

Study Guide Reproductive System and Development

1. Reproductive system works physiologically, for the continuity of generations. All other organs work for the individual body.
2. Gonads are primary sex organs; Testes in males produce sperms and Ovaries in females produce eggs. Sperms and eggs are gametes, also called sex cells.
3. **Male Reproductive System:**
4. It consists of a pair of testes, a pair of ductus deferens or vas deferens, a pair of ejaculatory ducts, urethra, penis and associated glands seminal vesicles, prostate gland and bulbourethral glands.
5. **Testes** are oval bodies lying in Scrotum, a skin pouch. Testis has connective tissue covering tunica albuginea. Partitions start from tunica albuginea to form wedge shaped 200-300 lobules. Each lobule has 1-3 seminiferous tubules. Testes produce sperms and male hormone Testosterone. If the embryo secretes testosterone embryo grow into a male otherwise by default the sex of embryo is female. Testosterone is responsible for male characters including appearance.
6. **Scrotum and Penis:** have 3 coverings. Starting from outside Skin, superficial fascia, and deep fascia.
7. **Testes need about 2°C** cooler than body temperature to produce viable sperms. Cremaster muscles in spermatic cord, Dartos muscles in scrotum and Pampiniform plexus made by veins help to keep temperature around 35°C.
8. **Seminiferous tubules** form sperms by Spermatogenesis. Spermatogonial cells divide by mitosis and later by Meiosis to form sperms. Spermatogonial cells → primary spermatocytes → secondary spermatocytes → spermatids (n) → sperms (n).
9. Seminiferous tubules → rete testis → efferent ductules → Epididymis
10. **Sperms** have Acrosome, head, middle piece and tail. Acrosome has hydrolytic enzymes to dissolve egg membranes. Head has the sperm nucleus. Middle piece has mitochondria and centrioles. Tail is a flagellum for swimming. Sperms enter vagina and swim through uterus to upper parts of uterine = fallopian tubes where fertilization may take place.
11. **Epididymis** is elongated structure lying posterolateral to testis and caps it. It collects sperms from testes and stores them for maturation (at least 20 days).
12. **Ductus = Vas deferens** moves superior and coils around ureter of its side. It receives sperms from Epididymis and joins seminal vesicle duct to form ejaculatory duct.
13. **Ejaculatory duct** then carries the sperms to urethra. Prostate Gland adds its secretion to urethra. Sperms and secretion of glands form semen which is ejaculated through penis during intercourse.
14. **Urethra** has 3 distinct parts. Prostatic urethra is the part passing through prostate gland. Middle part of urethra is not covered and is Membranous urethra. Urethra enters penis and is termed Spongy or Penile urethra. Penile urethra opens out at external urethral orifice, which passes out both urine and semen.
15. **Seminal Vesicles:** produce 60% of semen. It has vitamin C, Fructose and prostaglandins.

16. **Prostate Gland:** is a single gland lying below bladder. It produces an alkaline solution which neutralizes acids of vagina.
17. **Erectile Tissue:** Corpora cavernosa are 2 anterior and Corpus spongiosum is posterior erectile tissues. Normally a little blood flows through them but release of NO causes these tissues to swell with blood.
18. **Impotence:** is the failure of penis to get erect or to remain erect during intercourse. Smoking and drug use increase the chance of impotence. Drugs like Viagra and Cialis restore temporarily this function.
19. **Sterility:** if a male cannot produce sperms or enough sperms to ensure fertilization he is called a sterile male.
20. **Hormones:** Anterior pituitary gland secretes LH to stimulate Interstitial cells to release Testosterone and FSH to stimulate seminiferous tubules to undergo spermatogenesis.
21. **Female Reproductive System:**
22. It consists of a pair of ovaries, a pair of uterine = fallopian tubes, a uterus, a vagina and external genitalia.
23. **Ovaries** produce eggs in follicles. Follicles start developing before birth. Primordial follicles (before puberty) → primary follicles → secondary follicles → Tertiary follicles (with large fluid filled space antrum).
24. **Ovulation:** Many follicles start maturing but only 1, the largest, releases the secondary oocyte with 1st polar body.
25. **Oogenesis:** Oogonial cell (germinal cell) → primary oocyte (the cell ready to divide by meiosis) → secondary oocyte (has undergone Meiosis-1 and produced 1st polar body).
26. Follicles release female hormones called estrogens.
27. **Uterine = Fallopian tubes** draw egg through ostium of fallopian = uterine tubes by beating cilia. Fertilization takes place in upper uterine = fallopian tubes.
28. **Uterus:** is the womb for development of baby. Both fallopian tubes lead to it. Uterus has smooth muscle fibers = myometrium and inner glandular and vascular tissue = Endometrium. The neck part of uterus protrudes into vagina and is called Cervix. In many women it becomes cancerous and called Cervical Cancer – the number 1 cancer in women.
29. **Vagina** is genital duct used for intercourse and birth. The opening of vagina is partially closed by a mucous membrane, Hymen. Greater Vestibular glands secrete mucous to lubricate distal vagina.
30. **Hormones:** Anterior Pituitary secretes FSH and LH.
31. FSH = Follicle Stimulating hormone secreted by anterior pituitary initiates growth and maturation of follicles.
32. **FSH** also stimulates follicles to release Estrogens the female sex hormones.
33. **LH** stimulates ovulation and ruptured follicle (after ovulation) to form Corpus Luteum. Corpus luteum secretes Progesterone.
34. **Ovarian Cycle:** Ovaries have large number of follicles. Under the influence of FSH and LH some follicles start developing. Ultimately only one follicle reaches maturity. In most women ovarian cycle is of about 28 days. Ovulation is the release of secondary oocyte around 14th day of cycle.

