

Type class,  
opens out by urethral orifice situated just in front of the genital aperture.

## (E) REPRODUCTIVE SYSTEM

The sexes are separate in rat. The male and female animals can be identified by the sexual diamorphic characters shown by the individuals.

### 1. Male Reproductive System

The male reproductive system of rat consists of a pair of testes, pair of epididymes, pair of vasa deferentia, pair of seminal vesicles, number of associated glands, urethra and penis.

(a) **Testes** : The testes are paired ovoid bodies, lie in abdomen in young rat but in adult the testes descend from abdominal cavity through the inguinal canals and lie in the scrotal sacs. The two scrotal sacs are separate internally while externally one fold of hairy skin covers them. The paired scrotal sacs thus consists of the scrotum. A scrotal

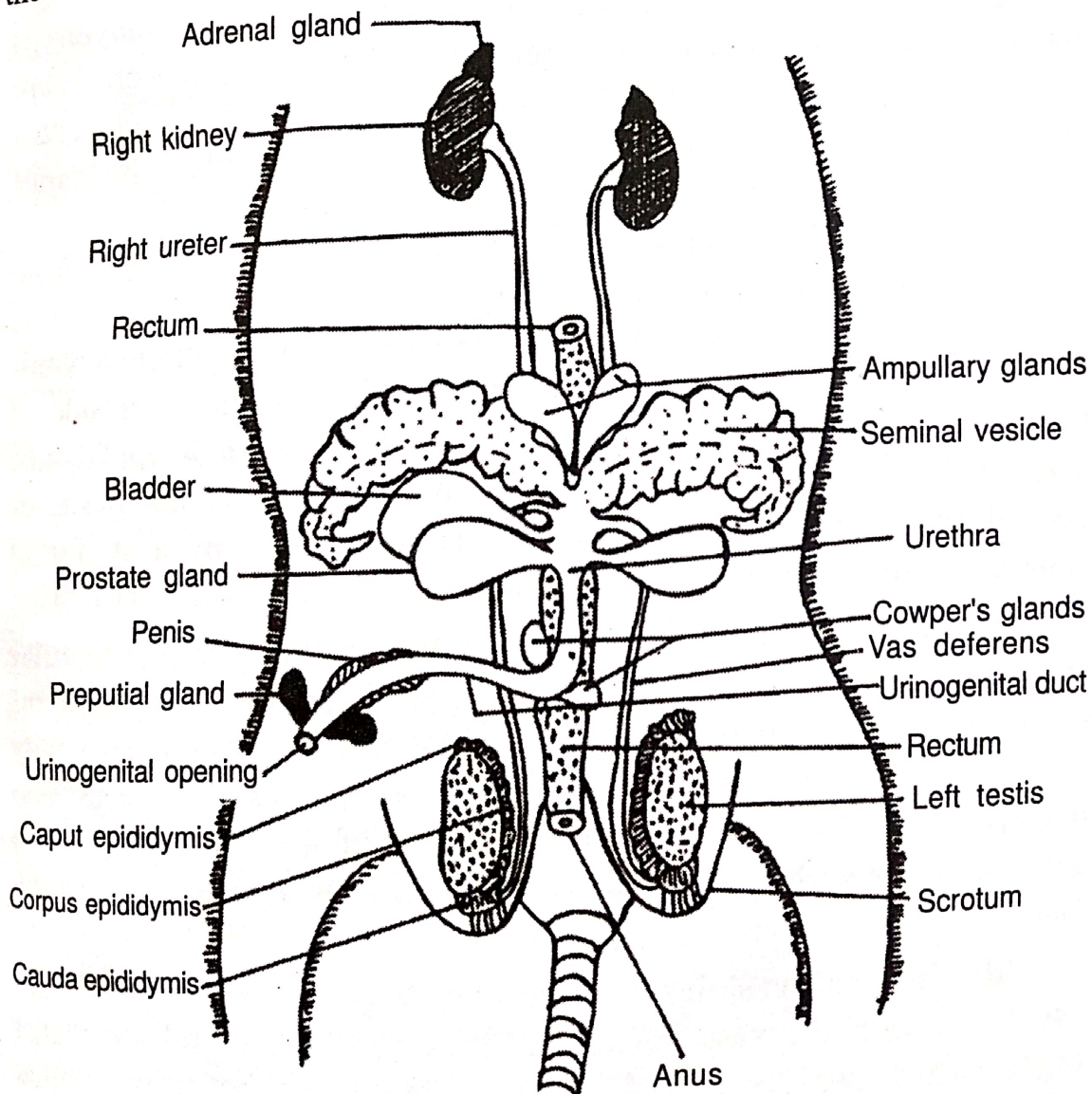


Fig. 1.35 : Male Reproductive System

septum separates the two scrotal cavities. The testes are attached to the posterior end of the scrotal sacs and can be easily pulled back into the abdominal cavity during periods of sexual inactivity. The fibrous muscular part containing the testis and scrotal sac is called gubernaculum.

