UNIT 12 THE REPRODUCTIVE SYSTEM

Structure

12.1 INTRODUCTION

In the previous units, we learnt about the physiology of various body systems. In this last unit, we are going to deal with the reproductive system, both female and male reproductive organs along with their functions. The ability to reproduce, as you already know, is one of the properties which distinguishes living from the non-living matter. In human beings, this process is through sexual mode of reproduction.

We will study about the role of different hormones that are involved in the growth and development of the sex organs. You would realize that like any other organ system, this system has also some disorders which could possibly affect the normal functioning of the reproductive system. What are these? What are their possible effects? In this unit, we would learn about these issues.

Further in this unit, we shall look at the various physiological changes taking place in the body during the periods of pregnancy and lactation.

Apart from these, we shall deal with contraception. What is it? What are the different methods available? What are their benefits and limitations?

So let us get started.

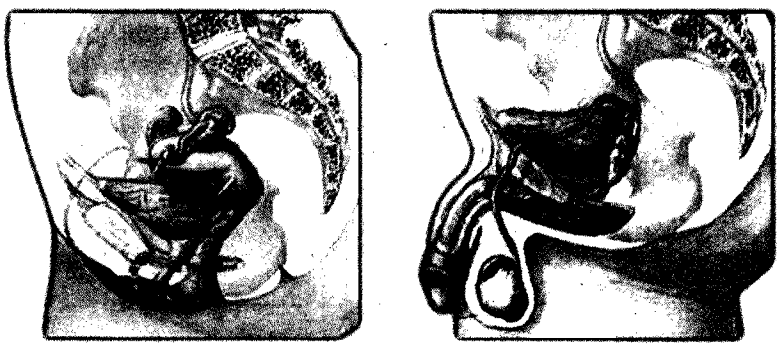
Objectives

After studying this unit, you will be able to:

- enumerate the various reproductive organs of the female and male along with their functions,
- describe the role of different hormones involved,
- highlight the physiological changes during pregnancy and lactation,
- understand the disorders that affect the functioning of the reproductive system,
- enlist the different methods of contraception and their benefits and limitations, and
- discuss the various pregnancy determination tests.

12.2 THE REPRODUCTIVE SYSTEM

The reproductive organs of the male and female differ anatomically and physiologically as you can see in the Figure 12.1. Both the sexes produce specialized reproductive cells called *gametes*, containing genetic material, i.e. genes and chromosomes.



Female reproductive system Male reproductive system

Figure 12.1: Female and male reproductive system

Other body cells contain 46 chromosomes arranged in pairs. The gametes contain only one of each pair i.e. 23 chromosomes. When an ovum is fertilized by a spermatozoon (sperm), the resultant zygote contains the full complement of 23 pairs of chromosomes, half obtained from the mother and half from the father. The zygote embeds in the wall of uterus where it grows and develops during the 40 week gestation period before birth.

The function of the female reproductive system is, therefore, to form the ovum and if it is fertilized, to nurture it until it is born and feed it with breast milk until it is able to take a mixed diet. The function of the male reproductive system is to form the spermatozoa and transmit it to the female. Let us proceed first with the female reproductive system.

12.3 THE FEMALE REPRODUCTIVE SYSTEM

Female reproductive organs or genitalia are divided into *external* and *internal* organs.

The external female genitalia performs two major functions, both allowing the penis and thus the sperm to enter (in order to fertilize an ovum), as well as, protecting the more sensitive internal genital organs from pathogens, which can produce infection. The internal female genitals are: the vagina, the cervix, the uterus, the fallopian tubes and the ovaries. Let us learn about the external and the internal female reproductive organs in greater details.

12.3.1 External Genitalia

The external genitalia are collectively known as *vulva*, which consists of:

1) Mons Pubis
2) Labia Majora
3) Labia Minora
4) Clitoris
5) Vestibule
6) Hymen
7) Greater Vestibular glands

Let us get to know about their structure and location in the body. Look at Figure 12.2 which illustrates these parts.

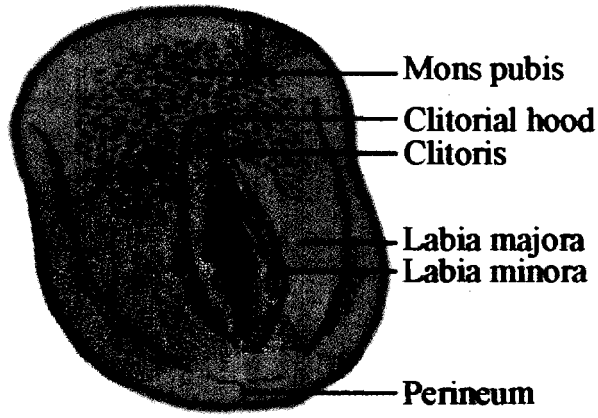


Figure 12.2: External genitalia

1) *Mons pubis:* The *mons pubis* is a pad of fatty tissue over the pubic bone. This structure, which becomes covered with hair during puberty, protects the internal sexual and reproductive organs.
2) *Labia Majora:* The labia majora are two spongy folds of skin, one on either side of the vaginal opening, that cover and protect the genital structures. They form the boundary of vulva, as shown in the Figure 12.2. It is composed of skin, fibrous tissue, fat and sebaceous glands. The fold joins anteriorly and posteriorly. At puberty, hairs grow on the mons pubis and lateral aspects of labia majora.
3) *Labia Minora:* The labia minora are the two erectile folds of skin between the labia majora that extend from the clitoris on both sides of the urethral and vaginal openings. They have sebaceous gland and they posteriorly fuse as shown in the Figure 12.2. The cleft between labia minora is the *vestibule*. Here, vagina, urethra and ducts of greater vestibular glands open.
4) *Clitoris:* It contains an erectile tissue. The *clitoris,* in fact, is an erectile, hooded organ at the upper joining of the labia that contains a high concentration of nerve endings and is very sensitive to stimulation. The clitoris is the only anatomical organ whose sole function is providing sexual pleasure.
5) *Vestibule:* The vestibule is the space where the vagina opens.
6) *Hymen:* It is the mucous membrane which partially occludes the vaginal membrane.

7) *Greater Vestibular Glands:* They lie in labia majora near the vaginal opening. They have ducts opening into vestibule. They secrete mucous so that the vulva remains moist.

Next we move on to the internal organs.

12.3.2 Internal Organs

The internal organs lie in the pelvic cavity and contain vagina, the cervix, uterus, fallopian tubes and the ovaries as you can see in the Figure 12.3. Let us get to know these structures.

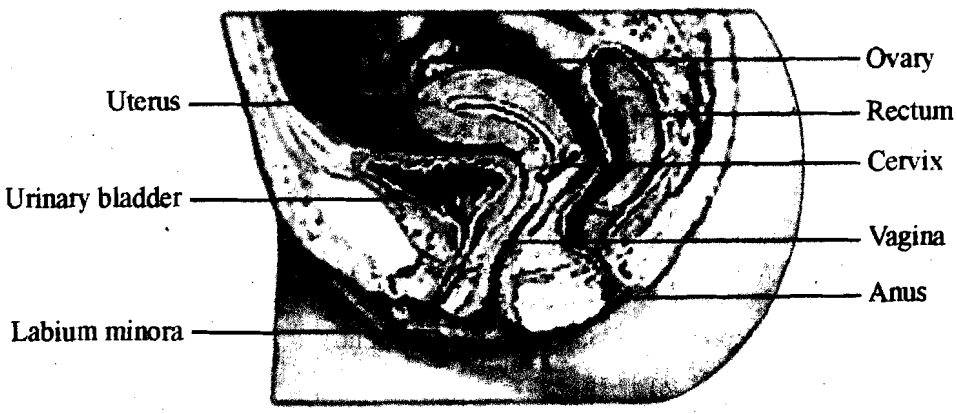


Figure 12.3: The internal organs of the female reproductive system

A) *Vagina:* The vagina is a muscular, highly expandable, tubular cavity leading from the vestibule to the uterus as shown in the Figure 12.3. It is a fibro-muscular tube lined with stratified epithelium. It lies in front of anus and has rectum at the posterior part.

B) *Uterus:* It is a hollow muscular pear-shaped organ, flattened antero-posteriorly. As you can see from the Figure 12.3, it lies in the pelvic cavity. When the body is in the upright position, it lies in almost horizontal position. Parts of the uterus are *fundus, body* and *cervix*, which are shown in Figure 12.4.

The walls of the uterus has 3 layers of tissues perimetrium, myometrium and endometrium.

The uterus is supported by surrounding organs, muscles of the pelvic floor, ligaments that suspend it from the walls of the pelvis.

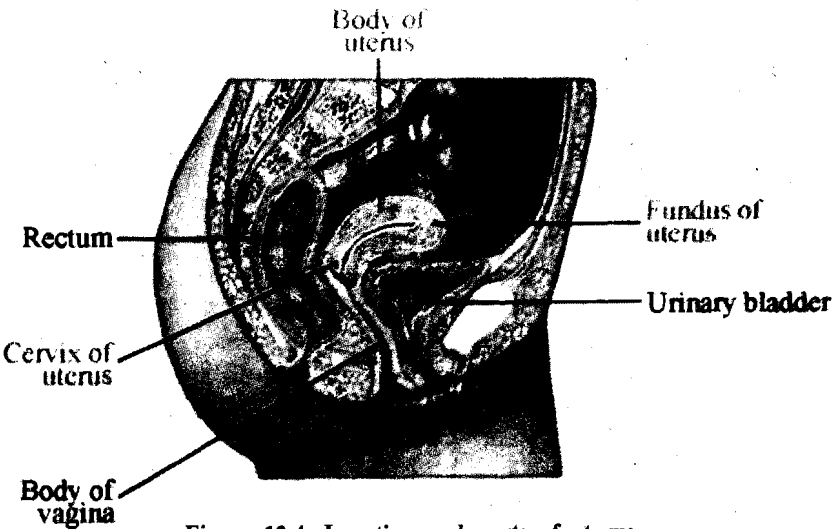


Figure 12.4: Location and parts of uterus

What are the functions of the uterus? Let's find out.

The functions of the uterus have been considered at the different stages in the following discussion:

1) After puberty, uterus goes through a regular cyclic change, the *menstrual cycle*, which prepares it to receive, nourish and protect a fertilized ovum.

2) It helps the growth of foetus during the 40 week gestation period, at the end of which the baby is born. The cycle lasts between 26-30 days. If the ovum is not fertilized, the cycle ends with a short period of bleeding, referred to as *menstruation*.

3) If the ovum is fertilized, the zygote embeds in the uterine wall which relaxes to accommodate the growing foetus. It provides the right environment for the embryo and foetal growth. At the end of the gestation period, labour begins and is concluded when the baby is born, and the placenta is extruded.

4) During labour, the muscle of the fundus and body of the uterus contract intermittently, and the cervix relaxes and dilates. As labour progresses, the uterine contractions become stronger and more frequent. Thus the uterus muscles contract and expels the foetus and the placenta.

