HUMAN REPRODUCTION

- Humans are sexually reproducing and viviparous (give birth to young ones) organisms. The reproductive units in sexual reproduction are specialised cells called gametes (sperms in males and ova in females).
- The union of sperm and egg cell produces a fertilized egg, or zygote, that develops by mitotic division into a new multicellular organism.
- Manis unisexual and reveals distinct sexual dimorphism. Male visibly differs from the female in physical standards, external genital organs and accessory sex characters.
- The reproductive systems of human males and females are made of two types of sex organs, primary and secondary.
- Primary sex organs are those sex organs which produce gametes. They are also called gonads.
- Primary sex organs or gonads of males are called testes while those of females are known as ovaries.
- They also produce steroid hormones essential for reproduction as well as the growth and development of the entire body.
- Sex organs, glands and ducts which do not produce gametes and hormones but are otherwise essential for sexual reproduction are known as secondary sex organs.
- These include prostate, seminal vesicles, vasa deferentia and penis in male, and the Fallopian tubes, uterus, vagina and mammary glands in females.
- Accessory or external or secondary sex characters are those external features which provide distinctiveness to the two sexes. The secondary or the external sex characters have no direct role in sexual reproduction.
- Puberty is the period when primary sex organs become functional and start secreting sex hormones which bring about development of secondary sex organs and appearance of secondary sex characters. As a result sexual maturity is attained.
- It is characterised by rapid growth. The average age of onset for girls is 10 to 12 years old and for boys, 12 to 14 years old.

- In boys pubertal changes occur in response to testosterone and in girls in response to estrogen.
- Table: Secondary sex characters in male and female

	Character	Male	Female
1.	General build up	More muscular	Less muscular
2.	Aggressi- veness	More marked	Less marked
3.	Hair growth		
	(i) Facial	Beard, moustache	Absent
		present	
	(ii) Axillary	Present	Present
i	(iii) Pubic	Hair distribution more	Upward growth not
		lateral and upwards	so marked and is
		towards umbilicus.	more, horizontal.
	(iv) Chest	Present	Absent
4.	Mammary glands	Undeveloped	Well developed
5.	Skin	More hairy and	Less hairy and soft
		coarse	
6.	Shoulder	Broad	Not broad
7.	Pelvis	Not broad	More broad
8.	Larynx	More apparent	Less apparent
9.	Voice	Low pitched	High pitched
10.	BMR	High due to greater	Not so high as
	ļ	activity	compared to males.

MALE REPRODUCTIVE SYSTEM

- Male reproductive system is located in the pelvis region. It includes a pair of testes along with accessory ducts, glands and the external genitalia.
- Testes are paired structures which lie outside the abdominal cavity in a thin pouch of skin called scrotum. The scrotum helps in maintaining the low temperature of the testes (2-2.5°C lower than the normal internal body temperature) necessary for spermatogenesis.
- In adults, each testis is oval in shape, with a length of about 4 to 5 cm and width of about 2 to 3 cm. The testis is covered by a dense covering **Tunica albuginea**.