Each testis rests on a cushion like muscular portion of the scrotal sac. Each testis is covered by a fibrous capsule called tunica albuginea together by connective tissue. This tissue contains fibres, blood vessels, tissue corpuscles and certain interstitial cells called Leydig cells. These cells secrete a hormone called testosterone which influence the secondary sex characters. Each seminiferous tubule is lined by the germinal epithelium. It gives rise to spermatozoa. The inner layer of the seminiferous tubule shows various stages of development of the spermatozoa. In between the germinal epithelial cells are often seen large cells called the cells of sertoli. They nourish the developing spermatozoa.

(b) Epididymis : These are two in number. Each epididymis is connected with the testis on its inner side. It serves as the store house of sperms. It is a coiled tubule consists of three parts namely caput epididymis, corpus epididymis and cauda epididymis. The caput epididymis is a cap like enlarged part that lies on the anterior face of the testis. It receives many, minute tubules the vasa efferentia from the testis. These are ciliated ducts lying in the mesorchium. These tubules bring the sperms produced in the testis to the caput epididymis. A narrow strip called the corpus epididymis lies on the inner side of the testis. It connects the caput epididymis with the cauda epididymis. The cauda epididymis is an expanded part that lies at the posterior end of the testis. It is connected to the scrotal sac by a strand of connective tissue called gubernaculum.

(c) Vasa deferentia : These are two in number and tubular structures emerging from the cauda epididymis. Each vas deferens passes forward through the inguinal canal into the abdominal cavity and then loops over the ureter of its own side. Then it opens into the urinary bladder, just near the beginning of the urethra. The vasa deferentia carry the spermatozoa to the narrow end of the urinary bladder.

(d) Seminal vesicles : A pair of large seminal vesicles are associated with the vasa deferentia. These are curved and sacculated organs which produce a viscid secretion that forms the major volume of the semen or spermatid fluid.

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(e) Associated glands : There are about five glands which are associated with the male reproductive system. These glands are as follows.

(i) Ampullary gland : It is also called as the gland of vas deferens. It lies round the two vasa deferentia at the point where they converge near the neck of the bladder. It roughly consists of two lobes. It also secretes the fluid which is then added into the semen.

(ii) Coagulating gland : Closely applied along the inner curve of each seminal vesicle within the same sheath, there is a coagulating gland. It secretes an alkaline fluid which aids in coagulating the seminal fluid.

(iii) Prostate glands : These are smooth, shiny, whitish glands about the size of peas. These are paired glands, lie at the base of the urethra and open into the proximal end of the urethra. They are subdivided so as to appear as two pairs of glands. They secrete an alkaline fluid which adds bulk to the semen and neutralizes the acidity of the urethra. This secretion is a thin fluid with a characteristic odour. It keeps the sperms active and motile.

(iv) Cowper's glands : These are a pair of small flask shaped, white glands about 3 mm in diameter. They are embedded in muscles on the sides of the base of the penis. They produce a mucous like secretion which is added to the semen at the time of ejaculation. The fluid serves as a lubricant for the passage of sperms.

(v) Preputial glands : These are paired, small and flat glands located on the sides of the urinogenital aperture or opening. Actually they lie between the prepuce and the skin on either side of the penis. They open into the border of the prepuce. They produce slimy secretion which serves to lubricate the penis during copulation.

(f) Urethra : The urethra is a common passage for both urine and semen. Hence, it is also called the urinogenital canal. It starts at the bladder and ends at the tip of the penis. In male it is a long muscular tube which carries urine.

(g) Penis : The Penis is a cylindrical, erectile organ, hanging from the ventral wall of the abdomen in front of the anus. It is ensheathed distally by a fold of skin called the prepuce. The terminal part of the penis is called the glans. The glans penis is highly sensitive. The surface of it is somewhat rough and bears small pits. The penis consists of two lateral corpora cavernosa and a mid-ventral corpus spongiosum. The corpora cavernosa enclose the urethra and contain



### Female Reproductive System

The female reproductive system consists of a pair of ovaries, a pair of oviducts, a pair of uteri, vagina and six pairs of teats.