C) *Uterine tubes (Fallopian tubes):* The fallopian tubes are *a pair of tubes that extend from the upper uterus, extending out toward the ovaries* (but not touching them), through which ova (eggs) travel from the ovaries towards the uterus and in which fertilization of the ovum takes place. The end of each tube has finger – like projections called *fimbrae,* as can be seen in Figure 12.5. Let us find out what its structure and functions are.

Structure of fallopian tubes: The tubes have an outer covering of peritoneum, middle layer of smooth muscle and are lined with ciliated epithelium.

Functions of fallopian tubes: The fallopian tubes assist in transporting the ovary and spermatozoa. The mucous present in the fallopian tube helps in smooth movement of ova and spermatozoa. Fertilization takes place in the uterine tubes, then the zygote moves into the uterus.

D) *Ovaries:* They are female gonads or sex glands, lie shallow in the walls of pelvis. Look at Figure 12.5. The ovaries are two organs located at the end of each fallopian tube, that produce ova (releasing one per month from puberty to menopause). The ovaries produce *oestrogen* and *progesterone*, the hormones responsible for the development of sex characteristics. Each ovary is attached to the upper part of uterus by the ligament of the ovary. Let us understand the structure and functions of ovaries.

Structure and *functions of ovaries:* The ovaries have 2 layers of tissue. The *medulla* lies in the center and consists of fibrous tissue, blood and nerves. The *cortex* surrounds the medulla. It has a framework of connective tissue or stroma covered by germinal epithelium. It contains ovarian follicles, each of which contains an ovum. Before puberty, the ovaries are inactive but the stroma already contains immature (primordial) follicles as shown in Figure 12.5. During the child bearing years, one ovarian follicle matures, then ruptures and releases its ovum into the peritoneal cavity during each menstrual cycle. The process of ovum formation in females is called *oogenesis*.

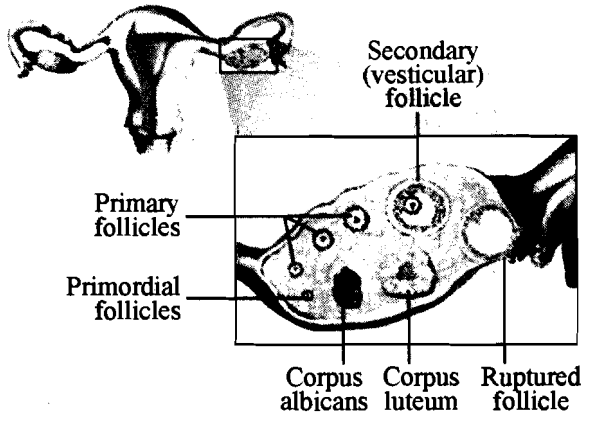


Figure 12.5: Structure of an ovarian follicle

Maturation of the follicle is stimulated by follicle stimulating hormone (FSH) from the anterior pituitary. Figure 12.6 highlights the female reproductive hormones and their target tissues. While maturing, the follicle lining cells produce the hormone oestrogen. After ovulation, the follicle lining cells develop the corpus luteum (yellow body), as shown in the Figure 12.5, under the influence of *luteinizing hormone* from the anterior pituitary.

The *corpus luteum,* as can be seen in Figure 12.6, produces the hormone progesterone. If the ovum is fertilized, it embeds in the wall of the uterus where it grows and develops and produces chorionic gonadotropin hormone which stimulates the corpus luteum to continue secreting progesterone for the first 3 months of the pregnancy.

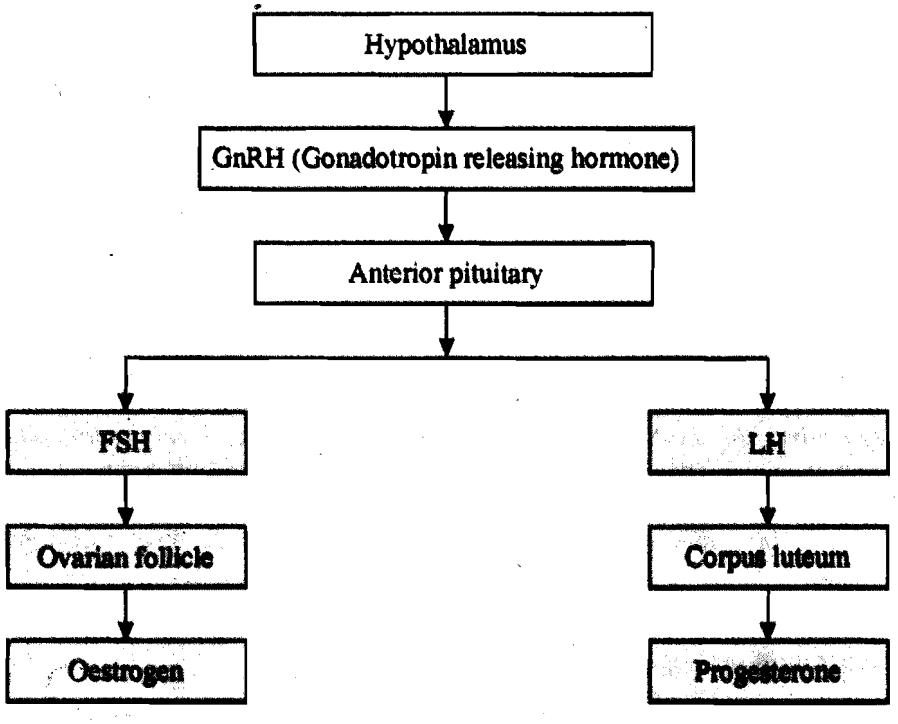


Figure 12.6: Female reproductive hormones and target tissues

If the ovum is not fertilized, the corpus luteum degenerates, menstruation occurs and the next cycle begins. Refer to Figure 12.7, where all these steps have been indicated. Sometimes more than one follicle matures at a time, releasing 2 or more ova in the same cycle. When this happens and the ova are fertilized, the result is a multiple pregnancy. What is menstruation? Which hormones are involved in it? What are the phases of the menstrual cycle? We shall learn about these aspects next.

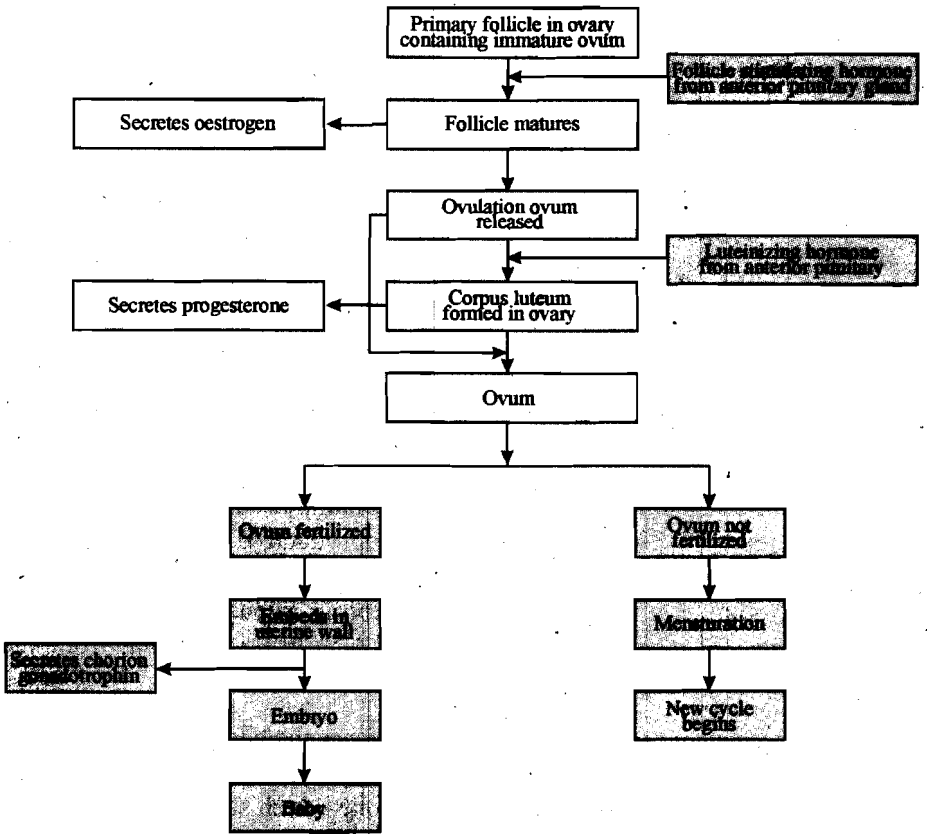


Figure 12.7: A summary of stages of development of the ovum and the associated hormones

12.3.3 Menstrual Cycle

What is menstrual cycle? Menstrual cycle, is *a series of events that occur regularly in females every 26-30 days*. The cycle consists of a series of changes that take place concurrently in the ovaries and uterine walls.

Menstrual cycle, in fact is a recurring cycle (beginning at menarche and ending at menopause) in which the endometrial lining of the uterus prepares for pregnancy. If pregnancy does not occur, the lining is shed at menstruation. The average menstrual cycle is 28 days.

Next, let us see how the cycle begins? The cycle begins with the *hypothalamus*. The hypothalamus, as you already know by now, is *a structure in the brain responsible for regulating the body's thirst, hunger, sleep patterns, libido and endocrine functions*. It releases the chemical messenger, follicle stimulating hormone releasing factor (FSH-RF) to tell the pituitary, another gland in the brain, to do its job. The anterior pituitary then secretes the following hormone as also highlighted in Figure 12.6.

1) *Follicle stimulating hormone:* promotes the maturation of ovarian follicles, secretion of oestrogen, leading to ovulation, and

2) *Luteinizing hormone:* stimulates corpus luteum and secretion of progesterone.

The hypothalamus responds to changes in the blood of oestrogen and progesterone. It is depressed by high levels and stimulated when they are low.

What are the phases of the menstrual cycle? Next, let us get to know about these phases. The phases in the menstrual cycle are as follows:

1) *Proliferative phase (10 days):* An ovarian follicle stimulated by FSH, grows towards maturity and produces oestrogen. Oestrogen stimulates proliferation of endometrium, prepares for receiving the fertilized ovum. The endometrium lining becomes tall and thick by rapid cell multiplication. The phase ends when ovulation occurs and oestrogen production stops.

2) *Secretary phase (14 days):* After ovulation, the lining of ovarian follicle is stimulated by LH to develop corpus luteum which produces progesterone. The endometrium becomes oedematous, watery mucous increases. This is believed to assist the passage of spermatozoa through the uterus to uterine tubes where the ovum is usually fertilized.

   The ovum fertilizes by 8 hours. The survival of the sperm is only for 24 hours. The date of ovulation however, cannot be predicted with certainty, even when the cycles are regular. If fertilization of ovum does not occur, cycle goes to a third phase – the *menstrual phase.*

3) *Menstrual Phase (4 days):* If the ovum is not fertilized, a high level of progesterone in the blood inhibits the activity of pituitary gland and the production of luteinizing hormone is reduced. The decrease in hormone causes degeneration of corpus luteum. Thus progesterone production is decreased. Around 14 days after ovulation, the lining of uterus degenerates and breaks down, menstruation begins. The flow consists of extra secretion of endometrial cells, blood from broken capillaries and the unfertilized ovum.