- Each testis has about 250 compartments called testicular lobules. Each testicular lobule of testis contains one to three highly coiled seminiferous tubules.
- Wall of each seminiferous tubule is formed of a single layered germinal epithelium. Majority of cells in this epithelium are cuboidal called male germ cells (spermatogonia) and at certain places, there are present tall Sertoli or sustentacular cells. Sertoli cells provide nutrition to the developing sperms.
- In between the seminiferous tubules in the connective tissue, there are present small groups of rounded interstitial or Leydig's cells which secrete androgens (e.g, testosterone), *i e.*, male sex hormones.
- The seminiferous tubules are closed at one end but on the other side they join to a network the **rete testis** from where fine ciliated ductules, the **vasa efferentia** arise. The vasa efferentia leave the testis and open into epididymis located along the posterior surface of each testis.
- Vas deferens is connected with epididymis at the tail end. The union of the canals from seminal vesicles and vas deferens form the ejaculatory duct. This duct stores and transports the sperms from the testis to the outside through urethra. The urethra originates from the urinary bladder and extends through the penis to its external opening called urethral meatus.
- The penis is a cylindrical and highly vascularised copulatory organ. It is made up of special tissue that helps in erection of the penis to facilitate insemination. The enlarged end of penis called the glans penis is covered by a loose fold of the skin called foreskin.
- The male accessory glands include paired seminal vesicles, a prostate and paired bulbourethral glands.
- Seminal vesicles are paired tubular coiled sac-like structures, situated behind the urinary bladder. They secrete viscous fluid which constitute the main part of the ejaculate. Seminal fluid contains fructose (as a source of energy which provide nourishment for the activity of sperm), prostaglandins and clotting proteins.
- The prostate gland is a chestnut shaped gland which lies at the base of the urinary bladder and surrounds the first part of the urethra. Prostate fluid contains citric acid (sperm nutrient), a number of enzymes (amylase, pepsinogen) and prostaglandins.
- The two **bulbourethral glands** or **Cowper's gland** are pea-sized structures lying adjacent to the urethra at the base of penis. They secrete a clear, viscous mucus which is lubricating in function. The alkaline fluid secreted by them neutralize any acid urine remaining in the urethra.
- Semen is a collection of secretion from seminal vesicles, prostate gland and Cowper's gland.

COMMON DISORDERS OF MALE REPRODUCTIVE SYSTEM

- **Prostatitis :** It is inflammation of prostate generally caused by infection. Prostatitis results in perineal or testicular discomfort, mild dysuria and symptoms of urinary obstruction.
- **Prostate carcinoma :** It is cancer of prostate which may growunnoticed up to stage of metastasis. Some symptoms

are dysuria, difficulty in voiding, increased frequency of urination or urinary retention.

- Impotence : It is the inability of the adult male to achieve penile erection. It can be due to physiological, psychological or neuromuscular defects.
- **Cryptorchidism :** It is a failure of one or both of the testicles to descend into the scrotum. Cryptorchidism is caused by deficient secretion of testosterone by foetal testes. If sponteneous descent does not occur by the age of one year, hormonal injection is given. Retention of testes in the abdomen results in sterility.
- **Inguinal hernia :** Failure of inguinal plug creates a passage from abdomen to scrotum. It often results in pushing of an intestinal loop into scrotum, resulting in its abnormal size and discomfort.
- **Hydrocoele :** It is enlargement of testicle due to accumulation of fluid either in tunica vaginalis or along the spermatic cord.

FEMALE REPRODUCTIVE SYSTEM

۲

6

0

- The female reproductive system consists of a pair of ovaries along with a pair of oviducts, uterus, cervix, vagina and the external genitalia located in pelvic region.
- The two ovaries are small bodies each 2 to 4 cm in length which remain attached to the abdominal wall by an ovarian ligament called **mesovarium** (or fold of peritoneum). It is covered by a layer of cubical epithelium called the **germinal epithelium** and under it is ovarian **stroma**. The ovarian stroma consists of dense outer layer called the **cortex** and a less dense inner portion called the **medulla**.
- The oviduct (Fallopian tubes), uterus and vagina constitute the female accessory ducts.
 - Each Fallopian tube is about 10 to 12 cm long muscular tube. It conveys the egg from the ovary to the uterus, and also provides the appropriate environment for its fertilization. The oviduct shows 3 regions—infumdibulum, ampulla and isthmus. Infundibulum is the broad, funnel-shaped proximal part lying closer to the ovary. Its margin bears motile, finger-like processes called fimbriae which help in the collection of the ovum after ovulation. Ampulla is the widest and longest part of the Fallopian tube next to the infundibulum. Ampulla is the place where fertilization of ovum takes place. Isthmus is a very short, narrow, thick-walled, straight part that follows the ampulla.