**(a) Ovaries :** The ovaries are small, pinkish, rounded organs lie in the abdominal cavity ventrolateral to the kidneys. There are two ovaries in female rat. Each ovary gives a blistered appearance when ripe. This appearance is due to the presence of ripe graafian follicles containing ova. Each ovary is suspended in the abdomen by a broad fold of peritoneum called mesovarium. Fat often covers the surface of the ovary.

Each ovary is enclosed in a tough, transparent capsule, the bursa ovarica or periovarian sac. It is continuous with the mesovarium. The surface of each ovary shows several small, rounded, semitransparent projections called the ovarian or Graafian follicles. The ripe Graafian follicle migrates to the surface, then ruptures and releases the contained ovum. This act is known as ovulation.

**(b) Oviducts :** There are two oviducts, corresponding to the two ovaries. Each oviduct shows two regions. The anterior narrow and

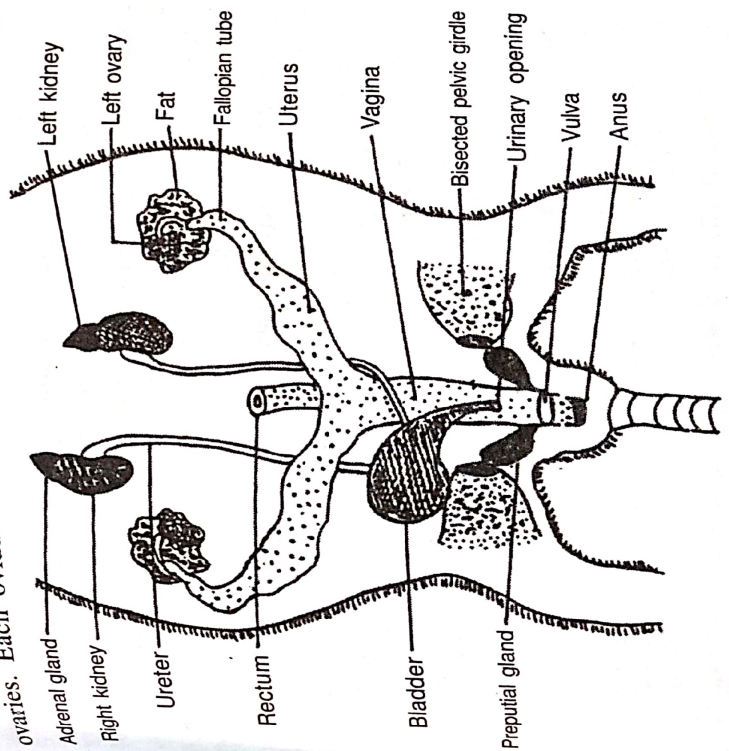


Fig. 1.37 : Female Reproductive System

During sexual excitement, the blood rushes into the corpora and makes the penis turgid and erect. Now the penis can serve as an intromittent organ. In most of the time when there is no sexual excitement the penis becomes curved backward.

### Working of the Male Reproductive System

The testes produce spermatozoa by spermatogenesis. The spermatozoa pass into the epididymis through the vasa deferentia by the action of cilia lining them. The epididymis serve to store spermatozoa for some time. The vasa deferentia carry the spermatozoa from the epididymis to the urethra. The spermatozoa pass through the epididymis and vasa deferentia by the peristaltic contractions of their muscular walls. From the urethra the spermatozoa are transferred into the vagina of the female at the time of copulation. The spermatozoa are transferred along with the secretions of the prostate and cowper's glands which form the spermatid fluid or semen without spermatid fluid the spermatozoa are non-motile. During copulation millions of sperms are liberated.

### Spermatozoan : Each spermatozoan

has a head, a middle piece and a long tail. The head contains a dark staining nucleus with a less dense tip called the acrosome. The middle piece contains internally a spirally coiled thread. The tail is long and vibratile. The sperm moves with a lashing movement using the tail.

The immature spermatozoa when leave the testis are non-motile. They have no power of movement. When they reach into the epididymis they become mature. The fluid secreted by the glands nourishes them and makes them viable. The glandular secretion is sufficiently alkaline so that it can neutralize the acidity of the vaginal fluid which help the spermatozoa to survive, otherwise they would have been destroyed in the vagina of the female.