When progesterone levels decreases considerably, another ovarian follicle is stimulated by FSH and the next cycle begins.

What happens when the ovum is fertilized?

If the ovum is fertilized, there is no breakdown of endometrium and no menstrual flow. The fertilized ovum travels through uterine tube to the uterus where it becomes embedded in the wall and produces chorion gonadotrophins as highlighted in Figure 12.7. This keeps corpus luteum intact enabling it to continue to secrete progesterone for the first 3-4 months of pregnancy, inhibiting the maturation of ovarian follicles. During that time, placenta develops and produces oestrogen, progesterone and gonadotrophins. The placenta provides an indirect link between the circulation of the mother and that of the foetus. Through the placenta, the foetus obtains maturational materials, O_2, antibodies and gets rid of CO_2 and other waste products.

While on the topic of menstrual cycle, we must also focus on menopause.

What is menopause?

The cessation of menstruation is menopause. Natural menopause typically occurs between 45 and 55 years of age. It is caused by changes in concentration of the sex hormones.

During menopause, the ovaries become less responsive to the FSH and LH and ovulation and menstrual cycle becomes irregular, eventually ceases. Other changes are vasodilatation, sweating palpitations, discomfort and disturbance in normal sleep and shrinking of breasts, atrophy of sex organs etc.

The discussion above focused on menstruation and menopause. The two terms are used commonly with respect to female reproductive system. While studying about the female reproductive organs, you might also come across certain accessory glands such as the mammary glands. What are these glands? Let's find out.

12.3.4 Accessory Glands – Breasts or Mammary Glands

The breasts or mammary glands are accessory glands of the female reproductive system. They also exist in the male but only in a rudimentary form. Figure 12.8 illustrates the mammary gland.

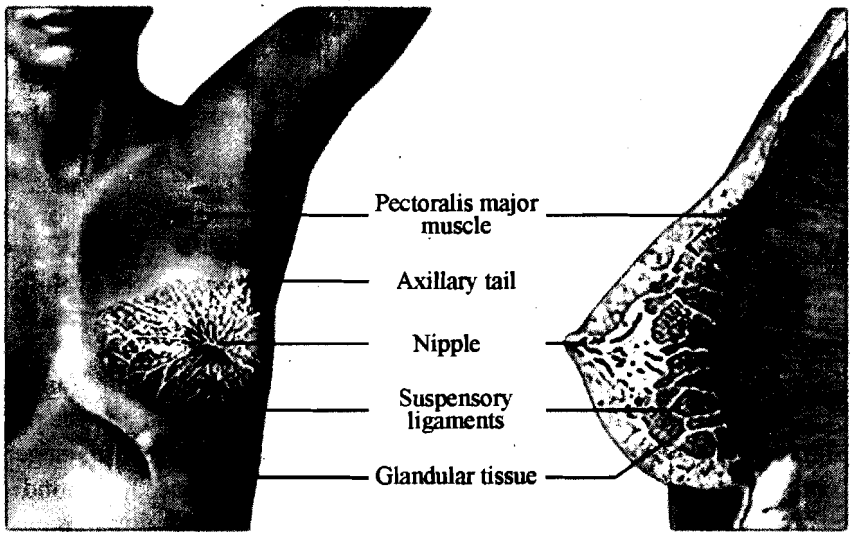


Figure 12.8: Structure of mammary gland or breast

The breasts are small until puberty. They develop to their mature size under the influence of oestrogen and progesterone. During pregnancy, these hormones stimulate further growth. After the baby is born, protection from anterior pituitary stimulates the production of milk. The posterior pituitary stimulates release of milk in response to the stimulation of the nipple by the sucking baby. The mammary glands consist of a glandular tissue, fibrous tissue and a fatty tissue. as can be seen in Figure 12.8. In human females there are usually two mammary glands, one in each breast, although polythelia (accessory nipples) and polymastia (accessory glands) can occur anywhere from the knee to the neck.

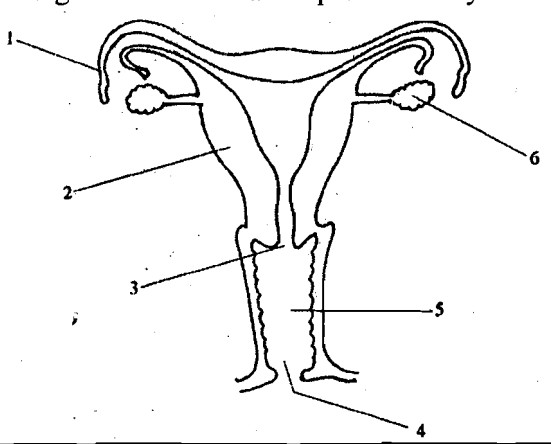
The mammary glands overlie the pectoral muscles as can be seen in Figure 12.8 and are attached to them via *fascia* (connective tissue). The glands are connected to the skin by the suspensory ligaments of the breast. These glands are *modified sweat glands* that produce and secrete milk during the lactation process to feed the newborn. During pregnancy, high blood oestrogen and progesterone levels stimulate lactation. The corpus luteum produces these hormones during early pregnancy, the placenta takes over later. The hormones stimulate the ducts and glands in the breasts, enlarging the breasts. So remember, the development of mammary glands is controlled by hormones. *Oestrogen* promotes formation of mammary glands, while testosterone inhibits it. *Prolactin*, which is stimulated by oestrogen, acts on the mammary glands to produce milk (lactation).

We shall get to know more about the structure and function of the mammary glands later in section 12.6 under lactation.

With the study of the accessory glands, we come to an end of our discussion about the organs of the female reproductive system. In the next section we will focus on the male reproductive system.

Check Your Progress Exercise 1

1) Identify the organs of the female reproductive system.



2) Enumerate the functions of the following organs:

   a) Uterus

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   b) Fallopian tubes

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3) What are the phases of menstrual cycle? Also mention the hormonal and physiological changes occurring during menopause.

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4) Which hormones are responsible for stimulating changes in the following organs? Also mention their roles.

   a) Ovaries

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   .....

   b) Mammary glands

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12.4 THE MALE REPRODUCTIVE SYSTEM

We have studied about the female reproductive system in the last section. We saw that most of the organs of the female reproductive system are located inside the pelvis. Unlike the female, the male have sex organs or genitals, both inside and outside the pelvis. We shall look at the different organs that constitute the male reproductive system in this section and also learn about male puberty. Let us start with a review on the male reproductive system.

12.4.1 What is the Male Reproductive System?

The male reproductive system includes:

1) The scrotum which contains -
   a) two testes, and
   b) two epididymis
2) A pair of vas deferens
3) A pair of spermatic cords
4) A pair of seminal vesicles
5) A pair of ejaculatory ducts

6) Prostrate gland
7) Penis

Figure 12.9 illustrates these organs of the male reproductive system.

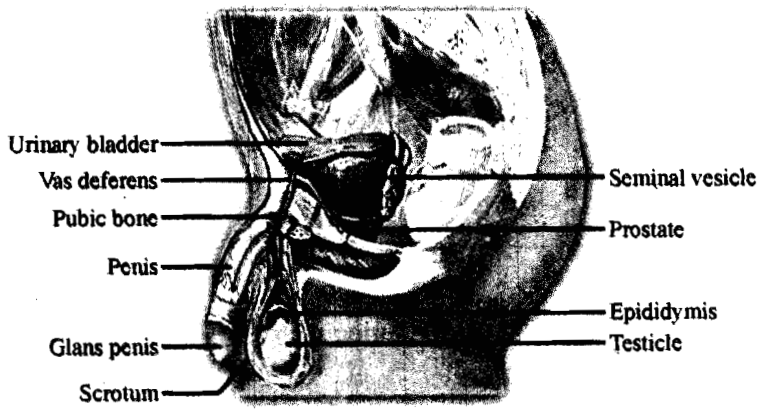


Figure 12.9: Parts of the male reproductive system

Let us get to know about the physiology of these organs.

1) *Scrotum*: It is a pouch, as can be seen in Figure 12.9, divided into two compartments each of which contains a testis, an epididymis, testicular end of a spermatic cord. It lies in front of the upper part of the thighs and behind the penis. Let us get to know about these different parts within the scrotum.

   a) *Testes:* They are male reproductive glands, suspended in the scrotum by spermatic cords. Testes produce and store millions of tiny sperm cells. Testes are surrounded by 3 layers of tissues.

      - *Tunica vaginalis:* Outer covering which grows downward. In early foetal life, they develop in lumbar region, just below the kidneys. They descend into the scrotum and peritoneum covers them. It also surrounds the testis. This is almost completed by 8th month of foetal life.
      - *Tunica albugenia:* A fibrous cover surrounds the testes is situated under tunica vaginalis. It grows in depth, forms septa, and divides the glandular structure of testis into lobules.
      - *Tunica vasculosa:* It consists of a network of capillaries supported by delicate connective tissue.

      Testes are also a part of the endocrine system because they produce hormones, including testosterone. Along with the testes are the epididymis and vas deferens which make the duct system of the male reproductive system. Let us get to know them.

   b) *Epididymis:* It is the tightly coiled, thin-walled tube that conducts sperm from the testicles (testes) to the vas deferens. Figure 12.10 presents a schematic representation of the epididymis. The epididymis, as you can see, can be divided into a number of segments or regions: initial segment, caput (head), corpus (body), cauda (tail) and the vas deferens. The epididymis provides for the storage, transmission and maturation of sperm. Apart from this, it facilitates the transport of spermatozoa along the duct and protects spermatozoa from harmful substances.

To the right in Figure 12.10, are shown cross-sectional representations of the epididymal duct at each region. Note how the luminal diameter increases and the cell height decreases from the initial segment to the cauda.

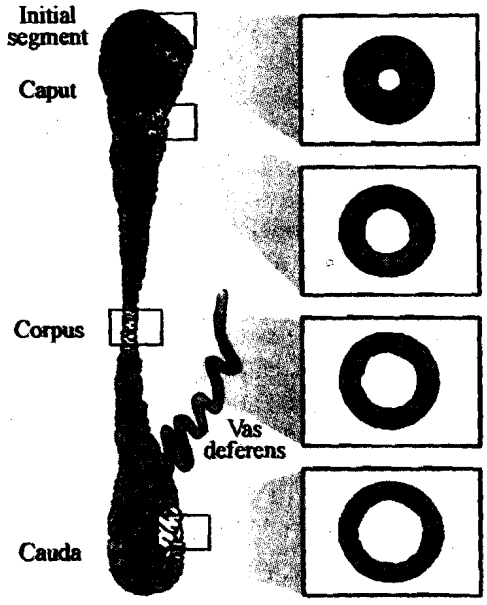


Figure 12.10: Schematic representation of an epididymis

We have looked at the epididymis and the testicles in the discussion above. Note, the epididymis and the testicles hang in a pouch-like structure outside the pelvis in the scrotum. This bag of skin, called the *scrotum* helps to regulate the temperature of testicles, which need to be kept cooler than body temperature to produce sperm.