35. **Menstruation:** Each ovarian cycle, under the influence of Estrogen and Progesterone hormones, uterus prepares for development of baby by growing glandular/vascular tissue called Endometrium. If there is no pregnancy corpus luteum degenerates. Therefore, no progesterone is secreted and endometrium is shed off as menstruation, a flow of blood and tissue.
36. **Egg:** Released **secondary oocyte** is covered by a non-cellular Zona Pellucida and follicular cells called Corona radiata. Fallopian tubes draws coelomic fluid in them by beating cilia and sperms can come in contact in proximal fallopian tubes.
37. **Fertilization** is the entry sperm into an egg. Enzymes released by several sperms remove cells of corona radiata. The contact of 1st sperm results in Oocyte Activation. The sperm is engulfed and changes in egg membrane prevent entry of any further sperms. Secondary oocyte undergoes Meiosis-2 and produces the female pronucleus and 2nd polar body. Sperm produces male pronucleus. Spindle formation is initiated and degeneration of nuclear membranes results in intermixing of chromosomes of male and female pronuclei = Amphimixis. Fertilization is complete. The first diploid cell is called zygote. Fig 20.1
38. **Cleavage** is the series of mitotic divisions that divide the zygote into 2 → 4 → 8 → 16 → 32 and so on cells. At first a solid ball of cells, Morula is formed. The embryo continues to roll towards uterus.
39. The cells of morula continue to divide and rearrange to form a hollow ball of cells called Blastocyst. **Blastocyst** is formed of about 100 cells. It has an inner mass of embryonic cells surrounded by extra-embryonic Trophoblast. Inner Mass develops into embryo. Trophoblast absorbs nutrient rich uterine fluid and participates in formation of extra-embryonic membranes. It takes 7 days to form Blastocyst after fertilization / conception. **Implantation:** Blastocyst reaches uterus and gets attached to inner wall of uterus called Endometrium.
40. **Gastrulation:** The 1st embryonic structure to possess 3 distinct germ layers is Gastrula. 3 germ layers are Ectoderm, Mesoderm and Endoderm. Each germ layer produces particular tissues/organs in embryo called fate of germ layers.
41. Ectoderm is layer facing amniotic cavity.
42. Endoderm is layer facing blastocoel cavity in blastocyst.
43. Mesoderm is the 3rd layer formed between ectoderm and endoderm by migration of cells from the surface.
44. **Ectoderm** forms epidermis and associated glands, nails and hair, nervous tissue including brain and spinal cord, and mucous linings of mouth, anus and nasal cavities; pituitary and adrenal medulla.
45. **Mesoderm** forms muscles, bones and cartilages, heart and vessels, kidneys, gonads and secondary sex organs.
46. **Endoderm** produces Respiratory lining, thymus, thyroid, pancreas, liver, stem cells that produce gametes; distal portions of ducts of urinary and reproductive systems.
47. During pregnancy ovaries stop ovarian cycles and therefore no menstruation. It is 1st sign of pregnancy and can be confirmed with pregnancy kits testing urine.
48. Gestation Period = length of human development from day of fertilization is 270 days.
49. Early embryo is covered with embryonic membranes, amnion, chorion, yolk sac and allantois. **Amnion** surrounds amniotic fluid to cushion the embryo against shocks and protect against

dehydration. **Yolk Sac** produces blood cells in early embryo, later this function is taken over by liver. **Chorion**: Early embryo develops placenta, to get food and oxygen from mother's blood and pass out wastes, from another embryonic membrane. **Allantois** is reduced in humans and forms urinary bladder.

50. **Placenta**: Chorionic Villi enter into Endometrium. The composite of chorionic villi and Endometrium surrounding them form Placenta. The embryonic blood capillaries in chorionic Villi and maternal capillaries in Endometrium lie very close to each other and exchange of materials (O₂, CO₂, glucose, amino acids, vitamins, urea and lot of others) takes place.
51. **Labor and Delivery**: Oxytocin hormone and many other factors initiate spasmodic contractions of uterine smooth muscle fibers termed Labor. The goal of labor is forcible expulsion of fetus from uterus =Parturition. Birth takes place after about 38 weeks from last menstruation.
52. **Dizygotic Twins**: result from fertilization of 2 separate eggs. They are like any other siblings, may be of same or different sexes. They have different combination of genes.
53. **Monzygotic or Identical Twins**: form from separated blastomeres of same zygote. They have similar genes and are of same sex and look alike.