foetal growth during pregnancy, takes part in placenta formation and expulsion of the baby during parturition.
- The wall of uterus is composed of three layers of tissues, i.e. **perimetrium** (outer and thin membrane) **myometrium** (middle, thick muscular layer that initiates contractions during parturition) and **endometrium** (inner, glandular, vascular layer that undergoes cycles during menstruation).

- Uterus is divisible into three parts, i.e. **fundus** (upper dome-shape part), **body or cavity** (main and middle part) and **cervix** (long and narrow part of uterus).
  Cervix opens into a structure called vagina which is formed of most powerful sphincter muscles. Cervical canal is cavity of cervix which forms the **birth canal**, along with the vagina.

(iii) **Vagina** It is a fibromuscular elastic tube about 7.5 cm long, into which uterus opens.

- It is highly vascular and lined internally by mucus membrane that forms transverse folds called vaginal rugae.
- Vaginal opening is covered by a membranous hymen, which becomes perforated at puberty, to facilitate menstrual flow.
- Vagina acts both as **copulation canal** (receives sperms during coitus) and **birth canal**.



Diagrammatic view of female reproductive system showing accessory ducts

Accessory Glands

Accessory glands are as follows

(i) **Vestibular glands** There are two types of vestibular glands found in female genitalia, which can be further classified as:

- **Greater vestibular or Bartholin's glands** Pair of small reddish-yellow glands. These are located at each side of vaginal orifice. It's alkaline secretion helps in lubrication and neutralisation of acidic urine.
- **Lesser vestibular glands or paraurethral or Skene's glands** These are numerous small mucus glands present between urethral and vaginal orifices.

(ii) **Mammary glands** Mammary glands or breasts are paired structures containing glandular tissue and variable amount of fat. Glandular tissue is divided into 15-20 mammary lobes, having clusters of cells called **alveoli**.

- The mammary alveolus secretes milk and store in its lumen. These alveoli open into mammary tubules, which join to form mammary duct.
- The numerous mammary ducts connect to form wider ampulla which connects to lactiferous duct from which milk is sucked out.
- Each breast has a nipple (external opening from which milk is drained out) surrounded by circular pigmented area called **areola**.

External Genitalia

Vulva has a depression called the **vestibule** in front of anus which has two apertures, upper external urethra orifice and lower vaginal orifice. The external genitalia includes.

(i) **Mons pubis** It is a cushion of fatty tissue covered by skin and pubic hair.

(ii) **Labia majora** These are fleshy folds of skin extending from mons pubis, surrounding the vaginal orifice. It is homologous to scrotum.

(iii) **Labia minora** These are paired folds of (skin) tissue under labia majora. It contains sebaceous glands. Labia minora fuse anteriorly to form skin fold called prepuce or clitoris.

(iv) **Clitoris** It is a tiny, finger-like structure lying at the upper junction of labia minora. It is an erectile organ (homologous to penis).

(v) **Hymen** The opening of vagina is often covered partially by a membrane called **hymen**.

Menstrual Cycle

- The reproductive cycle in female primates is called as menstrual cycle. It is the regular natural change that occurs in female reproductive system.
- In human females, menstruation is repeated at an average interval of about 28/29 days and the cycle of events starting from one menstruation till the next one is called menstrual cycle.

Phases of Menstrual Cycle

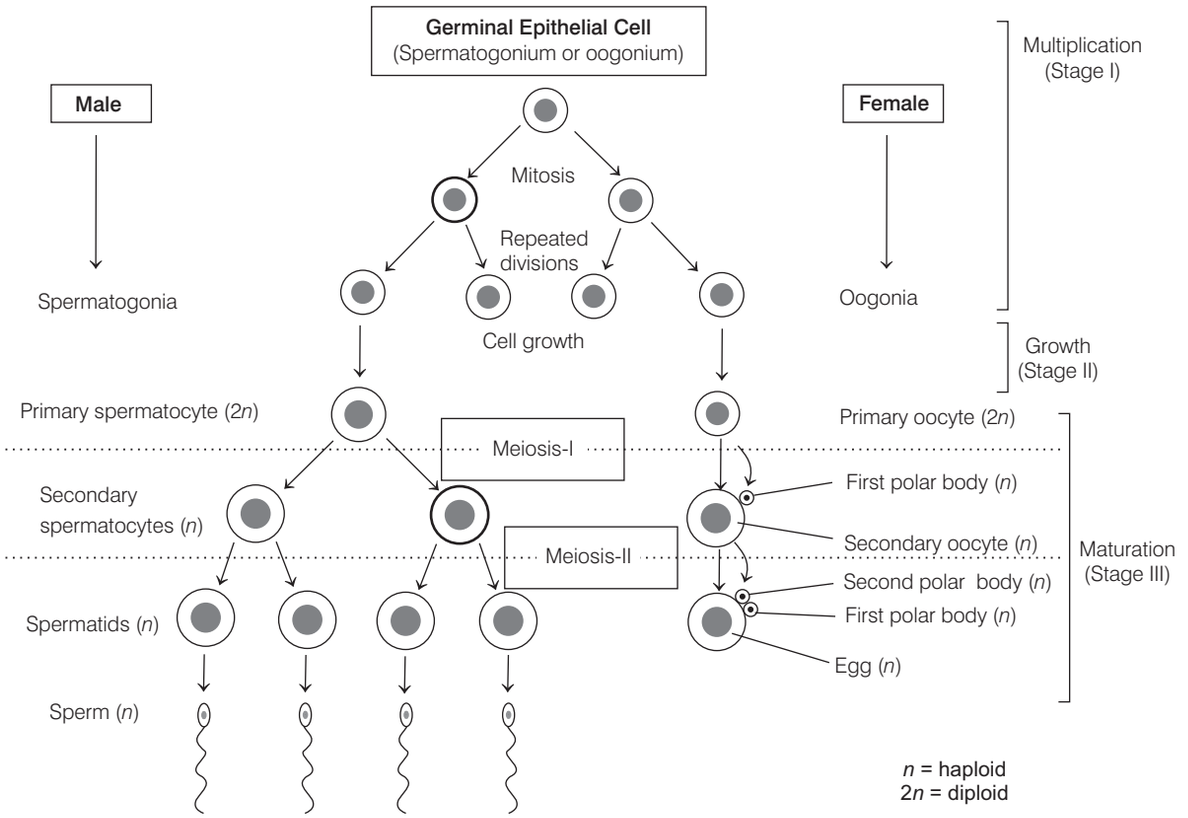
- The first menstruation begins at puberty is called **menarche**. One ovum is released during the middle of each menstrual cycle.
- The cycle starts with the **menstrual phase** and the menstrual flow lasts for 3-5 days. Lack of menstruation may be indicative of pregnancy. However, it may also be caused by stress, poor health, hormonal imbalance, etc. The LH level decreases causing regression of corpus luteum.
- The next phase is **proliferative phase**, in which primary follicles in the ovary grow to become fully mature Graafian follicle. Simultaneously the endometrium of uterus regenerates through proliferation. In the ovulatory phase, both LH and FSH hormone levels attain maximum level during mid cycle called **LH surge**. This induces rupture of Graafian follicle and thereby the release of ovum (ovulation).