2) *A pair of Vas Deferens:* Its name is Latin, which literally means "carrying-away vessel". It is a long, muscular tube that passes upward alongside the testicles and carries spermatozoa from the epididymis to the ejaculatory duct, as illustrated in Figure 12.11, and transports the sperm-containing fluid called *semen.* During ejaculation, the wall of the vas deferens thickens and thins itself, thus propelling the sperm.

Figure 12.11: Figure showing the location of vas deferens and testicles

3) *The Spermatic cords:* These are two, one leading from each testis, by suspending it in the scrotum. It is composed of fibrous tissue, smooth muscle, connective tissue, lymph and blood vessels, nerves and deferent duct.

4) *Seminal vesicles:* These are two small fibro-muscular pouches as you can see in Figure 12.9, lined with columnar cells. They are sac-like structures attached to the vas deferens to the side of the bladder. In fact, they lie on the posterior aspect of bladder. At its lower end, each vesicle opens into a short duct which joins the corresponding deferent duct to form an ejaculatory duct.

5) *Ejaculatory ducts:* They are 2 tubes, 2 cm long, each formed by the union of the duct from a seminal vesicle and a deferent duct. They pass through prostrate gland and join the urethra. The tissue layers are parallel as in seminal vesicles.

6) *Prostrate glands:* It lies in the pelvic cavity, as depicted in the Figure 12.12. If you have a closer look at it, you will notice that the prostate gland, which produces some of the parts of semen, surrounds the ejaculatory ducts at the base of the urethra just below the bladder. The prostrate gland has an outer fibrous covering, layer of smooth muscles, glandular cells, columnar cells etc. It secretes a thin lubricating fluid, passes into urethra through numerous ducts.

7) *Urethra:* The urethra is the channel that carries the semen to the outside of the body through the penis. The urethra, about which you may recall reading earlier in Unit 7, is also part of the urinary system because it is also the channel through which urine passes as it leaves the bladder and exits the body. Hence, male urethra provides a common pathway for the flow of urine and semen. It is almost 18-20 cm long, originates at the urethral orifice in the bladder, where it is surrounded by prostrate gland, passes through the perineum into the penis. Have a look at the Figure 12.12, where you can see all these structures and their location.

There are 2 urethral sphincters, internal and external sphincter which consists of striated muscle fibres surrounding membranous part.

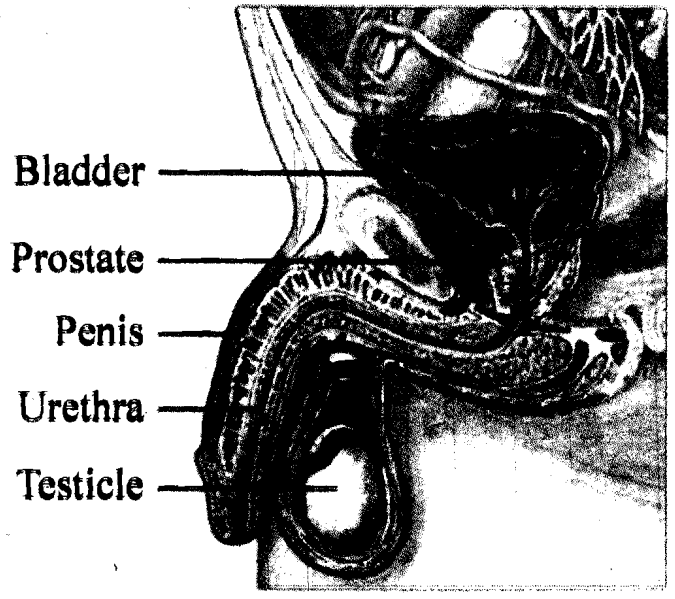


Figure 12.12: Figure showing the location of urethra and prostrate glands

8) *Penis:* The *penis* has a root and body. It is formed by 3 erectile masses of tissues and involuntary muscle. Erectile tissue is supported by fibrous tissue and covered with skin. It has a rich blood supply. The two lateral columns of tissues are known as *corpora cavernosa* and the median column is *corpora spongiosa.* At its tip, it is expanded into a triangular structure known as *glans penis*, above which is a flap of double layered movable skin referred to as prepuce. It is supplied with autonomic and somatic nerves. Parasympathetic stimulation leads to engorgement with blood and erection of penis.

So far we have looked at the male reproductive system. Next, let us look at what functions does this system perform. Certainly, we know it is a organ which makes the sperm, which along with the egg, produced by the female reproductive system, helps in reproduction. Let us get to know the process of sperm formation i.e. spermatogenesis in greater details.

Sperm development, i.e. *spermatogenesis* takes place in the *seminiferous tubules* (ducts) of the testes. Cell division produces spermatozoa (mature sperm cells) that contain one-half of a man's genetic code. Each spermatogenesis cycle consists of six stages and takes about 16 days to complete. Approximately five cycles, or 2 ½ months are needed to produce one mature sperm. Mitochondria (energy-generating organelles) inside each sperm powers its tail (flagellum) so that it can swim to the female egg once inside the vagina. Figure 12.13 illustrates the structure and parts of a spermatozoa. Sperm development is ultimately controlled by the endocrine (hormonal) system that comprises the hypothalamic-pituitary-gonadal axis.

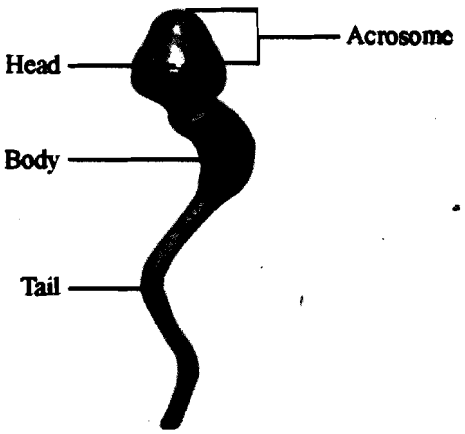


Figure 12.13: Structure of a spermatozoa

The male reproductive organs are stimulated by gonadotrophic hormones from the anterior lobe of pituitary gland. The FSH stimulates the seminiferous tubules of testes to produce male germ cells, the *spermatozoa*. The spermatozoa passes through epididymis, deferent duct, seminal vesicle, ejaculatory duct and finally reach the urethra. *Semen* is the fluid ejaculated from urethra. It consists of (a) spermatozoa (b) viscid fluid, which nourishes the sperm (c) thin lubricating fluid from prostrate glands, and (d) mucus by the glands of urethra.

In the epididymis and deferent duct, the spermatozoa become more mature and are capable of independent movement through a liquid medium. An ejaculation usually consists of 2-5ml of semen containing 40-100 million spermatozoa/ml. If they are not ejaculated, they are reabsorbed by the tubules. Generally, spermatogenesis occurs at 3 degree Celsius less than the body temperature.

In section 12.3, we studied about menstruation, i.e. female puberty. Puberty, in fact, refers to *the physical development when sexual reproduction first becomes possible*. Here in this section, let us review puberty in males.

12.4.2 Male Puberty

Puberty is *the process that occurs when a child grows into a sexually mature individual*. In fact, the reproductive system does not start functioning until puberty. The male maturation, i.e. puberty is from the age of 10-14 years. Puberty is caused by secretion of hormones. Luteinizing hormone from the anterior lobe of pituitary gland stimulates the interstitial cells of the testes to increase the production of testosterone. This hormone influences development of the body to sexual maturity.

Next, let us look at the changes which occur at puberty. These include:

1) growth of bones, muscles, increase in height and weight,

2) enlargement of larynx and deepening of the voice – it 'breaks',

3) growth of hair on the face, maxillae, chest, abdomen and pubis,

4) enlargement of penis, scrotum and prostrate gland, and

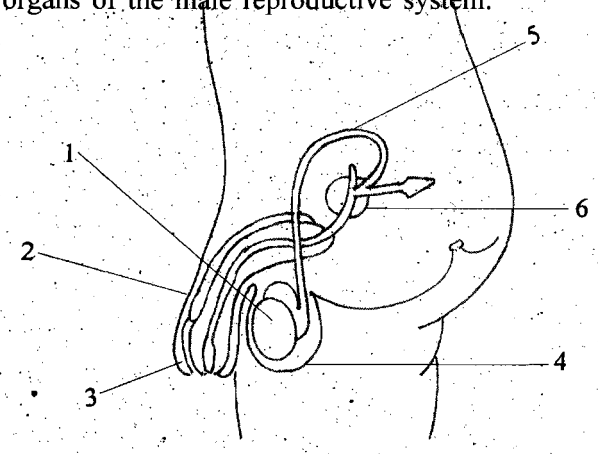
5) maturation of seminiferous tubules and production of spermatozoa.

Though sexual ability in males declines with age, interestingly, there is no period in males comparable to menopause in the females.

Our study so far focused on understanding the structure and the role of the different organs of the male and female reproductive system. We learnt that the female reproductive organs produce the eggs and the male organs produce the sperm. You may already know that the sperm and the egg unite in the mother's body to form a *zygote* which develops into the foetus. This period from conception to birth when a woman carries a developing foetus in her uterus is called *pregnancy*. Certain physiological changes take place in the mother's body to support the growth and development of the foetus. What are these physiological changes? In the next section we shall study about these aspects. We shall look at these changes during pregnancy and then during lactation. We start with pregnancy. Read this information very carefully, since you will find it useful when you study about pregnancy/lactation, later in the Advance Nutrition Course.

Check Your Progress Exercise 2

1) Identify the organs of the male reproductive system.



2) Enumerate the functions of the following organs:

a) Epididymis

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b) Vas Deferens

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c) Prostrate Glands

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3) Discuss the composition of semen and name the glands that produce it.

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4) Describe the process of spermatogenesis and list the hormones involved in it.

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5) Enumerate the hormonal changes that take place during male puberty.

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12.5 GROWTH AND DEVELOPMENT DURING PREGNANCY

Pregnancy, as you may already know, is the period of time between fertilization of the ovum (conception) and birth, during which mammals carry their developing young in the uterus. The duration of pregnancy in humans is about 280 days, equal to 9 calendar months. After the fertilized ovum is implanted in the uterus, rapid changes occur in the reproductive organs of the mother. The uterus becomes larger and more flexible, the placenta develops, enlargement of the breasts begins, and alteration of renal function, blood volume and blood cell count occur. Growth and development during pregnancy largely reflects the growth and development of the foetus and the placenta. Let us look at the placenta first.

12.5.1 The Placenta

The placenta is *a transitory chorio-decidual structure developing during pregnancy and lies implanted on the uterine wall.* It is connected with the foetus through the umbilical cord. It is not a passive barrier between the mother and foetus but plays a very active role. For the developing foetus, it is the sole critical route for receiving nutrients from the mother and exchanging waste products.

In the early days of pregnancy, the placenta and the two associated structures form from a tiny mass of cells, which you can see in Figure 12.14.