Reproduction

- The uterus (womb) is a large, highly elastic medium specialized for the development of the embryo. Its shape is like an inverted pear. It is attached to the body wall by a double fold of peritoneum, the mesometrium (broad ligament). It varies in size. In a nulliparous woman (who has not borne any child), it is about 8 cm. long, 5 cm wide and 2 cm thick. It is somewhat larger in a multiparous woman (who has borne two or more children).
- The uterus has a thick, highly vascular wall composed of three tissues: outer peritoneal covering called perimetrium, middle smooth muscle layer termed myometrium, and inner mucous membrane known as endometrium.
- The endometrium consists of simple columnar epithelium of ciliated and nonciliated cells. It is rich in tubular glands. It undergoes cyclic changes during different phases of menstrual cycle. The uterus opens into vagina through a narrow cervix. The cavity of the cervix is called **cervical canal**.
- The vagina is a large, median, elastic, muscular tube about 7.5 cm long and extends from the cervix to the outside of the body.
- The female external genitalia is called the vulva. The sides of the vulva have two small fleshy folds, the labia minora (lesser lips) which are hidden by larger hairy folds the labia majora (greater lips). A fleshy elevation above the labia majora is known as mons public. It bears public hair.
- In the upper-most angle of the vulva, infront of the urethral opening is located a small erectile cliteris which is highly sensitive as it contains numerous sensory nerve endings for touch and pressure.
- The vaginal orifice is normally covered in the virgin by a membrane, the hymen. The hymen is ruptured during first copulation. However, it can also be broken by a sudden fall or jolt, insertion of a vaginal tampon, active participation in some sports like horseback riding, cycling, etc. In some women the hymen persists even after coitus. In fact, the presence or absence of hymen is not a reliable indicator of virginity or sexual experience.
- The mammary glands are modified sweat glands that lie over the pectoralis major muscle. Externally, each breast has a projection, the nipple surrounded by a circular pigmented area of skin (deep pink to light brown) called areola. Internally, the mammary gland consists of the glandular tissue, the fibrous tissue (connective tissue) and the fatty or adipose tissue. The glandular tissue comprises about 15-20 mammary lobes in each breast. Each lobe is made up of a number of lobules. Each lobule is composed of grape-like clusters of milk secreting glands termed alveoli.
- When milk is produced it passes from the alveoli into the mammary tubules and then into the mammary ducts. Near the nipple, mammary ducts expand to form mammary ampullae (= lactiferous sinuses) where some milk may be stored before going to lactiferous ducts. Each lactiferous duct typically carries milk from one of the lobes to exterior

DISORDERS OF THE FEMALE REPRODUCTIVE SYSTEM

• Breast cancer : Breast cancer is rarely seen before the

age of thirty. Its incidence increases after menopause. Breast cancer is difficult to detect until it has spread to other organs. The standard treatment for breast cancer is mastectomy (removal of breast). Sometimes only lumps are found in the breast which may not be malignant (cancerous).

- Cervical cancer : It is relatively slow-growing cancer. Its main risk is that it is unnoticed until it has invaded other tissues. Cervical cancer may be treated by radiation or surgery.
- Oophorocystosis (Ovarian cysts) : Ovarian cysts are fluid filled tumours of the ovary. Such cysts sometimes rupture and regress (get smaller) during pregnancy. In old women they are removed surgically.
- Ectopic pregnancy : It is implantation of embryo at a place other than uterus, generally in the oviduct.
- **Oophoritis :** It is inflammation of ovary, usually caused by an infection.
- Endometriosis : It is the growth of endometrial tissue outside the uterus. Symptoms include premenstrual pain or unusual menstrual pain. Treatment is usually hormone therapy or surgery. Endometriosis disappears at menopause or when the ovaries are removed.

GAMETOGENESIS

 Gametogenesis is the process by which male and female sex cells or gametes, *i.e.*, sperms and ova are formed respectively, in the male and female gonads (testes and ovaries). Gametogenesis is of two types: spermatogenesis and oogenesis.