- The ovulatory phase is followed by **luteal phase** in which the remaining parts of the Graafian follicle transform as the **corpus luteum.** The corpus luteum secretes large amounts of progesterone, which is needed for the maintenance of endometrium, which is required for implantation of fertilised ovum and other events of pregnancy.
- In the absence of fertilisation, the corpus luteum degenerates. This causes disintegration of endometrium leading to a new cycle of menstruation.
- Menstrual cycle ceases around 50 years of age, i.e. **menopause.**

NOTE Oestrous cycle is the main reproductive cycle of non-primate vertebrates. It consists of cyclic changes in which oestrogen level rises in blood resulting in strong sex urge. It runs only during breeding season.

Gametogenesis

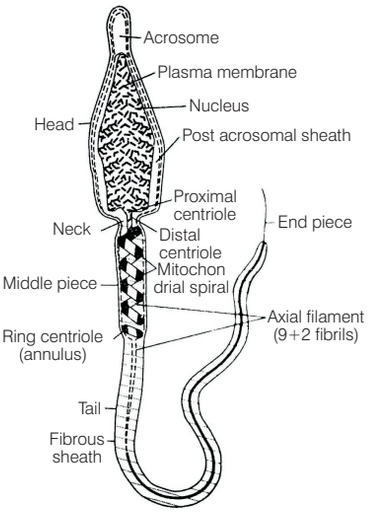
- It is the production of gametes (i.e. both male and female gametes).
- The production of male gametes or sperms is called **spermatogenesis** and the production of female gamete or egg is called **oogenesis**.
- Spermatogenesis occurs in testes and oogenesis in ovaries. Both spermatogenesis and oogenesis involve meiotic division (reduction division), which halves the number of chromosomes from diploid condition (i.e. the presence of two sets of chromosomes) to haploid condition (i.e. the presence of single set of chromosomes).
- Spermatogenesis is a continuous process of sperm production in seminiferous tubules of the testes. Both spermatogenesis and oogenesis start with cells in the outer layer of the gonad known as the **germinal epithelium.**
- Oogenesis is initiated during the embryonic development stage when a couple of million gamete mother cells (oogonia) are formed within each foetal ovary, no more oogonia are formed and added after birth.
- Spermatogenesis and oogenesis involve three stages, multiplication, growth and maturation stage (See diagram for further detail).



Summary of gametogenesis in male and female

Structure of Sperm

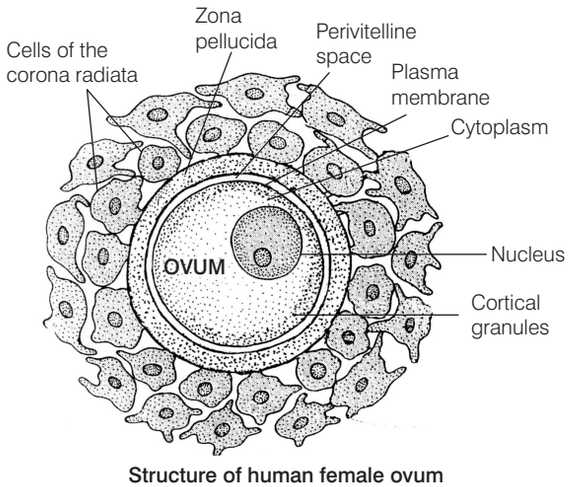
- It is a microscopic structure composed of head, neck, middle piece and a tail. It is the male gamete.
- The sperm head contains an elongated haploid nucleus, the anterior portion of which is covered by a cap-like structure acrosome.



Structure of mature human sperm

Structure of Ovum

- It is a non-cledoic, alecithal and microscopic structure with about 100-130 µm diameter. It is the female gamete.
- It grows from the primitive germ cells that are embedded in substances of ovary.
- The ovum possesses three coverings, i.e. inner plasma membrane, middle glycoprotein, zona pellucida and outer cellular corona radiata.
- The uppermost pole of an egg that is the site of maturation division is called **animal pole**. The lower pole of the ovum that is opposite to animal pole is **vegetal pole**.



Structure of human female ovum

Fertilisation

- It is the process of fusion of a sperm with an ovum. During fertilisation, a sperm comes in contact with the zona pellucida layer of the ovum and induces changes in the membrane that blocks the entry of additional sperms.
- The secretions of the acrosome help the sperm to enter into the cytoplasm of the ovum through the zona pellucida and the plasma membrane.
- The sperms in the female's genital tract are made capable of fertilising the egg by secretions of the female genital tract. These secretions alter or remove certain molecules from semen. This process is known as **capacitation.**
- Important sperm lysins are hyaluronidase (that acts on ground substance of follicle cells), corona penetrating enzyme (that dissolves corona radiata) and zona lysine or acrosin (that helps to digest the zona pellucida).
- Optimum pH, Ca and Mg^{2+} ions concentration and temperature are essential for acrosomal reaction.
- This induces the completion of the meiotic division of secondary oocytes. The second meiotic division is also unequal and results in the formation of second polar body and a haploid ovum.
  Soon the haploid nucleus of the sperm and that of ovum fuse together and form a diploid zygote. Zygote is the result of fertilisation. It has 46 chromosomes in contrast to haploid sperm (23 chromosomes) and ovum (23 chromosomes).