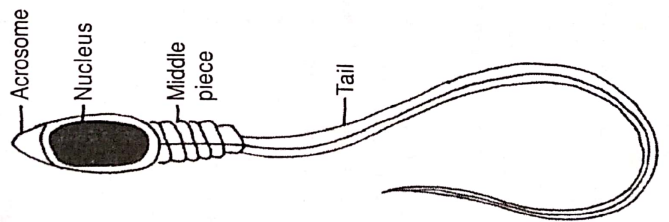


Fig. 1.36 : Rat Spermatozoan

looped region is the fallopian tube, whereas the posterior wider region is the uterus. The fallopian tube is less than 2.5 mm in length when coiled. It is lined by ciliated epithelium. It has at its anterior end a small funnel-shaped opening, the ostium or infundibulum. The ostium receive the ova from the ovary.

(c) **Uteri** : There are two uteri present in the female reproductive system of rat. The fallopian tubes lead into a broad, thick-walled parts of the uteri. Each uterus is highly vascular and distensible. The two uteri, one from each side approach each other and join to form a median muscular passage, the vagina. The uterus of this type is often called as the "uterus duplex". Each uterus is referred to as the uterine horn or cornua.

(d) **Vagina** : The vagina lies ventral to the rectum but dorsal to the urethra. The vagina runs straight backwards and opens to the exterior by the vaginal orifice or genital aperture or vulva. The opening of the vagina lies immediately posterior to the opening of the urethra. The vagina and urethra together form a short common passage called the vestibule. The vagina remains closed by a membrane called hymen until the beginning of puberty.

The urinary aperture is slightly raised up forming the urinary elevation. This is homologous to the prepuce in the male. A pair of glands, similar to the preputial glands in the male, lies under the skin, in a similar position in the female. Below the urinary elevation there is a small clitoris which is vestigial homologue of the penis in the male. It also contains an erectile tissue.

(e) **Teats** : These are small outgrowths on the ventral side of the trunk. The teats are of about six pairs, three pairs on the thorax and three pairs on the abdomen. The maximum gap occurs between the third thoracic and the first abdominal pairs. They enlarge at puberty and become conspicuous during pregnancy and lactation. The mammary glands embedded in the skin open on the teats by minute pores. They start secreting milk for nourishment of young ones, after the birth of the young ones.

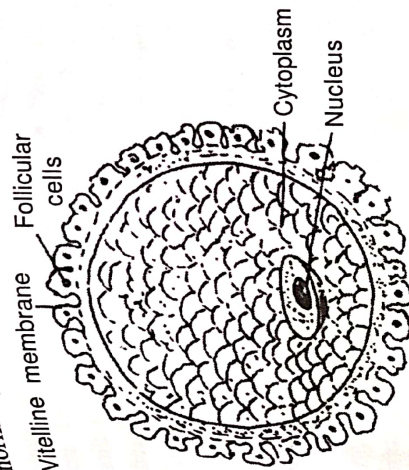
### Working of the Female Reproductive System

The female rat after its birth attains sexual maturity at about 72 days. The oestrous cycle or period of heat starts after puberty or sexual maturity.

Ovulation usually takes place after about eight hours. The release of ova from the ovary is called ovulation. The first ovulation usually

occurs on the 77th day of life and continues every four days thereafter until the rat conceives. The ova released from the ovaries are received by the ostia and are passed on into the fallopian tubes by the action of cilia.

**Copulation** : The act of sexual union is called as copulation. It normally takes place when the female is on heat. The heat behaviour *i.e.* willingness to be mated occurs about 8-20 hours before ovulation. The external sign of heat and the approach of oestrus is the swelling of lips of vagina. This swelling starts about 36 hours before ovulation.



When female is ready then only male copulate with the female. During copulation, the penis of the male becomes straight,

Fig. 1.38 : Ovum

erect and enlarged. It is due to sudden rush of blood into the spongy tissue of the penis. When sexually excited, the male mounts on the female rat and insert the penis into her genital tract. At the time of insertion of the penis, the prepuce is pushed back and expose the glands. Friction of this sensitive part with the walls of the vagina provides the stimulus for the ejaculation of the semen. Ejaculation of the semen is the end of the copulation. The spermatozoa from the fluid becomes motile. They swim upto the uteri and reach the fallopian tubes.

**Fertilization** : The ova released from the ovaries are received by the ostia and are passed on into the fallopian tubes by the action of cilia. Here the spermatozoa are released by the male during copulation and union of ova takes place with the spermatozoa in the same tubes. This is called as fertilization. After fertilization the zygotes are formed, which is called as pregnancy. At the time of pregnancy the oestrous cycle stops.