Spermatogenesis

- The process of formation of sperms is called spermatogenesis. It occurs in the seminiferous tubules of the testes after attaining puberty or sexual maturity. The seminiferous tubules are lined by germinal epithelium. The germinal epithelium consists largely of cuboidal primary or primordial germ cells (PGCs) and contains certain tall somatic cells called Sertoli cells (= nurse cells).
- The undifferentiated primordial germ cells undergo repeated mitotic divisions and produce large number of cells called sperm mother cells or spermatogonia (2N). On sexual maturity of the animal, some spermatogonia stop dividing and grow in size by accumulating cytoplasm and replicating DNA, and are then termed the primary spermatocytes (2N).
- Each primary spermatocyte which is diploid undergoes two successive maturation divisions. The first is reductional or meiotic division which gives rise to two haploid secondary spermatocytes. These in turn undergo a quick second maturation division which is an ordinary mitotic division (equational division) to produce a total of four haploid spermatids.
- The transformation of spermatids into spermatozoa (sperms) is called **spermiogenesis**. After spermiogenesis sperm heads become embedded in the Sertoli cells which provide nourishment to sperms and are finally released into the cavity of seminiferous tubules by the process called **spermiation**.
- Spermatogenesis starts at the age of puberty due to significant increase in the secretion of gonadotropin

releasing hormone (GnRH). The increased levels in GnRH then acts at the anterior pituitary gland and stimulates secretion of two gonadotropins – luteinising hormone (LH) and follicle stimulating hormone (FSH). LH acts at the Leydig cells and stimulates synthesis and secretion of androgens. Androgens, in turn, stimulate the process of spermatogenesis. FSH acts on the Sertoli cells and stimulates secretion of some factors which help in the process of spermiogenesis. The functions of male sex accessory ducts and glands are maintained by the androgens.

• A typical mammalian sperm consists of a head, neck, middle piece and tail.



Fig.: A mammalian spermatozoon as seen under electron microscope.

- Head is flat and oval in human sperm. It is composed of a large posterior nucleus and a small anterior cap like acrosome. Acrosome is formed from a part of Golgi apparatus. Acrosome contains hydrolytic enzymes, and is used to contact and penetrate the egg during fertilization.
- Neck is very short and is present between the head and

middle piece. It contains the proximal centriole and distal centriole.

- The middle piece of human sperm contains the mitochondria coiled around the axial filament and is called mitochondrial spiral. They provide energy for the movement of the sperm.
- The tail is several times longer than the head. It gives motility to the sperm.
- The human male ejaculates about 200 to 300 million sperms during a coitus of which, for normal fertility, at least 60 per cent sperms must have normal shape and size and for at least 40 per cent of them must show vigorous motility.

Oogenesis

- The process of formation of a mature female gamete (ovum) is called **oogenesis**. It occurs in the ovaries (female gonads).
- In the foetal development, certain cells in the germinal epithelium of the ovary of the foetus are larger than others. These cells divide by mitosis, producing undifferentiated germ cells called **egg mother cells** or **oogonia** in the ovary of the foetus.
- The oogonia multiply by mitotic divisions and project into the stroma of the ovary as a cord, the egg tube of Pfluger which later becomes a round mass, the egg nest. One cell in the egg nest grows and becomes the primary oocyte. Meiosis begins in the primary oocytes soon after their formation.
- However, the oocytes are arrested in the early part of meiotic prophase I (diplotene stage). Each primary oocyte then gets surrounded by a layer of granulosa cells and then called the primary follicle. A large number of these follicles degenerate during the phase from birth to puberty Therefore, at puberty only 60, 000-80, 000 primary follicles are left in each ovary. The primary follicles get surrounded by more layers of granulosa cells and a new theca and called secondary follicles.
- The secondary follicle soon transforms into a tertiary follicle which is characterised by a fluid filled cavity called antrum. The theca layer is organised into an inner theca interna and an outer theca externa. It is at this stage that



Fig.: Schematic representation of (a) Spermatogenesis, (b) Oogenesis

Reproduction

the primary oocyte within the tertiary follicle grows in size and completes its first meiotic division. It is an unequal division resulting in the formation of a large haploid secondary oocyte and a tiny first polar body.

• The secondary oocyte retains bulk of the nutrient rich cytoplasm of the primary oocyte. The tertiary follicle further changes into the mature follicle or Graafian follicle. The secondary oocyte forms a new membrane calledzona pellucida surrounding it. The Graafian follicle now ruptures to release the secondary oocyte (ovum) from the ovary by the process called ovulation.