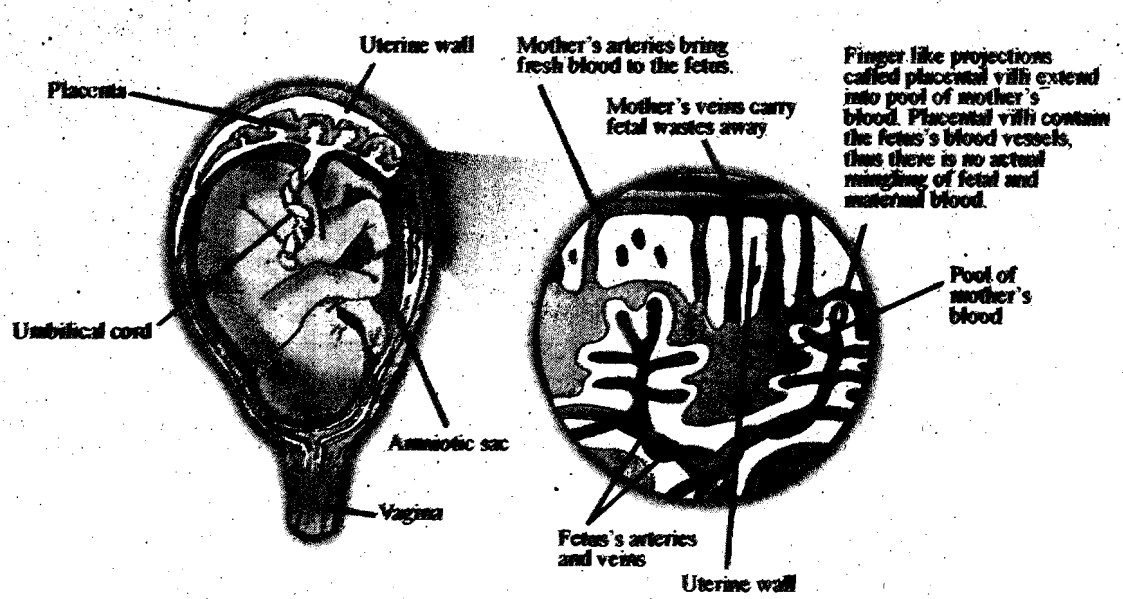

Figure 12.14: The placenta and associated structures

The other two structures are:

i) the amniotic sac, which houses the developing foetus, and

ii) the umbilical cord, a rope-like structure which contains foetal blood vessels which extend through the foetus' umbilicus to the placenta.

The placenta evolves during the 6^{th} – 12^{th} week of pregnancy from a small mass of cells into a complex spongy network of tissues and blood vessels. At 12 weeks of pregnancy, the placenta has attained its definite form.

Table 12.1 presents information regarding the size of the placenta and foetus at different stages of pregnancy.

Table 12.1: Placenta size with progression of pregnancy

	Weeks of Pregnancy			
	10	**20**	**30**	**40**
Foetus (g)	5	300	1500	3000-3300
Placenta (g)	20	170	430	650

After 12 weeks of pregnancy, the placenta has attained its definite form. The placenta has 2 principal parts: *uterine* and *foetal*. On the maternal side, the placenta is a part of the uterine mucosa. When the blastocyst (an early preimplantation embryo) implants in the uterus at 6 – 7 days after fertilization, the uterine tissue and blood vessels breakdown to form small spaces (lacunae) that fill with maternal blood. Blood begins to circulate in the spaces at about 12 day's gestation. Figure 12.14 also highlights the relationship between maternal and foetal side. On the foetal side, the trophoblast grows and sends out root-like villi into the pools of maternal blood. These villi contain capillaries, which will exchange nutrients and waste products between the mother and the foetus.

What is the role of the placenta?

When you read through the functions of placenta, you will realize that it is a versatile, metabolically active organ. Look at the Table 12.2, which summarizes its functions.

Table 12.2: Functions of placenta

Nourishes the foetus	• facilitates transfer of oxygen and nutrients from mother to foetus.
Removes wastes	• picks up foetal waste products such as CO_2, urea, bilirubin.
Foetal lung	• performs the respiratory, absorptive and excretory functions that the foetus' lungs, digestive system and kidneys will provide after birth.
Protective barrier	• protects the foetus from harmful agents, which are of high molecular weight including proteins except maternal immuoglobulin G conferring immunity to the foetus. • transports nutrients and in some cases can store them.
Endocrine gland	• produces several hormones that maintain pregnancy and prepare the mother's breasts for lactation.

One of the special functions of the placenta, as you may have noticed in Table 12.2, is to produce a variety of hormones. In chronological order, with progression of pregnancy, the hormones produced are:

- Human Chorionic Gonadotropin (HCG)
- Progesterone
- Human Placental Lactogen (HPL), and
- Chorionic Somatomammotropin

By means of these hormones, the placenta carries out the functions of the foetus's pituitary until the organ is ready to perform on its own.

Since the placenta plays such a vital role, a healthy placenta is essential for foetal well-being. A well-developed healthy placenta is able to transfer nutrients efficiently. However, conditions such as reduced surface area of the villi, insufficient vascularisation, changes in the hydrostatic pressure in the intervillous space limit nutrient supply to the foetus and constrain growth. Maternal nutrition is important for ensuring placental development. Next, let us study about the foetal growth and development during pregnancy.

12.5.2 Foetal Growth and Development

Intrauterine life is one of the most critical periods. Foetal development begins with fertilization of an ovum by a sperm. Three stages follow: *the zygote, embryo* and *foetus*. Let us look at these three stages of foetal growth and development.

Zygote: The newly fertilized ovum or zygote begins as a single cell. During the days after fertilization it divides. Within 2 weeks, the zygote embeds itself in the uterine wall (implantation). Cell division continues and as development proceeds, the zygote becomes an embryo.

Embryo: The development in the embryonic period is amazing. Let us briefly list the accomplishments during this period (2 to 8 weeks of gestation).

- The number of cells at first doubles approximately every 24 hours.
- The size of the embryo changes very little. At 8 weeks, the 1¼ inch embryo has a complete central nervous system, a beating heart, a digestive system, well-defined fingers and toes, and the beginnings of facial features.

Foetus: During the next 7 months, each organ grows to maturity on its own schedule. Foetal growth is phenomenal, weight increases from < 1 gram to about 3000 gms.

Table 12.3 summarizes the developing foetus's vital statistics and main developmental features. What is of importance is that before the mother even knows she is pregnant, the embryo reaches a critical stage in its development. Therefore, it is vital to:

a) plan for pregnancy, and

b) ensure that the mother is well-nourished and cared for during pregnancy

Table 12.3: Developing foetus's vital statistics and main developmental features

Period	Major developmental features	Vital Statistics
4 weeks	Embryo has gill like structures that will later become its jaw, neck and part of the face. Rudimentary spinal cord appears. By end of the 3rd week, the heart begins to beat. In the 3rd week, the embryo enters a sensitive phase, when all the major organs are forming. Embryos can be harmed by drugs, alcohol, smoking, infections etc.	Length: approx. 4 mm Weight: Less than a gram Crown to rump length: 2.5 cm Weight: Approx. 3 gm.
8 weeks	Face begins to develop, eyes and nose appear. All internal organs are now present, most major structures are formed. Tail is reabsorbed. Muscles start to build. By 7th week, the first embryonic movement can be detected using ultra sound.	Crown to rump length: 9 cm Weight: 48 g
12 weeks	Baby is fully formed, head and neck extend and grow. Bones (in the form of flexible cartilage) are rapidly developed. Jaws show 32 permanent tooth buds.	Crown to rump length: 13.5 cm Weight: 180 g

Period	Major developmental features	Vital Statistics
16 weeks	Respiratory movements and protective "brown fat" can be detected. Taste buds have begun to develop. Eyelids have formed. Begins to make first facial expressions. Retinas of eyes have become sensitive to light.	Crown to rump length: 18.5 cm Weight: 0.5 kg
20 weeks	Ears now well developed. Can hear sounds from outside the uterus. Can distinguish sweet from bitter taste. Skin is sensitive to touch. Teeth have already formed.	Crown to rump length: 25 cm Weight: just under 1 kg
24 weeks	Skin still wrinkled because enough fat deposits have built up. Continues to grow bigger slowly and steadily, puts on more weight, taking up more and more of the uterus. Bronchi of lungs are growing, although they are immature. Has developed patterns of sleeping and waking. Patterns of brain waves resemble those of a full-term new born.	Crown to rump length: 28 cm Weight: 1.5 kg
28 weeks	Continues to gain weight and to mature. Hands are fully formed. Fat builds up under skin, filling out the wrinkles. Eyelids are now open and the baby can now see and focus. Begins to control own body temperature. Bone marrow has now taken over total responsibility for production of RBC. Passes urine into amniotic fluid @ approx. ½ litre per day.	Crown to rump length: 32 cm Weight: 2.5 kg
32 weeks	Puts on weight, about 8 % of total weight is fat – will have gained at least 1 kg since last month, made up primarily of increased muscle tissue and fat. Face now smooth with most of the wrinkles gone. Eyes can now focus and blink. Lungs are still developing. If the baby is born at this stage, she would have breathing difficulties, although she would stand an excellent chance of survival.	Crown to rump length: 35-37 cm Crown to heel length: 20 inches Weight: about 3 kg
38 weeks	Fully mature. Fully formed and working organs. Lungs are mature. Last of the brown fat is laid down.	From eight weeks to term, the foetus has grown 20 times longer and 50 times heavier.

Growth, as you know, consists of hyperplasia and hypertrophy – a combination of both enlargement and maturation of cells. What do we mean by hypertrophy and hyperplasia? The enlargement or overgrowth of an organ or tissue due to an increase in *size* of its cells, rather than the number is *hypertrophy*. On the other hand, enlargement of an organ or a tissue because of an increase in the *number* of cells in that organ or tissue is *hyperplasia*.

You have seen that by 60 days of gestation all the major features of the human infant have been achieved. The foetal stage is a period of most rapid growth, from the 3rd month to term, the weight increases nearly 500-fold. Figure 12.15 depicts the average weight curve of foetal growth.

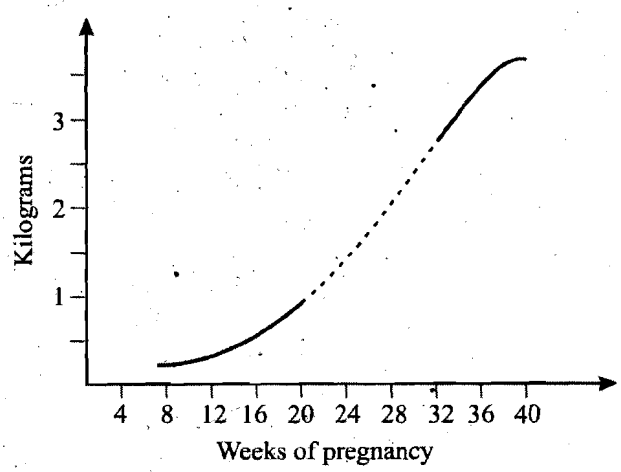

Figure 12.15: Average curve of foetal growth

From our discussion above, you would have got a very clear idea about the growth and development process during pregnancy. Next, let us look at the physiology of lactation.

12.6 PHYSIOLOGY OF LACTATION

Lactation is an ancient physiologic process. It is the period following pregnancy when a woman nourishes a fully developed and a rapidly growing baby with breast milk.