Implantation

The embedding of blastocyst to the uterine wall, with the side containing the inner mass positioned against the endometrium is called implantation.

The implantation of embryo follows the steps given below in female reproductive tract:

- After 30 hrs of fertilisation first cleavage completes which divides the zygote into two equal sized **blastomeres** (holoblastic cleavage).
- These mitotic divisions continue as the zygote moves from isthmus (of oviduct) to uterus, resulting in 2, 4, 8, 16 cells or blastomeres. The zygote with 16-32 cells is called **morula**.
- Further continuous divisions in morula transforms it into **blastocyst** or **blastula**. This process is called **blastulation**.
- The blastomeres in the blastocyst are arranged into an outer layer called **trophoblast** and the inner group of cells attached to trophoblast called the **inner cell mass**.
- The trophoblast layer then gets attached to the endometrium and the inner cell mass differentiates into the embryo. After attachment, the uterine cells divide rapidly and cover the blastocyst.

- As a result, the blastula becomes embedded in the endometrium of the uterus. This process is called **implantation**. Immediately after implantation, the blastula procedes to the formation of the gastrula in which the germ layers of embryo forms. This process is called **gastrulation**.

Placenta

- For the first few days after implantation, finger like projections appears on the trophoblast called **chorionic villi,** surrounded by the uterine tissue and maternal blood.
- During development placenta passes through three stages of villi formation, i.e. **primary villi** (only syncytiotrophoblast and cytotrophoblast involve), **secondary villi** (made up of A + B + C mesoderm) and **tertiary villi** (made up of A + B + C + fetal blood vessels).
- The endometrial secretions provides the nutrition to the implanted embryo. Afterwards a connection, is formed by the mother as well as foetus, comes into the role and is known as **placenta**.
- It develops from chorion. The foetal part of placenta is termed as **chorion** and the maternal part is termed as **decidua basalis**.
  - The placenta acts as an ultrafilter, as a kidney, lungs and alimentary tract of the foetus.
  - The **umbilical cord** serves as a mediator between foetus and placenta. It helps in the transport of substances to and from the embryo.
    Two foetal umbilical arteries and one umbilical vein spiral about each other in the umbilical cord. In placenta, maternal blood is separated from foetal blood (placental barrier).

Parturition

- The time period during which the embryo remains in the uterus, i.e. after the last day of menstruation to the day of parturition is called **gestation** period, which in humans is about 9 months. Vigorous contraction of the uterus at the end of pregnancy causes expulsion/delivery of the foetus.
- This process of delivery of the foetus (child birth) is called **parturition.** It is induced by a complex neuroendocrine mechanism.
- The signals of parturition originate from the fully developed foetus and the placenta, which induce mild uterine contractions called **foetal-ejection reflex.** It triggers the release of **oxytocin** from the maternal pituitary which promotes contractions of uterine muscles and in turn stimulate further secretion of oxytocin. The stimulatory reflex between the uterine contraction and oxytocin secretion continues resulting in stronger contractions.
- This leads to the expulsion of the baby out of the uterus through the birth canal, i.e. parturition. Soon after the birth of baby, placenta is also expelled out. Relaxin hormone relaxes the pelvic ligaments of mother to prepare for the childbirth.

Lactation

- The mammary glands in females undergo differentiation during pregnancy. The production and release of milk by mammary glands of female after birth of a young one is called **lactation**.
- After parturition, the primary stimulus for milk formation (prolactin production) is the sucking action of baby. A nerve impulse is sent to hypothalamus by the stretch receptors in the breast.
- This impulse inhibits the hormone called Prolactin Inhibiting Hormone (PIH) and stimulates another hormone called Prolactin Releasing Hormone (PRH).
- Increased PRH triggers the release of **Prolactin** from the anterior pituitary which then circulates to the alveoli of mammary gland and promotes lactation.
- Once milk is formed, it is ejected by the action of another hypothalamic hormone called **Oxytocin** (OT). The primary stimulus for the production of oxytocin is also sucking action of baby.
- The milk produced during the initial few days of lactation is called **colostrum**. It contains several antibodies, which provide passive immunity to the newborn. Exclusive breast feeding is recommended for initial 6 months for bringing up a healthy baby.

Embryonic Development

The three germ layers of embryo formed are **ectoderm** (outer layer), **endoderm** (inner layer) and **mesoderm** (develop between ectoderm and endoderm).

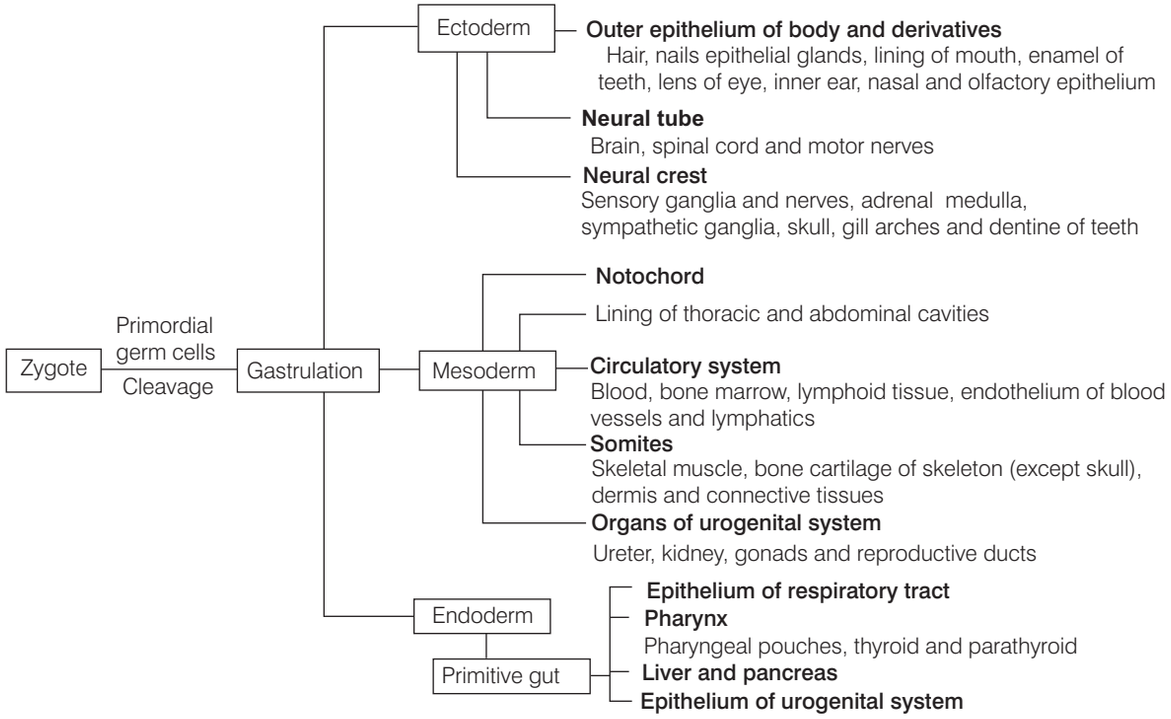
The establishment of the germ layers initiates the final phase, i.e. embryonic development, during which they give rise the specific tissues, organs and organ system. This process is called **organogenesis**.