MENSTRUAL CYCLE

- Menstrual cycle is the cyclic change in the reproductive tract of primate females. The reproductive period of the human female continues from about the age of about 13 to 15 years (menarche) to 45-50 years.
- This period is marked by a characteristic event repeated almost every month (28 days with minor variation) in the form of a menstrual flow (*i.e.*, shedding of the endometrium of the uterus with bleeding). It may be temporarily stopped only by pregnancy.
- The period of a menstrual cycle is counted from the day of the onset of the flow to the next onset after 28 days. This period can be divided into four main phases explained in the given table.
- Menopause is a phase in woman's life when ovulation and menstruation stop. It occurs between 45 to 55 years of age.

Phases	Days	Events
Menstrual phase	3–5	Endometrium breaks down,
		menstruation begins. The cells of
		endometrium, secretions, blood and
		the unfertilized ovum constitute
		the menstrual flow, progesterone
		production is reduced.
Follicular phase	6–13	Endometrium rebuilds, FSH & LH
(Proliferative		secretion increases that stimulates
phase)		follicular development as well as
		secretion of oestrogen.
Ovulatory phase	14	Both LH and FSH attain a peak
r		level. Ovulation occurs.
Luteal phase	15-28	Corpus luteum secretes
(Secretory phase)		progesterone. Endometrium
		thickens and uterine glands
		become secretory.

Table: Simplified menstrual cycle (28 days cycle)

FERTILIZATION

- During copulation (coitus) semen is released by the penis into the vagina (insemination). Fertilization is the penetration of a mature ovum by the spermatozoon and fusion of the respective male and female pronuclei.
- In humans, fertilization takes place in **ampullary-isthmic** junction of Fallopian tube.
- The secretions of the female genital tract remove coating substances deposited on the surface of the sperms particularly those on the acrosome. The capacitated

sperm undergoes acrosomal reaction and releases various chemicals contained in the acrosome. These chemicals are collectively called sperm lysins.

- Due to acrosomal reaction, plasma membrane of the sperm fuses with the plasma membrane of the secondary oocyte so that the sperm contents enter the oocyte. Changes in the membrane of the oocyte block the entry of additional sperms. Thus, it ensures that only one sperm can fertilize an ovum.
- The egg extends around the entering sperm finger-like processes, called microvilli, which constitute a fertilization cone. The latter take the entire sperm into the egg.
- The distal centriole of the sperm divides and forms two centrioles to generate the mitotic spindle for cell division. The mammalian egg lacks centrioles of its own.
- The sperm entry stimulates the egg (secondary oocyte) to resume and complete the suspended meiosis II. This produces a haploid mature ovum and a second polar body. At this time, the head of the spermatozoon, which consists of the nucleus, separates from middle piece and tail, and becomes the male pronucleus. The second polar body immediately degenerates, and so does the sperm tail. The nucleus of the ovum is now called the female pronucleus. The male and female pronuclei move towards each other. Their nuclear membranes disintegrate.
- Mixing up of the chromosomes of a spermatozoon and an ovum is called karyogamy, or amphimixis. This completes the act of fertilization. It combines the genetic information from two parents. The ovum is now a diploid cell having 23 pairs of chromosomes, and is termed zygote.
- A glycoprotein fertilizin composed of monosaccharides and amino acids is secreted by ovum. Penetrating sperm also has a protein substance called antifertilizin on its surface. The interaction of fertilizin of an ovum with the antifertilizin of a sperm (agglutination) is species specific.

Sex determination

- The sex chromosome pattern in the human female is XX and that of male is XY. Therefore, all the haploid female gametes (ova) have the sex chromosome X, however, the haploid male gametes have either X or Y. Thus 50% of sperms carry the X-chromosome while the other 50% carry the Y-chromosome.
- After fusion of the male and female gametes, the zygote carries either XX or XY depending upon whether the spenn carrying X or Y fertilizes the ovum. The zygote carrying XX would be a female baby and XY would be a male baby.
- That is why it is correct to say that the sex of the baby is determined by the father.