A lactating woman secretes about 500 ml milk/day in the first month which increases to about 1L/day by the fifth month. On an average, a well-nourished lactating woman secretes about 850 ml milk/day. The process of breastfeeding is successfully initiated by at least 99% of women who try.

During pregnancy, a change occurs in the mother's breasts to prepare for milk production and as you have seen, body fat is deposited to ensure that energy is available for lactation. The establishment and maintenance of lactation are determined by several factors including the anatomical structure of the mammary gland and adequate development of the alveoli, ducts and nipples, initiation and maintenance of milk secretion and the ejection of milk from the alveoli to the nipple. Let us look at the anatomy of mammary glands, which you may recall reading earlier under the female reproductive system, are the accessory glands.

12.6.1 Anatomy of the Mammary Gland

The human mammary gland consists of milk-producing cells and a duct system embedded in connective tissue and fat. Figure 12.16 here illustrates the mammary glands.

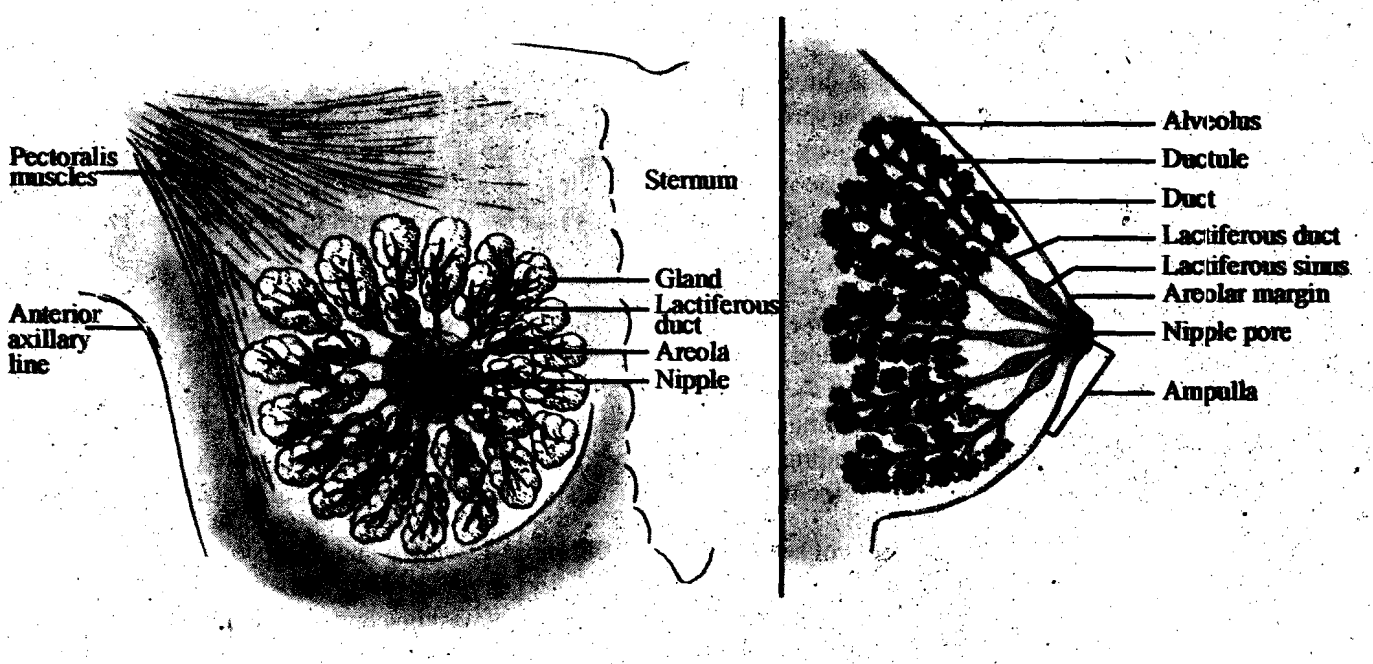

Figure 12.16: General anatomical features of the human breast

The basic components of the mammary gland are the *alveoli* lined with milk-secreting epithelial cells surrounded by myoepithelial cells and a rich capillary network. These alveoli join up to form *lactiferous ducts* that drain into openings in the *areola*.

Each breast consists of 15-20 lobes of glandular tissue, each lobe being made up of a number of lobules as can be seen in Figure 12.16. The lobules consist of a cluster of alveoli, which open into ducts and these unite to form large excretory ducts called *lactiferous ducts*. These ducts converge towards the center of the breast where they form dilatation or reservoirs for milk. Leading these dilatations, there are narrow ducts which open onto the surface at the nipple. Fibrous tissue supports the glandular tissue and ducts, and covers the surface of the gland and is found between the lobes.

The nipple is a small conical eminence at the center of the breast surrounded by a pigmented area, the areola. On the surface of areola, there are numerous sebaceous glands which lubricate the nipple in pregnancy. The function of this gland is to secrete milk.

The nipple contains 15-20 lactiferous ducts surrounded by modified muscle cells. These ducts expand to form the short lactiferous sinuses in which milk may be stored. The sinuses are continuations of the mammary ducts, which extend outward from the nipple towards the chest wall with numerous secondary branches. The ducts end in epithelial masses, which form lobules (15-20 in number). Generally, the terminal tubules and glandular structures are most numerous during the child-bearing period and reach their full physiological development only during pregnancy and lactation.

There is proliferation of the terminal tubules, dilation of the tubular lamina and lining of the acinar structures by cuboidal epithelium. During the last trimester, the clumps of milk-producing cells progressively dilate in final preparation for the lactation process. The breasts are capable of milk secretion sometime in the second trimester.

The placenta plays an important role. The hormones secreted by the placenta – human placental *lactogen, prolactin* and *chorionic gonadotropin,* contribute to mammary gland growth. Also placental *estradiol* and *progesterone* stimulate breast development. Shortly after parturition, proliferation of parenchymal cells occurs.

Next, let us look at the physiology of lactation.

12.6.2 Physiology of Lactation

Lactogenesis is the onset of copious milk secretion around parturition, triggered by a fall in plasma progesterone levels. Although some colostrum is secreted after delivery (2-3 days), full lactation begins later. The first 2-3 days after delivery is a period of rapid lactation initiation, followed by the longer period of maintenance of lactation. This complex neuroendocrine process is facilitated by an interplay of various hormones.

Oxytocin and *prolactin* instigate the lactation process. *Prolactin* is responsible for milk production and *oxytocin* is involved in milk ejection from the breast. The basic secretory units of the mammary gland, as you may already know now, are the *alveoli* composed of a single layer of epithelial cells. The alveoli produce the secretory product. Surrounding the alveoli are the myoepithelial cells which are contractile and are responsible for the ejection of milk from alveoli and alveolar ducts.

A cyclic process of secretory activity, luminal distention and expulsion of milk into the duct system continues throughout lactation as directed by the suckling of the infant and the letdown reflex. Regular sucking stimulates the continuation of milk secretion. Milk removal from the breast is a product of coordinated interaction between suckling of the infant and letdown reflex of the mother. As the infant commences suckling, afferent impulses generated in the receptors in the areola travel to the brain where they stimulate the release of oxytocin from the posterior pituitary. Oxytocin travels through the blood stream to the breast where it combines with specific receptors on the myoepithelial cells, stimulating them to contract and force milk from the alveoli into the mammary ducts and sinuses.

So from our discussion above, you would have got a clear idea about the physiology of lactation. You may have noticed that hormones play an important role both during pregnancy and lactation. In the next section, you will find a comprehensive discussion on the role of hormones in reproduction. So go ahead, read and refresh your understanding.

12.7 ROLE OF HORMONES IN REPRODUCTION

Throughout pregnancy, more than 30 different hormones are secreted in the mother's body, some being specially secreted in pregnancy. Others, which are normally secreted in the non-pregnant state, now have altered rates of secretion.

The mother's health and nutritional status influence their production. As you are aware, in any human being, complex feedback systems maintain homeostasis. During pregnancy, many of these mechanisms are "reset" in order to support retention, utilization or excretion of nutrients. Table 12.4 below lists some of the important hormones, which influence nutrient metabolism in the pregnant mother.

Table 12.4: Hormonal effects on nutrient metabolism in pregnancy

Hormone	Primary Source of Secretion	Principal Effects
Progesterone	Placenta	Reduces gastric motility, favours maternal fat deposition, increases sodium excretion, reduces alveolar and arterial CO_2, interferes with folic acid metabolism.
Oestrogen	Placenta	Reduces serum proteins, increases hydroscopic properties of connective tissue, affects thyroid function, interferes with folic acid metabolism
Human Placental Lactogen	Placenta	Elevates blood glucose from glycogen breakdown
Human chorionic thyrotropin	Placenta	Stimulates production of thyroid hormones
Human growth hormone	Anterior pituitary	Elevates blood glucose, stimulates growth of long bones, promotes N_2 retention
Thyroid stimulating hormone	Anterior pituitary	Stimulates thyroxine secretion, increases iodine uptake by thyroid gland
Thyroxine	Thyroid	Regulates basal metabolism (rate of cellular oxidation)
Parathyroid hormone	Parathyroid	Promotes calcium resorption from bone, increases calcium absorption, promotes urinary excretion of phosphate
Calcitonin	Thyroid	Inhibits calcium resorption from bone
Insulin	Beta cells of pancreas	Reduces blood glucose levels to promote energy production and fat synthesis
Glucagon	Alpha cells of pancreas	Elevates blood glucose levels from glycogen breakdown
Aldosterone	Adrenal cortex	Promotes sodium retention and potassium excretion
Cortisone	Adrenal cortex	Elevates blood glucose from protein breakdown
Renin-angiotensin	Kidneys	Stimulates aldosterone secretion, promotes sodium and water retention

We can summarize the role of hormones as to:

- promote breast development,
- increase fat deposition to provide energy stores to be utilized during late pregnancy and lactation,
- promote uterine growth, and
- relax muscles and ligaments to accommodate the growing foetus and to allow for childbirth.

Among these hormones, progesterone and oestrogen have major effects on maternal physiology. Secretion of oestrogen is lower than that of progesterone during the early months of pregnancy, but rises sharply near term.

Thyroxine has a major role in metabolism and influences caloric requirements. Figure 12.17 depicts the role of thyroxin, estrogen and progesterone in regulating energy metabolism.