So, the development of embryo can be summerised as:

Zygote → Morula → Blastula → Gastrula → Embryo

The germ layers have almost the same fate in all animals.

Various organs derived from different germ layers are as follows



A Summary of Human Pregnancy

Development Stage	Description
Zygote	Single cell resulting from the fusion of a sperm nucleus with the nucleus of a secondary oocyte at fertilisation; zygote usually forms in the oviduct.
Morula	Solid ball of about 16 cells called blastomeres, produced through cleavages of the zygote.
Blastocyst	Ball of cells with a surface layer (the trophoblast) and an inner cell mass. Produced after the morula enters the uterus then, fluid enters the ball and lifts some cells to form a cavity.
Embryo	Embryo refers to all developmental stages from two weeks after fertilisation (at which time the inner cell mass forms a two layer embryonic disk) until the end of the 8th week. All major body structures begin forming during the embryonic period.
Foetus	Foetus refers to all developmental stages from the 19th week until birth, about 38th weeks after fertilisation. The rate of overall growth and structural elaborations increases dramatically during the foetal period.
Newborn	Baby from 0-28 days is called neonate, which can be divided into early neonate (0-7 days and late neonate (7-28 days). The physiological transition from life in the uterus to life in the external world requires many gradual changes, as in respiration.
Infant	Individual from 4 week to 1 year after birth. During infancy, body weight triples and height doubles, on the average.

Reproductive Health

- World Health Organisation (WHO) states that reproductive health is a total well-being in all aspects of reproduction, i.e. physical, emotional, behavioural and social.
- Reproductive health programmes are important in the areas of better awareness about sex-related matters, increased number of medically assisted deliveries and better postnatal care leading to decreased maternal and infant mortality rates, increased number of couples with small families, better detection and cure of STDs and overall increased medical facilities for all sex-related problems, etc. All these aspects indicate improved reproductive health of the society.
- India first initiated the action plans and programmes in 1957 at the national level to attain total reproductive health. These programmes are called **Family Planning Programmes**. Currently, they are called as R**eproductive and Child Healthcare** (RCH) **Programmes**.

Objectives of Reproductive Health

The objectives and requirement of RCH programmes are as follows

- To create awareness among people for reproduction related aspects. Provide facilities and support for building up a reproductively healthy society.
- Introduction of sex-education in schools to give right information.

Educating infertile couples and those in marriageable age group about the following

(i) Birth control options

(ii) Care of pregnant women

(iii) Postnatal care of mother and child

(iv) Importance of breastfeeding.

(v) Various assisted reproductive technologies available for infertile couple.

Population Explosion

Uncontrolled increase in population leads to high pressure on resources and food. Therefore, birth control is required.

The reasons for population explosion are as follows

(i) Decline in death rate, maternal and infant mortality rate due to increased medical facilities and improved technologies.

(ii) Increase in the number of people in the reproductive age. Therefore, control of population explosion is necessary.

Birth Control or Contraception

The population growth can be controlled only by adopting suitable contraceptive methods. Some other ways include

(i) Raising the marriageable age to 18 for females and 21 for males.

(ii) Incentives given to couples with small families.

Methods of Birth Control

- **Natural methods** of contraception work on the principle of avoiding chances of meeting gametes. This can be done by following periodic abstinence, coitus interruptus and lactational amenorrhoea.
- **Barrier methods** for fertilisation are based on preventing ovum and sperm coming closer. This is done with the help of condoms, diaphragms, cervical caps, spermicidal creams, etc. Intra-Uterine Devices (IUDs) are introduced into the uterus. The IUDs in use are Lippes loop, Cu-T, Cu-7, multiload 375, LNG 20, etc. The Cu ions released by IUDs suppress sperm motility.
- **Oral contraceptives** are hormonal preparations used as pills, e.g. Saheli (once a week pill). Injections and implants are progesterone-oestrogen combination. Their effective period is longer than pills.
- **Surgical methods** block the transport of gametes and thereby prevent conception. Vasectomy is used in males and tubectomy in females. Vasectomy and tubectomy are permanent methods of contraception.

Medical Termination of Pregnancy (MTP)

- Voluntary or intentional termination of pregnancy before full term is called Medical Termination of Pregnancy (MTP) or induced abortion. MTP has been legalised by the government of India in 1971 with strict conditions to avoid its misuse, especially in case of illegal female foeticide.
- MTPs are safe during first trimester (up to 12 weeks of pregnancy) after that MTPs are riskier.

Sexually Transmitted Diseases (STDs)

Diseases or infections, which are transmitted through sexual contact are called **Sexually Transmitted Diseases** (STDs) or Veneral Diseases (VDs) or Reproductive Tract Infections (RTI). The infections could be avoided/prevented by the following practices

- Avoiding sex with unknown partner or multiple partners.
- Using condoms during coitus.
- Seeking medical help in case of doubt and getting it completely cured.

Some examples of STDs are syphilis, gonorrhoea, chlamydiasis, trichomoniasis, AIDS, hepatitis-B, genital herpes, etc.