**Development** : The zygotes are slowly pushed back through the fallopian tubes by ciliary and muscular actions and reach the uteri in a day or two. Now begins the further development. The first stage in development is cell division which is called as cleavage. Each fertilized egg undergoes repeated divisions. Within 4 days it forms a mass of

38 regulate the flow of *substance such as bile, urine, feces, through the body*

16 cells. It soon becomes hollow and is called as the blastocyst. At this time the sphincter muscles lying at the junction of the fallopian tube and uterus relax and allow the blastocyst to pass into the uterus.

The blastocyst becomes hollow and elongated. On the 6th or 7th day it becomes implanted into a pit in the wall of the uterus. The young one is now called as an embryo. At the end of the second week of pregnancy a disc-shaped placenta is developed. It is a spongy structure developed between the uterine wall of the mother and the embryo. Now embryo is called as foetus. The placenta helps the foetus for nourishment, respiration and excretion, upto the time of birth. Each embryo or foetus developing from a zygote gets surrounded by special protective foetal membranes.

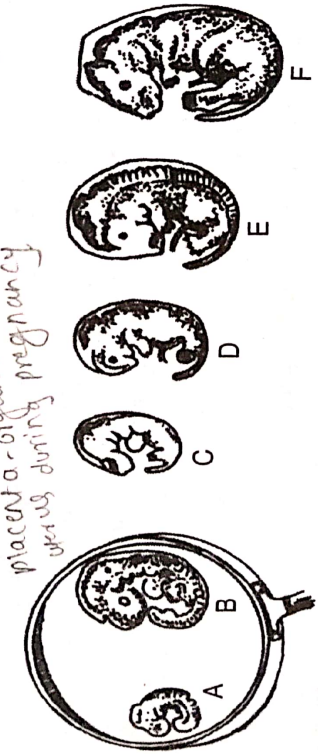


Fig. 1.39 : Stages in the gradual development of rat foetus

The period of foetal development in the uterus is known as gestation period. In rat this period, is about 21-30 days. During this period, maturation or ripening of the follicles and ovulation are stopped

totally. On the completion of the development of the foetus, the uterus undergoes rhythmic contractions which rupture the embryonic membranes, loosen the placental connection, and then gradually expel the young one from the uterus through the vagina and vulva. The process of giving birth to young ones is known as

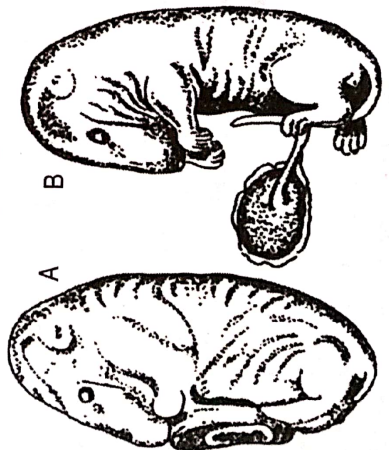


Fig. 1.40 : Young ones of rat with placenta and umbilical cord

parturition. The duration between fertilization of the ovum and birth of the young one is called the gestation period.

Rat is very prolific breeder and may have 5-6 litters a year. Average number of young in a litter is about eight. In rat young are born one at a time and within 1-2 hours all the young ones are delivered. The young rats are born naked and blind. They are unable to move from place to place or to protect themselves. They are fed on milk till they are about 3 weeks old. At this time they have grown hair, they are able to see and move any where. They get the teeth and behave like their parents in habits.

**(F) NERVOUS SYSTEM - BRAIN**

There is always a close relationship between the organism and its environment. An immediate response is given by an organism, if there is a change in the surrounding. Such response is to be initiated, controlled and co-ordinated in a proper manner. In most multicellular organisms like rat, all the activities are controlled and co-ordinated through a system called nervous system.

The nervous system of rat consists of the central nervous system, the peripheral nervous system and autonomic nervous system.

The brain and spinal cord constitute the central nervous system. The peripheral nervous system consists of the cranial and the spinal nerves. Closely associated with this nervous system there is autonomous nervous system which constitute the parasympathetic and sympathetic system.

The brain and the spinal cord are enclosed in the cranial cavity of the skull and the neural canal of the vertebral column respectively. They are also covered by connective tissue sheaths collectively called as the meninges.

**1. Brain**

The brain lies within and protected by the cranium. The cranial nerves arising from the brain emerge through a number of foramina in the skull. The brain of rat is divisible into three regions : the fore-brain, mid-brain and hind-brain. Posteriorly, the hind brain constitutes the spinal cord.

(a) **Fore brain** : The fore brain is an anterior part of the brain which consists of a pair of olfactory lobes, a pair of large cerebral hemispheres and the diencephalon.

(i) **Olfactory lobes** : These are small and lie anteriorly. These are