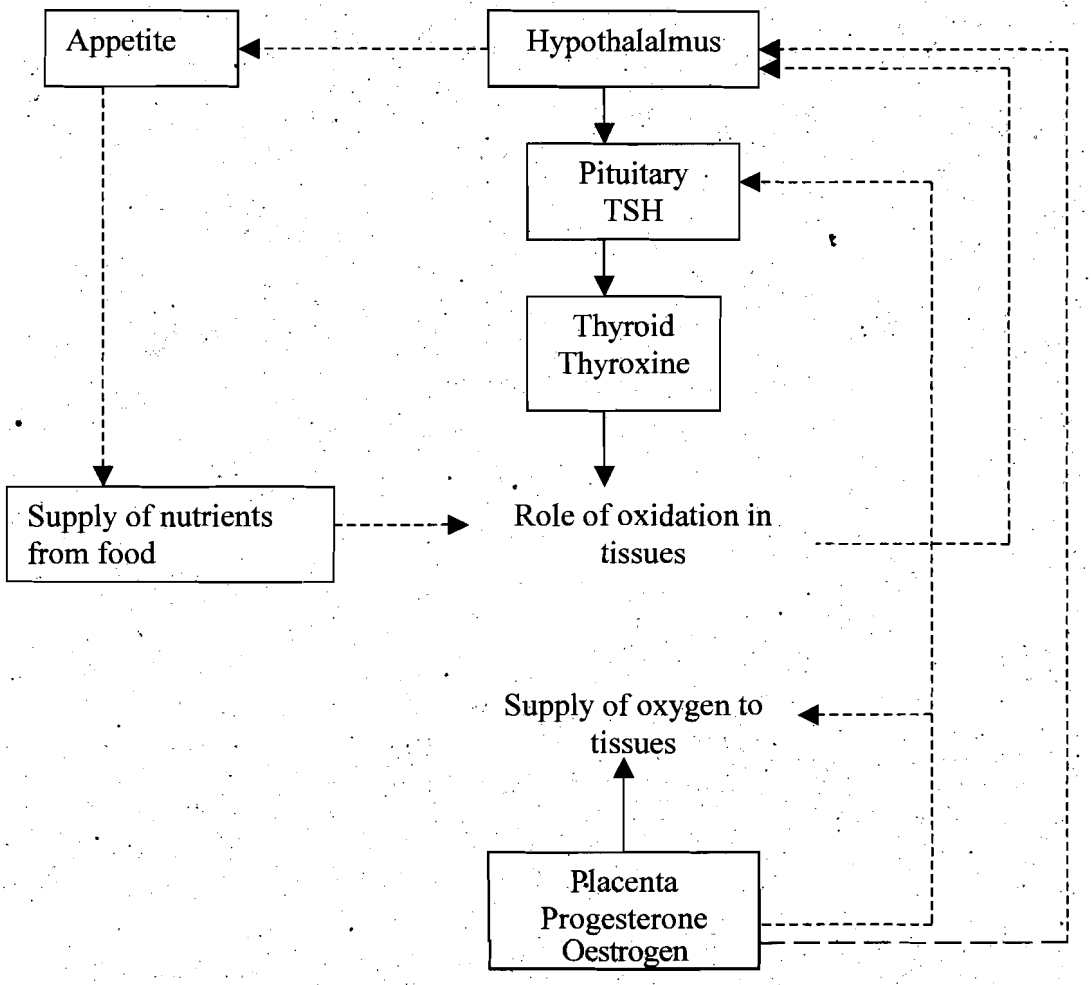

Figure 12.17: Hormonal regulation of energy metabolism in pregnancy

Check Your Progress Exercise 3

1) Define the following terms:

a) Hyperplasia

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b) Hypertrophy

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c) Lactogenesis

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2) Mention the various roles of placenta. List the hormones produced by it.

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3) Enumerate the three stages of foetal development.

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4) What are the basic components of a mammary gland? Also highlight the role of different hormones in the process of lactogenesis.

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5) Discuss the role of following hormones during pregnancy:

a) Progesterone

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b) Oestrogen

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c) Parathyroid

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Sometimes, certain disorders affect the reproductive system, which affect the proper functioning of the organs. What are these disorders? The next section focuses on this aspect.

12.8 DISORDERS OF THE REPRODUCTIVE SYSTEM

Disorders that may affect the proper functioning of the reproductive system include abnormal hormone secretion, sexually transmitted diseases and the presence of cancerous tissues in the region. Such problems frequently affect fertility and may complicate pregnancy. We shall look at the different disorders specific to the female and male reproductive system in this section. Let us start with the study of the disorders affecting female reproductive system.

12.8.1 Disorders of the Female Reproductive System

Over the last decade, there has been a growing concern regarding the prevalence and extent of reproductive tract infections (RTIs) and other gynaecological disorders in women in the developing countries.

For a proper understanding of gynaecological disorders (including reproductive tract infections - RTIs), it is important to have a common conceptual framework for defining the different types of morbidity that can occur in women. Morbidity in women can be categorized as reproductive or non-reproductive morbidity.

Reproductive morbidity refers to *diseases that affect the reproductive system,* although not necessarily as a consequence of reproduction. Reproductive morbidity can be subdivided into three broad categories:

1) *Obstetric/maternal morbidity*, which covers morbidity in a woman who is, or has been, pregnant from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes. *Genitourinary prolapse* and *vesico-vaginal fistula* are classified as obstetric morbidities. Both conditions are usually the direct result of multiple pregnancies and prolonged or obstructed labour respectively. Vesico-vaginal fistula can also be caused by crude attempts at induced abortion, female genital cutting and accidental injury during obstetric surgery and pelvic irradiation.

2) *Gynaecological morbidity*, which covers any condition, disease or dysfunction of the reproductive system that is not related to pregnancy, abortion or childbirth, but may be related to sexual behaviour.

3) *Contraceptive morbidity*, which covers any condition that result from efforts (other than abortion) to limit fertility, whether they are traditional or modern methods.

   There is a considerable overlap between these subcategories. Infertility, for example, can have an obstetric cause but can also be the result of a gynaecological morbidity. However, the focus here is on gynaecological morbidity.

   Gynaecological morbidity can further be divided into reproductive tract infections, endocrine disorders, infertility, gynaecological cancers, congenital malformations or birth defects, injuries, sexual dysfunction, menopausal symptoms and others. Let us discuss each of these.

i) *Reproductive tract infections* include three different types of infection that affect the reproductive tract. These are:

   - *Sexually transmitted infections:* These include, for example, chlamydial infection, *gonorrhoea, trichomniasis*, syphilis, chancroid, *genital herpes, genital warts* (caused by the human papilloma virus) and HIV. They are caused by viruses, bacteria or other microorganisms that are transmitted through sexual activity with an infected partner.

- *Endogenous infections:* These include bacterial *vaginosis* and *candidiasis*, which result from an overgrowth of organisms normally present in the vagina.
- *Iatrogenic infections:* These are caused by the introduction of microorganisms into the reproductive tract through a medical procedure. Iatrogenic infections are acquired through a number of routes, including unhygienic delivery conditions and other procedures such as pregnancy termination, menstrual regulation, IUD insertion, sterilization procedures and circumcision carried out under unhygienic conditions.

Reproductive tract infections are often categorized by the site of infection. Infections that cause inflammation of the external genital area and lower reproductive tract in women are referred to as *vulvovaginitis* or *vaginitis*, inflammation of the cervix as *cervicitis,* and infection of the upper reproductive tract as *pelvic inflammatory disease.*

ii) *Endocrine* or *hormonal disorders* can affect several aspects of reproduction, from menstruation to fertility. Menstrual disorders are frequently reported in studies on gynaecological morbidity and include problems with the regularity, frequency, volume and duration of menstrual bleeding, as well as, painful menstruation and premenstrual syndrome.

iii) *Infertility* can be caused by endocrine disorders, long-term sequelae of sexually transmitted infections, puerperal sepsis, post-abortion sepsis and congenital malformations. In many societies, the social and psychological consequences of infertility are severe. Infertility is, therefore, a component of many population-based studies of gynaecological morbidity.

iv) *Gynaecological cancers* include cancers of the cervix, breast, endometrium, ovary, vagina, vulva and rarely, the fallopian tube. Cervical cancer is the most common cancer in women in the developing world and is often fatal if it is not diagnosed early.

v) Other gynaecological morbidities cover *congenital malformations* or *birth defects* of the genital organs. These occur in almost infinite variations and are often not apparent until an adolescent fails to menstruate or a sexually active woman fails to conceive.

vi) *Injuries* include those caused by traditional practices (such as female genital mutilation), sexual abuse or accidents. Recently, sexual abuse and violence against women have gained recognition as major causes of reproductive morbidity.

vii) *Sexual dysfunction* can be caused by a variety of factors, including infertility, childhood sexual abuse, rape, female genital mutilation, fistula, genito-urinary prolapse, vaginal infections, congenital malformations, adhesions from injuries or inconsiderate partners.

viii) *Menopausal symptoms* include: (i) hormone-related gynaecological problems that occur around the menopause, and (ii) post-menopausal uterine bleeding and atrophic vaginitis (inflammation of the vaginal mucosa secondary to thinning and decreased lubrication of the vaginal walls caused by a decrease in oestrogen).

ix) Other gynaecological morbidity includes endometriosis, ovarian cysts, uterine fibroids and polyps, and non-inflammatory and inflammatory diseases of the pelvic organs not attributable to sexually transmitted infections (for example, female genital tuberculosis and genital tract schistosomiasis).

Gynaecological morbidity and family planning are closely linked. Symptoms of reproductive tract infections may be attributed to contraceptive methods and might

thus change attitudes towards contraception. For example, the insertion of an IUD or tubal ligation may induce iatrogenic infections, if the surgical instruments are not properly sterilized. Also, IUD insertion may induce pelvic inflammatory disease if lower reproductive tract infections are present at the time of the procedure. Hormonal contraceptives may disturb the balance of the vaginal environment and cause endogenous infections. On the other hand, they may decrease the risk of pelvic inflammatory disease.

Unfortunately, the methods that best prevent pregnancy (hormonal methods, IUDs and sterilization) are not the same methods that best prevent transmission of Sexually Transmitted Infections (STIs) (male and female condoms). Dual protection (protection from both unwanted pregnancy and STIs, including HIV) can be achieved, among other ways, through the use of another method in conjunction with male or female condoms. An alternative is the use of condoms as the principal method of contraception, with the use of emergency contraception in the event of condom slippage or breakage. Given the information gaps that exist, the interaction between gynaecological morbidity and family planning methods, strategies for dual protection and the development of new methods (such as vaginal microbicides) to prevent STIs, including HIV will be the important areas of research in the next decade.

Next, let us look at the disorders of the male reproductive system.

12.8.2 Disorders of the Male Reproductive System

Infertility is *the inability to conceive (reproduce) after at least one year of unprotected intercourse*. Since most people are able to conceive within this time, physicians recommend that couples unable to do so be assessed for fertility problems. In men hormonal disorders, illness, reproductive anatomy trauma and obstruction, and sexual dysfunction can temporarily or permanently affect sperm and prevent conception. We have learnt earlier that sperm development takes over 2 months. So any illness that was present during the first cycle may affect mature sperm, regardless of a man's health at the time of examination. Some disorders become more difficult to treat the longer they persist without treatment.

Let us get to know what are the causes and risk factors to male infertility.

The primary causes of male infertility are problems with sperm production or delivery. Impaired production or delivery may result from hormonal dysfunction; trauma or a defect in the reproductive system and illness. Some of the causes include:

- Cryptorchidism (failure of testes to descend, can impair spermatogenesis)
- Cystic fibrosis (may cause absence of sperm, vas deferens or seminal vesicles)
- Ductal obstruction (caused by repeated infection, inflammation or developmental defect)
- Hemochromatosis (a metabolic disorder, causes iron deposition in the testes)
- Hormone dysfunction (caused by a disorder in the hypothalamic-pituitary-gonadal axis)
- Drugs
- Retrograde ejaculation
- Sexually transmitted diseases (STDs, cause obstruction, infection and scarring)
- Sickle cell anaemia (can cause hypogonadism)
- Systemic disease (fever, infection, kidney disease, metabolic disorder; can impair spermatogenesis)

- Testicular cancer
- Testicular trauma (damage to testes)
- Varicocele (a varicose vein in the network of veins that run from the testicles).