Reproductive Techniques

There are special techniques called **Assisted Reproductive Technologies** (ART) to help infertile couples to produce children. These techniques are as follows

1. ***In Vitro* Fertilisation** (IVF) or test tube baby programme is the method in which ova from the wife or a donor female and the sperms from the husband or a donor allowed to fuse under controlled conditions in the laboratory. IVF can be done in two ways
   - **Zygote Intra Fallopian Transfer** (ZIFT) In this method, zygote or embryo up to eight blastomeres stage is transferred into the Fallopian tube.
   - **Intra Uterine Transfer** (IUT) Here, embryos with more than eight blastomeres are transferred directly into the uterus in this method.
2. **Gamete Intra Fallopian Transfer** (GIFT) It is a method in which transfer of an ovum collected from a donor female into another female is done, who cannot produce ova but can provide suitable conditions for fertilisation and further development of the foetus up to parturition.

3. **Intra Cytoplasmic Sperm Injection** (ICSI) In it, sperm is directly injected into the ovum to form an embryo in the laboratory and then embryo transfer is carried out. It is used in case of male infertility or low sperm count.
4. **Artificial Insemination** (AI) In this, semen is collected from the husband or a healthy donor and artificially introduced into the vagina or into the uterus. This method is used in such cases, where infertility is due to the inability of the male partner to inseminate the female or due to very low sperm counts in the ejaculates.

Amniocentesis

- It is a prenatal diagnostic technique, in which a sample of amniotic fluid from the womb of a pregnant woman is taken during the early stages of foetal development and the cells are cultured and analysed.
- This technique helps in diagnosis of chromosomal abnormalities, the sex of the foetus and the development disorders could be detected. However, it is being misused by some people for destroying the female foetuses.

DAY PRACTICE SESSION 1

FOUNDATION QUESTIONS EXERCISE

1. Which of the following is not a secondary sexual feature in males?

(a) Low pitched voice (b) Beard and moustache
(c) Muscular build up (d) Absence of facial hair

2. The female hormone that causes deposition of fat in the breasts and hips, as well as growth of pubic hair, during puberty is

(a) luteinising hormone
(b) follicle-stimulating hormone
(c) oestrogen
(d) progesterone

3. The vas deferens receives duct from the seminal vesicle and opens into urethra as

(a) epididymis (b) ejaculatory duct
(c) efferent ductule (d) ureter

4. Which of these cells help in negative feedback control of sperm?

(a) Leydig cells (b) Sertoli cells
(c) Spermatogenic cells (d) Germ cells

5. Sertoli cells are found in/between the

(a) seminiferous tubules
(b) germinal epithelium of seminiferous tubules
(c) germinal epithelium of ovary
(d) None of the above

6. Spot the odd one out from the following structures with reference to the male reproductive system

(a) Rete testis (b) Epididymis
(c) Vasa efferentia (d) Isthmus

7. Seminal plasma, the fluid part of semen is contributed by

I. Seminal vesicle II. Prostate
III. Urethra IV. Bulbourethral gland

(a) I and II (b) I, II and IV
(c) II, III and IV (d) I and IV

8. Which of the following depicts the correct pathway?

(a) Rete testis → Efferent ductules → Epididymis → Vas deferens
(b) Rete testis → Epididymis → Efferent ductules → Vas deferens
(c) Rete testis → Vas deferens → Efferent ductules → Epididymis
(d) Efferent ductules → Rete testis → Vas deferens → Epididymis

9. Which part of ovary in mammals acts as an endocrine gland after ovulation?

(a) Graafian follicle (b) Stroma
(c) Germinal epithelium (d) Vitelline membrane

10. In females, inhibin is secreted by

(a) Sertoli cells
(b) Granulosa cells of ovarian follicles
(c) Leydig cells
(d) Cowper's glands

11. Capacitation occurs in → NEET 2017

(a) rete testis
(b) epididymis
(c) vas deferens
(d) female reproductive tract

12. The anterior most structure of vulva is

(a) labia minora (b) labia majora
(c) mons pubis (d) hymen

13. The pigmented area present in each mammary gland externally is called

(a) sweat gland (b) ampulla
(c) lactiferous duct (d) areola

14. Ovulation takes place in a month during

(a) 11-14 days (b) 14-16 days
(c) 15-28 days (d) 21-28 days

15. After ovulation, Graafian follicle forms

(a) corpus arteria (b) corpus luteum
(c) corpus albicans (d) corpus callosum

16. A temporary endocrine gland in the human body is → NEET 2017

(a) pineal gland (b) corpus cardiacum
(c) corpus luteum (d) corpus allatum

17. Both corpus luteum and macula lutea are

(a) found in human ovaries
(b) a source of hormones
(c) characterised by a yellow colour
(d) contributory in maintaining pregnancy

18. At menopause, there is rise in urinary excretion of

(a) STH (b) FSH (c) LTH (d) MSH

19. In the human female, menstruation can be deferred by the administration of

(a) LH only
(b) combination of FSH and LH
(c) combination of oestrogen and progesterone
(d) FSH only

20. The mature oocytes are attached to the wall of follicle with the help of

(a) endometrium (b) corpus luteum
(c) cumulus oophorus (d) zona pellucida

21. Oestrous cycle is the characteristic of

(a) human females
(b) mammalian females
(c) primate females
(d) non-primate females

22. Changes in GnRH pulse frequency in females is controlled by circulating levels of → NEET-I 2016

(a) oestrogen and inhibin
(b) progesterone only
(c) progesterone and inhibin
(d) oestrogen and progesterone

23. Select the incorrect statement. → NEET-I 2016

(a) LH and FSH trigger ovulation in ovary
(b) LH and FSH decrease gradually during the follicular phase
(c) LH triggers secretion of androgens from the Leydig cells
(d) FSH stimulates the Sertoli cells which help in spermiogenesis

24. Mature Graafian follicle is generally present in the ovary of a healthy human female around

(a) 5-8 days of menstrual cycle
(b) 11-17 days of menstrual cycle
(c) 18-23 days of menstrual cycle
(d) 24-28 days of menstrual cycle