Significance of fertilization

0

- Fertilization has the following significance:
 - It restores the diploid number of chromosomes, characteristic of the species *viz.*, 46 in human being.
 - Fertilization initiates cleavage.

- It introduces the centrioles which are lacking in the mature egg.
- Fertilization results in determination of sex in the embryo.
- It combines the characters of two parents. This introduces variations.
- Fertilization membrane developed after the entry of the sperm prevents the entry of other sperms into the ovum.

EMBRYONIC DEVELOPMENT (MONOSPERMY)

- Embryonic development or embryogenesis is the development of embryo from fertilized ovum and its subsequent development into a young organism.
- Cleavage refers to a series of rapid mitotic divisions of the zygote following fertilization, forming a many celled hlastula. Cleavage in fertilized egg of human starts in Fallopian tube forming 2, 4, 8, 16 daughter cells called blastomeres.
- Embryo with 8-16 blastomeres is known as morula (little mulberry). At the next stage of development, which produces an embryo with about sixty four cells, a cavity is formed within the cellmass. The cavity is called blastocoel and the embryo is termed the blastocyst.
- 0 Blastocyst is composed of an outer envelope of cells, the trophoblast or trophoectoderm and inner cell mass (=embryoblast). The trophoblast layer then gets attached to the endometrium and the inner cell mass gets differentiated as the embryo. After attachment, the uterine cells divide rapidly and covers the blastocyst. As a result, the blastocyst becomes embedded in the endometrium of the uterus. This is called **implantation** and it leads to **pregnancy**.
- The side of the blastocyst to which the inner cell mass is 0 attached is called the embryonic or animal pole while the opposite side is the abembryonic pole.
- The trophoblast encircles the blastocoel and the inner cell mass. The inner cell mass is the precursor of the embryo *i.e.*, it gives rise to the embryo. The cells of trophoblast (Gr. troph e-nourishment) help to provide nutrition to the embryo. The cells of the trophoblast later form the extra embryonic membranes namely chorion and amnion and part of the placenta.
- Implantation takes place about seven days after

fertilization. The function of the zona pellucida is to prevent the implantation of the blastocyst at an abnormal site. It does not expose the sticky and phagocytic trophoblast cells till the blastocyst reaches the proper implantation site.

- After implantation, finger-like projections appear on the trophoblast called chorionic villi which are surrounded by the uterine tissue and maternal blood. The chorionic villi and uterine tissue become interdigitated with each other and jointly form a structural and functional unit between developing embryo (foetus) and maternal body called placenta.
- Through inorganic and organic nutrients, hormones, ۰ antibodies against various toxins and pathogens and oxygen pass from mother to foetus; CO_2 , nitrogenous and other wastes of foetus pass back into mother for elimination.
- 6 Placenta acts as a barrier as well as ultrafilter between foetus and mother. It is connected to foetus by a rope-like umbilical cord which helps in the transport of substances to and from the embryo.
- Placenta acts as an endocrine tissue and produces hormones like hCG (human chorionic gonadotropin), chorionic thyrotropin, chorionic corticotropin, human placental lactogen, oestrogen and progesterone.
- 6 hCG keeps the corpus luteum active. The latter secretes progesterone and relaxin. In addition, during pregnancy the levels of other hormones like estrogens, progestogens, cortisol, prolactin, thyroxine, etc., are increased several folds in the maternal blood. Increased production of these hormones is essential for supporting the fetal growth, metabolic changes in the mother and maintenance of pregnancy.
- 6 Cells of inner cell mass in contact with blastocoel flatten, divide and grow to form a complete layer around blastocoel. The layer is called endoderm. Endoderm is the first germinal layer that appears in human embryo. It forms an endodermal tube/archenteron/primitive gut. After formation of endoderm, the remaining cells of inner cell mass undergo regular arrangement and form an outer layer called ectoderm.
- ഒ Cells present in the space between ectoderm and endoderm arrange to form intraembryonic mesoderm.