25. Which of the following is correct?

(a) Average duration of menstrual cycle is 38 days
(b) Follicle is matured after 21 days
(c) A woman produces about 250 ova in her entire reproductive lifespan
(d) Generally, only one ovum is liberated in each menstrual cycle by alternate ovaries

26. Initial steps of oogenesis occur

(a) prior to birth in 25 weeks old foetus
(b) during menstrual cycle
(c) during menopause
(d) during fertilisation

27. Which of the following stages of spermatogenesis involves meiotic division?

(a) Multiplication stage (b) Growth stage
(c) Maturation stage (d) None of these

28. The differentiation of spermatids into spermatozoa is called

(a) spermatogenesis (b) spermiogenesis
(c) spermatocytogenesis (d) spermatids

29. Which of the following does not have any role in oogenesis?

(a) Polar body (b) Oocyte
(c) Primary follicle (d) FSH

30. Which of the following are diploid cells?

(a) Primary oocyte and primary spermatocyte
(b) Secondary oocyte and secondary spermatocyte
(c) Spermatid and egg
(d) Sperm and fertilised egg

31. The production of gametes, sperm and ova are called

(a) gametogenesis, spermatogenesis and oogenesis, respectively
(b) spermatogenesis, gametogenesis and oogenesis, respectively
(c) oogenesis, spermatogenesis and gametogenesis, respectively
(d) meiosis, mitosis and amitosis, respectively

32. Which of the following statements is true?

(a) Sperms are not motile until they pass through the epididymis
(b) Sperms require capacitation in the female reproductive tract before they can fertilise an ovum
(c) A secondary oocyte does not complete meiotic division until it has been fertilised
(d) All of the above are true

33. The difference between spermiogenesis and spermiation is → NEET 2018

(a) in spermiogenesis, spermatozoa from Sertoli cells are released into the cavity of seminiferous tubules, while in spermiation, spermatozoa are formed
(b) in spermiogenesis, spermatozoa are formed, while in spermiation, spermatids are formed
(c) inspermiogenesis, spermatids are formed, while in spermiation, spermatozoa are formed
(d) in spermiogenesis, spermatozoa are formed, while in spermiation, spermatozoa are released from Sertoli cells into the cavity of seminiferous tubules

34. Human egg is

(a) microlecithal (b) mesolecithal
(c) macrolecithal (d) alecithal

35. The membranous cover of the ovum at ovulation is

(a) corona radiata (b) zona radiata
(c) zona pellucida (d) chorion

36. Which of the following is not correct?

(a) Golgi complex of spermatid gives rise to acrosome
(b) Two centrioles are present in spermatozoa
(c) Mitochondria are absent in spermatozoa
(d) Spermatozoa consists of head, body and tail

37. A cross-section at the midpoint of the middle piece of a human sperm will show

(a) centriole, mitochondria and 9+2 arrangement of microtubules
(b) centriole and mitochondria
(c) mitochondria and 9+2 arrangement of microtubules
(d) 9+2 arrangement of microtubules only

38. A mammalian ovum fails to get fertilised, which one of the following is unlikely?

(a) Corpus luteum will disintegrate
(b) Oestrogen secretion further decreases
(c) Primary follicle starts developing
(d) Progesterone secretion rapidly declines

39. Fertilisation in humans is practically feasible only if

➞ NEET-I 2016

(a) the ovum and sperms are transported simultaneously to ampullary-isthmic junction of the Fallopian tube
(b) the ovum and sperms are transported simultaneously to ampullary-isthmic junction of the cervix
(c) the sperms are transported into cervix within 48 hrs of release of ovum in uterus
(d) the sperms are transported into vagina just after the release of ovum in Fallopian tube

40. Implantation of the blastocyst occurs

(a) just prior to conception (b) one week after fertilisation
(c) at one month's gestation (d) just prior to birth

41. Hormones secreted by the placenta to maintain pregnancy are ➞ NEET 2018

(a) hCG, hPL, progestogens, oetrogens
(b) hCG, hPL, oestrogens, relaxin, oxytocin
(c) hCG, hPL, progestogens, prolactin
(d) hCG, progestogens, oestrogens, glucocorticoids

42. Which one of the following is not the function of placenta? It

(a) secretes oestrogen
(b) facilitates removal of carbon dioxide and waste material from embryo
(c) secretes oxytocin during parturition
(d) fecilitates supply of oxygen and nutrients to embryo

43. Which of the following is not correct?

(a) The embryo develops up to blastocyst stage in Fallopian tube
(b) Fallopian tube conveys ovum from the ovary to the uterus through peristalsis
(c) Implantation takes place after 25 days of fertilisation
(d) Cowper's glands are present in male mammals

44. Gastrulation comprises

(a) differentiation of archenteron
(b) morphogenetic movements
(c) differentiation of three germ layers
(d) All of the above

45. Blastopore is the opening to the exterior of

(a) coelom (b) coelenteron
(c) archenteron (d) blastocoel

46. Cleavage differs from mitosis because

(a) in cleavage, there is no growth phase
(b) in cleavage, consumption of oxygen increases
(c) in cleavage, nucleus-cytoplasmic ratio increases
(d) All of the above

47. Which of these is not an important component of initiation of parturition in humans? ➞ CBSE-AIPMT 2015

(a) Increases in oestrogen and progesterone ratio
(b) Synthesis of prostaglandins
(c) Release of oxytocin
(d) Release of prolactin

48. The contraceptive 'SAHELI' ➞ NEET 2018

(a) is an IUD
(b) increases the concentration of oestrogen and prevents ovulation in females
(c) blocks oestrogen receptors in the uterus, preventing eggs from getting implanted
(d) is a post-coital contraceptive

49. Condoms are one of the most popular contraceptives because of the following reasons.

(a) These are effective barriers for insemination
(b) They do not interfere with coital act
(c) These help in reducing the risk of STDs
(d) All of the above

50. Choose the right one among the statements given below.

(a) IUDs are generally inserted by the user herself
(b) IUDs increases phagocytosis reaction in the uterus
(c) IUDs suppress gametogenesis
(d) IUDs once inserted need not to be replaced

51. Viagra (sildenafil citrate), which is used for the treatment of erectile dysfunction acts by blocking the enzyme

(a) *c*GMP phosphodiesterase, which breaksdown *c*GMP
(b) *c*GMP phosphodiesterase, which synthesises *c*GMP
(c) *A*TPase, which breaksdown ATP
(d) ATPase, which synthesises ATP

52. The function of copper ions in copper releasing IUDs is → NEET 2017

(a) they suppress sperm motility and fertilising capacity of sperms
(b) they inhibit gametogenesis
(c) they make uterus unsuitable for implantation
(d) they inhibit ovulation

53. One of the legal methods of birth control is → NEET 2013

(a) by abstaining from coitus from day 10 to 17 of the menstrual cycle
(b) by having coitus at the time of day break
(c) by a premature ejaculation during coitus
(d) abortion by taking an appropriate medicine

54. In case of a couple, where the male is having a very low sperm count, which technique will be suitable for fertilisation? → NEET 2017

(a) Intrauterine transfer
(b) Gamete Intracytoplasmic Fallopian transfer
(c) Artificial insemination
(d) Intracytoplasmic sperm injection

55. Assisted reproductive technology does not include

(a) zygote extra Fallopian transfer
(b) *in vitro* fertilisation and embryo transfer
(c) artificial insemination
(d) gamete intra Fallopian transfer

56. Embryo with more than 16 blastomeres formed due to in *vitro* fertilisation is transferred into → NEET-II 2016

(a) uterus
(b) Fallopian tube
(c) fimbriae
(d) cervix

57. A childless couple can be assisted to have a child through a technique called GIFT. The full form of this technique is

(a) Gamete Inseminated Fallopian Transfer
(b) Gamete Intra Fallopian Transfer
(c) Gamete Internal Fertilisation and Transfer
(d) Germ Cell Internal Fallopian Transfer

58. In context of amniocentesis, which of the following statements in incorrect? → NEET-I 2016

(a) It is used for prenatal sex-determination
(b) It can be used for detection of Down syndrome
(c) It can be used for detection of cleft palate
(d) If is usually done when a woman is between 14-16 weeks pregnant

59. Match the following columns.

	Column I		Column II
A.	Spermatogenesis	1.	Uterus
B.	Corpus luteum	2.	Testosterone
C.	Foetus	3.	Seminiferous tubule
D.	Leydig cells	4.	Oestrogen
		5.	Progesterone

Codes

	A	B	C	D
(a)	3	5	1	2
(b)	2	1	5	4
(c)	4	5	2	1
(d)	3	1	2	4

Directions (Q. Nos 60-62) *In each of the following questions a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as*

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion
(b) If both Assertion and Reason are true, but Reason is not it correct explanation of Assertion
(c) If Assertion is true, but Reason is false
(d) If both Assertion and Reason are false

60. **Assertion** Semen is a collective product of the testes, seminal vesicles and prostate gland.
Reason Cowper's glands, seminal vesicles and prostate gland constitute the accessory genital glands.

61. **Assertion** A chemical substance fertilizin is present in eggs.
Reason It helps in maturation of embryo after fertilisation.

62. **Assertion** Amniocentesis is often misused.
Reason Amniocentesis is meant for determining the genetic disorders in the foetus, but it is being used to determine the sex of the foetus, so that female foetus may aborted.

DAY PRACTICE SESSION 2

PROGRESSIVE QUESTIONS EXERCISE

1. The lytic enzyme released by sperm is

(a) acrosome (b) ligase
(c) androgamone (d) hyaluronidase

2. Foetus developing in the genital tract without getting nourishment from the mother is a case of

(a) vivipary (b) ovipary
(c) ovovivipary (d) None of these

3. The structure that helps scrotum in remaining connected with pelvic cavity is

(a) inguinal canals
(b) cremaster muscles
(c) connective tissue
(d) dartos muscles

4. Copper releasing IUD from those given below are

(a) CUT (b) Lippes loop
(c) LNG 20 (d) Progestart

5. Which of the foetal membrane is directly connected with blood?

(a) Allantois (b) Amnion
(c) Chorion (d) Yolk sac

6. Which of the following signalling molecules is responsible for erectile function?

(a) Acetylcholine (b) Nitric oxide
(c) Dopamine (d) Carbon dioxide

7. The amnion of mammalian embryo is derived from

(a) mesoderm and trophoblast
(b) endoderm and mesoderm
(c) ectoderm and mesoderm
(d) ectoderm and endoderm

8. Intracytoplasmic sperm injection is normally performed in case of

(a) low sperm count
(b) low motility of sperms
(c) azoospermia
(d) All of the above

9. Termination of gastrulation is marked by

(a) obliteration of archenteron
(b) closure of neural tube
(c) obliteration of lastocoel
(d) None of the labove

10. In human, the foetus

(a) has four extraembryonic membranes
(b) has developed organs and is recognisably human
(c) is dependent upon the placenta for excretion of wastes and acquisition of nutrients
(d) All of the above

11. The function of hyaluronidase in fertilisation is

(a) to form cone of reception in egg
(b) to puncture the vitelline membrane of egg
(c) to inactivate the neighbouring sperms
(d) None of the above

12. Grey crescent is the area

(a) at the point of entry of sperm into ovum
(b) just opposite to the site of entry of sperm into ovum
(c) at the animal pole
(d) at the vegetal pole

13. Which of the following cells secrete a glycoprotein hormone called inhibin, which is involved in the negative feedback control of sperm production?