6

Flow chart : Classification of types of cleavage

22

Reproduction

- Each germ layer gives rise to the specific tissues, organs and organ - systems. The germ layers have the same fate in all animals.
- In human beings, after one month of pregnancy, the embryo's heart is formed. By the end of the second month of pregnancy, the foetus develops limbs and digits. By the end of 12 weeks (first trimester), most

of the major organ systems are formed; The first movements of the foetus and appearance of hair on the head are usually observed during the fifth month. By the end of 24 weeks (second trimester), the body is covered with fine hair, eye-lids separate, and eyelashes are formed. By the end of nine months of pregnancy, the foetus is fully developed and is ready for delivery.

Germ layers		Structures derived from germ layers
Ectoderm 🔹		Epidermis of skin, hair, nails, sudoriferous (sweat) and sebaceous (oil) glands and chromatophores
		(pigment cells) of skin.
	8	Enamel of teeth, salivary glands, mucous membrane of lips, cheeks, gums, part of the floor of the mouth
		and part of palate, nasal cavities and paranasal sinuses. Lower part of anal canal.
	0	Nervous system including all neurons, neuroglia (except microglia), and Schwann cells. Piamater and arachnoid mater.
	© ⁻	Conjunctiva, cornea, lens of eye, muscles of iris, vitreous humour, retina, lacrimal gland.
	8	External ear, outer layer of tympanic membrane, membranous labyrinth (internal ear).
		Pituitary gland, pineal gland and medulla of adrenal glands.
	۲	Mammary glands, outer surface of labia minora and whole of labia majora.
	8	Terminal part of male urethra.
Mesoderm	0	Muscles except iris muscles.
	9	Connective tissues including loose areolar tissue, ligaments, tendons and the dermis of skin.
	۲	Specialised connective tissues like adipose tissue, reticular tissue, cartilage and bone.
	•	Dentine of teeth.
	0	Heart, all blood vessels, lymphatics, blood cells, spleen.
	1	Kidneys, ureters, trigone of urinary bladder.
	0	Coelomic epithelium (mesothelium of pleural, pericardial and peritoneal cavities)
1		Duramater, microglia.
		Sclera, choroid, ciliary body and iris.
	0	Basis of tympanic membrane.
		Cortex of adrenal glands.
		Mesenteries
		Notochord
	6	Reproductive system except prostate.
Endoderm	8	Epithelium of mouth, part of palate, tongue, tonsils, pharynx, oesophagus, stomach, small and large
		intestines including upper part of anal canal (not lower part of anal canal).
	0	Epithelium of Eustachian tube, middle ear, inner layer of tympanic membrane.
	0	Epithelium of larynx, trachea, bronchi and lungs.
	6	Epithelium of gall bladder, liver, pancreas including islets of Langerhans, gastric and intestinal glands.
	•	Epithelium of urinary bladder except trigone.
	8	Epithelium of lower part of vagina, vestibule and inner surface of labia minora.
	۲	Epithelium of prostate (except inner glandular zone), bulbourethral glands, greater vestibular and lesser vestibular glands.
		Epithelium of thyroid, parathyroid and thymus glands.

PARTURITION AND LACTATION

- Parturition is the act of expelling the full-term young one from the mother's uterus at the end of gestation. Gestation (pregnancy) is completed in about 280 days from the start of mother's last menstruation.
- Parturition is induced by a complex neuroendocrine mechanism. The signals for parturition originate from the fully developed foetus and the placenta which induce mild

uterine contractions called **foetal ejection reflex**. This triggers release of oxytocin from the maternal pituitary.

Oxytocin stimulates the uterine contractions. This provides force to expel the baby from the uterus, causing birth. Oxytocin also stimulates the placenta to secrete prostaglandins which stimulate more contractions of uterus. Uterine contractions, by positive feedback induce continuation of oxytocin and prostaglandins production.

The first milk after the birth of baby is called **colostrum**. It is rich in **proteins**; **calories** and **antibodies**. Milk secretion is under control of **prolactin** while its release is controlled by **oxytocin** of pituitary.