(a) Leyding cells (b) Sertoli cells
(c) Prostate gland (d) Interstitial cells

14. Intensely lactating mothers do not generally conceive due to the

(a) suppression of gonadotropins
(b) hypersecretion of gonadotropins
(c) suppression of gametic transport
(d) suppression of fertilisation

15. Inflammation of the seminiferous tubules will interfere with its ability to

(a) produce spermatozoa
(b) make semen alkaline
(c) secrete testosterone hormone
(d) eliminate urine from the body

16. The technique used for retrieving the egg from the patient while performing IVF is known as

(a) transvaginal oocyte retrieval technique
(b) transuterine oocyte retrieval technique
(c) transovarian oocyte retrieval technique
(d) None of the above

17. Acrosomal reaction of the sperm occurs due to

(a) its contact with zona pellucida of the ova
(b) reactions within the uterine environment of the female
(c) reactions within the epididymal environment of the male
(d) androgens produced in the uterus

18. Which of the following in not correct?

(a) Fertilizin is present in the surface of egg
(b) Antifertilizin is present on the surface of spermatozoa
(c) Fertilisation between different species is prevented due to species specific reaction between fertilizin and antifertilizin
(d) Cleavage involves cell division with increase in growth

19. Which of the following is not correctly matched?

(a) Equal holoblastic — Marsupials cleavage
(b) Unequal holoblastic — Amphibians cleavage
(c) Meroblastic cleavage — Humans
(d) Radial cleavage — *Synapta paracentrotums*

20. Following statements are given regarding MTP. Choose the correct options given below.

I. MTPs are generally advised during first trimester.
II. MTPs are used as a contraceptive method.
III. MTPs are always surgical.
IV. MTPs require the assistance of qualified medical personnel.

(a) II and III (b) III and IV
(c) I and IV (d) I and II

21. Identify the correct statement on inhibin

(a) It is produced by granulosa cells in ovary and inhibits the secretion of FSH
(b) It is produced by granulosa cells in ovary and inhibits the secretion of LH
(c) It is produced by nurse cells in testes and inhibits the secretion of LH
(d) It inhibits the secretion of LH, FSH and prolactin

22. Which of the following approaches does not give the defined action of contraceptive?

(a)	Intrauterine devices	increases phagocytosis of sperms, suppress sperm motility and fertilising capacity of sperms
(b)	Hormonal contraceptives	prevent/retard entry of sperms, prevent ovulation and fertilisation
(c)	Vasectomy	prevents spermatogenesis
(d)	Barrier methods	prevent fertilisation

23. Fertilisation in humans is practically feasible only if

(a) the ovum and sperms are transported simultaneously to ampullary isthmic junction of the Fallopian tube
(b) the ovum and sperms are transported simultaneously to ampullary isthmic junction of the cervix
(c) The sperms are transported into cervix within 48 hrs of released of ovum in uterus
(d) the sperms are transported into vagina just after the release of ovum in Fallopian tube

24. Diaphragm are contraceptive devices used by the females. Choose the correct option from the statements given below.

I. They are introduced into the uterus.
II. They are placed to cover the cervical region.
III. They act as physical barriers for sperm entry.
IV. They act as spermicidal agents.

(a) I and II (b) I and III
(c) II and III (d) III and IV

25. Match the following columns.

	Column I		Column II
A.	A hollow ball of cells	1.	Cleavage
B.	Outer germ layer	2.	Blastula
C.	Cavity within a blastula	3.	Blastocoel
D.	Division of embryo	4.	Ectoderm

Codes

	A	B	C	D
(a)	2	4	3	1
(b)	1	4	3	2
(c)	4	3	2	1
(d)	3	1	4	2

26. Match the following columns.

	Column I		Column II
A.	Proliferative phase	1.	Breakdown of endometrial lining
B.	Secretory phase	2.	Follicular phase
C.	Menstruation	3.	Luteal phase

Codes

	A	B	C
(a)	2	3	1
(b)	1	3	2
(c)	3	2	1
(d)	3	1	2

27. Match the following columns.

	Column I		Column II
A.	Gonorrhoea	1.	HIV
B.	Syphilis	2.	*Neisseria*
C.	Genital warts	3.	*Treponema*
D.	AIDS	4.	Human Papilloma Virus

Codes

	A	B	C	D
(a)	2	3	4	1
(b)	3	4	1	2
(c)	4	2	3	1
(d)	4	3	2	1

28. Match column I with column II and select the correct option using the codes given below.

	Column I		Column II
A.	Mons pubis	1.	Embryo formation
B.	Antrum	2.	Sperm
C.	Trophectoderm	3.	Female external genitalia
D.	Nebenkern	4.	Graafian follicle

Codes

	A	B	C	D
(a)	3	4	2	1
(b)	3	4	1	2
(c)	3	1	4	2
(d)	1	4	3	2

Directions (Q. No. 29-30) *In each of the following questions, a statement of Assertion is given followed by the corresponding statements of Reason. Of the statement, mark the correct answer as*

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion

(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion

(c) If Asertion is true but Reason is false

(d) If both Assertion and Reason are false

29. **Assertion** First meiotic division in primary oocytes results in the formation of two equal sized cells.

Reason Both of these cells are equally functional.

30. **Assertion** Sertoli cells are being involved in the process of spermatogenesis.

Reason Nutrition of developing sperm is provided by Sertoli cells.

ANSWERS

SESSION 1	**1** (d)	**2** (c)	**3** (b)	**4** (b)	**5** (b)	**6** (d)	**7** (b)	**8** (a)	**9** (a)	**10** (b)
	11 (d)	**12** (c)	**13** (d)	**14** (b)	**15** (b)	**16** (c)	**17** (c)	**18** (b)	**19** (c)	**20** (c)
	21 (d)	**22** (d)	**23** (b)	**24** (d)	**25** (d)	**26** (a)	**27** (c)	**28** (b)	**29** (a)	**30** (a)
	31 (a)	**32** (d)	**33** (d)	**34** (d)	**35** (a)	**36** (c)	**37** (c)	**38** (b)	**39** (a)	**40** (b)
	41 (a)	**42** (c)	**43** (c)	**44** (d)	**45** (c)	**46** (d)	**47** (d)	**48** (c)	**49** (d)	**50** (b)
	51 (a)	**52** (a)	**53** (d)	**54** (c)	**55** (a)	**56** (a)	**57** (b)	**58** (c)	**59** (a)	**60** (b)
	61 (c)	**62** (a)								
SESSION 2	**1** (d)	**2** (c)	**3** (a)	**4** (a)	**5** (c)	**6** (b)	**7** (c)	**8** (d)	**9** (a)	**10** (d)
	11 (b)	**12** (b)	**13** (b)	**14** (a)	**15** (a)	**16** (a)	**17** (a)	**18** (b)	**19** (c)	**20** (c)
	21 (a)	**22** (c)	**23** (a)	**24** (c)	**25** (a)	**26** (a)	**27** (a)	**28** (b)	**29** (d)	**30** (b)