Apart from these, there are certain inflammatory infections of the reproductive organs which are either specific or non-specific. Let us quickly review which organs are affected and what are its consequences.

1) *Penis:* Inflammation of the glands and the prepuce (a fold of skin covering the tip of the clitoris) can be specific or non-specific. In the non-specific, it could be due to lack of personal hygiene. In case of *phimosis* (an abnormal tightness of the foreskin preventing retraction over the glands), the orifice in the prepuce is too small to allow for its normal retraction. If the infection becomes chronic, there may be fibrosis of prepuce which increases the phimosis.

2) *Urethra:* Gonococcal urethritis is the most common specific type of infection. Non-specific infection may be spread from bladder (cystitis) or can occur due to catheterization, cytoscopy or surgery. Both types may spread throughout the system to prostrate, seminal vesicles, epididymis and testes. Due to chronic infection, fibrosis may lead to urethral stricture or obstruction.

3) *Epididymis and testes:* Non-specific epididymitis and orchitis are usually due to infection from the urethra, followed by prostratectomy. Microbes spread through vas deferens or via lymph. Specific epididymitis is caused by gonorrhoea from urethra. It is usually caused by an infection, such as the sexually transmitted disease chlamydia and results in pain and swelling next to one of the testicles. Orchitis is more commonly caused by mumps, viruses, blood-borne from parotid glands. Acute inflammation with oedema occurs about a week after appearance of parotid swelling. The infection is usually unilateral, causes damage to germinal epithelium, results in sterility. *Hydrocele* (pronounced: high-druh-seel) occurs when fluid collects in the membranes surrounding the testes. Hydroceles may cause swelling of the testicle but are generally painless. In some cases, surgery may be needed to correct the condition.

4) *Prostrate gland:* Non-specific infections from urethra, bladder, catheterization, cytoscopy, urethral dilatation, partial resection of glands etc. causes *prostatitis* i.e. inflammation of the prostrate gland. Fibrosis may occur during healing causing urethral stricture or obstruction. Beningn prostrate enlargement is common in men above 50 years. Though the cause is not clear, it could be due to acceleration of aging and decline in androgen secretion.

5) *Tumours:* Generally testicular tumours are malignant. They occur in children and young adults in whom the affected testes have not descended. Tumour tends to remain in the upper half of the gland and further spreads via the lymphatic pathways to retroperitoneal glands around the aorta, and around the level of the kidney. It is asymptomatic and painless initially. Later, it causes pain, nausea, vomiting etc.

With a brief discussion on the inflammatory infections of the male reproductive organs, we end our study on disorders of the reproductive system.

Earlier in this section we learnt that symptoms of reproductive tract infections may be attributed to contraceptive methods. Hence, a knowledge/understanding of contraception – methods and principles – will be useful. The next section focuses on this aspect. Before we move on to this section, let us recapitulate what we have learnt so far.

Check Your Progress Exercise 4

1) What do you understand by the term 'reproductive morbidity'? What are its three categories?

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2) What are the different types of gynaecological morbities? List the three different types of reproductive tract infections, giving an example of each.

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3) Enlist the infections occurring in the following organs:

Organ	Infections
a) Penis	.....
b) Urethra	.....
c) Epididymis and Testes	.....
d) Prostrate Gland	.....

4) What is meant by 'infertility'? Enumerate any five causes of male infertility.

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12.9 CONTRACEPTION

What is contraception? Birth control by the use of devices (diaphragm or intrauterine device or condom) or drugs or surgery is referred to as *contraception.* There are various contraceptive methods available today. The most common artificial methods are male/female condoms, spermicides, sponge, diaphragm, cervical cap, oral contraceptives (birth control pills), injectable contraceptions (Depo-Provera), IUDs and surgical sterilization. The following discussion presents information on the traditional, modern, irreversible and the newest contraceptive options available today. Hope you find the discussion informative.

A) *"Folk" methods*

People have been using birth control for thousands of years. Even quite early on, people had a pretty good idea of what they needed to do to prevent conception. Different folk methods have been used for ages. These included:

- *Coitus interruptus* – It refers to the withdrawal of the penis from the vagina prior to ejaculation. In theory, this method is probably as effective as some more conventional methods. However, in practice, some of the semen frequently escapes prior to full withdrawal. This may be sufficient to initiate a pregnancy. This is an unreliable method.

- *Postcoital douche* – Douching i.e. cleaning shortly after intercourse. Because sperm can make their way beyond the cervix within 90 seconds after ejaculation, this method is ineffective and unreliable.
- *Breastfeeding* – It is not true that women cannot become pregnant while breastfeeding. In about 6% of women, ovulation returns with the first cycle after delivery. Women who are breastfeeding infants and do not desire another pregnancy at that time need to use a reliable form of contraception.

B) *"Traditional" methods*

Certain methods have been used for long, which we have included here as traditional methods. These include:

- *Condoms* – Condom, you may already know, is a thin sheath (preferably latex to also protect from transmission of disease-causing organisms) placed on the penis or, in the case of the female, within the vagina prior to intercourse. Semen is collected inside the condom, which must be carefully maintained in place and then removed after intercourse. Effectiveness of condoms is increased when spermicide is also used. Condoms are readily available at low cost in most drug and grocery stores. Some family planning clinics may offer free condoms. About 14 pregnancies occur over 1 year out of 100 couples using male condoms, and about 21 pregnancies occur over 1 year out of 100 couples using female condoms.
- *Vaginal spermicides* – These are the sperm-killing chemical jellies, foams, creams, or suppositories, inserted into the vagina prior to intercourse. This method is readily available. All forms can be purchased in most drug and grocery stores. However, this method used by itself is not very effective. About 26 pregnancies occur over 1 year out of 100 women using this method alone, so spermicides are often combined with other methods (such as condoms).
- *Diaphragm* – Flexible rubber cup that is filled with spermicidal cream or jelly, and then placed into the vagina, over the cervix, before intercourse. It should be left in place for 6 to 8 hours after intercourse. Diaphragms must be prescribed by a woman's health care provider, who determines the correct type and size of diaphragm for each woman. About 20 pregnancies occur over 1 year in 100 women using this method.
- *Vaginal contraceptive sponge* – Soft synthetic sponge, saturated with a spermicidal, which is moistened and inserted into the vagina, over the cervix, before intercourse. It is quite similar to the diaphragm as a barrier mechanism. After intercourse, the sponge should be left in place for 6 to 8 hours. This method is available without a prescription in most drug and grocery stores. About 18 to 28 pregnancies occur over 1 year out of 100 women using this method. This method was removed from the market a few years ago, but plans are underway to re-introduce it in the near future.
- *Fertility awareness with abstinence* (natural family planning) – This method involves observing a variety of body changes in the woman (such as, cervical mucus changes, basal body temperature changes) and recording them on the calendar in an attempt to determine when ovulation occurs. The couple abstains from unprotected intercourse for several days before and after the assumed day ovulation occurs. This method requires special education and training in recognizing the body's changes, as well as, a great deal of continuous and committed effort. About 15 to 20 pregnancies occur over 1 year out of 100 women using this method (for women who are properly trained).

C) *"Modern" methods*

Few modern methods of contraception include:

- *Oral contraceptives (the "pill")* – This method utilizes a combination of oestrogen and progestin medications in doses that prevent ovulation and regulate cycles. A

health care provider must prescribe oral (by mouth) contraceptives. The method is highly effective if the woman remembers to take her pill consistently at the same time each day. Oral antibiotics may decrease the effectiveness of birth control pills. Therefore, a backup method of contraception should be used while taking antibiotics and until the next menstrual period after completion of the antibiotic. Because of the wide variety of oral contraceptives, women who experience unpleasant side effects on one type of pill are usually able to adjust to a different oral contraceptive. It is important for women who are just starting on "the pill" to communicate with their health care provider for optimal "matching" of the type of oral contraceptive to each patient. About 2 to 3 pregnancies occur over 1 year out of 100 women using this method.

- *Progestin-only oral contraceptive (the "mini-pill")* – This type of birth control pill does not contain any oestrogen component. It is therefore an alternative for those women who desire a highly effective method of contraception in a "pill" form, but are sensitive to oestrogen or cannot take a contraceptive containing oestrogen for other reasons. The effectiveness of progestin-only oral contraceptives is slightly less than that of the combination type. About 3 pregnancies occur over a 1 year period in 100 women using this method.

- *Progestin implants (such as Norplant)* – Six small progestin-containing rods are implanted surgically beneath the skin, usually under the upper arm, by a woman's health care provider. The rods release a continuous dose of progestin that inhibits ovulation, changes the lining of the uterus and thickens cervical mucus, which may prevent sperm from entering the uterus. The implants provide contraceptive protection for a period of 5 years. The method is highly effective. Less than 1 pregnancy occurs over 1 year out of 100 women using this type of contraception.

- *Hormonal injections (such as Depo-Provera)* – A progestin injection is ordered by a woman's health care provider and given into the muscular tissue of the upper arm or buttocks. This injection prevents ovulation. A single shot provides contraceptive protection for up to 90 days. This method is highly effective and does not depend on patient compliance. Less than 1 pregnancy occurs over 1 year in 100 women using this method.

- *Intrauterine contraceptive device (IUD)* – It is a small plastic or copper device, placed inside the woman's uterus by the health care provider, which changes the uterine environment to prevent pregnancy. IUDs may be left in place for up to ten years in some patients. The method should not be used by women who have a history of pelvic infection, ectopic pregnancy (a pregnancy in which a fertilized egg begin to develop outside the uterus i.e. in the fallopian tube) or who have more than one sexual partner (and are therefore at higher risk for acquiring sexually transmitted diseases). Depending on the IUD used, 1 to 3 pregnancies occur per year out of 100 women using this type of contraception.

D) *Permanent or irreversible methods*

A number of permanent or irreversible methods of contraception are available. These include:

- *Tubal ligation* – This procedure is the most commonly used method of female sterilization. Tubal ligations are usually done in an outpatient surgical center. During tubal ligation, a woman's fallopian tubes are cut, sealed or obstructed by a special clip, preventing eggs and sperm from entering the tubes, thus preventing conception. The operation can sometimes be reversed if a woman later chooses to become pregnant. Following tubal ligation reversal, about 60% to 80% of women eventually become pregnant. However, it is best to consider tubal ligation a permanent form of contraception.

- *Vasectomy* – A vasectomy is a simple, permanent sterilization procedure for men. The operation, usually done in a physician's office, requires cutting and

sealing the vas deferens (tubes in the male reproductive system that carry sperm.) Like tubal ligations, vasectomies can sometimes be reversed through a vasovasectomy, an operation to reattach and open the vas deferens. Men who undergo vasovasectomies have a 30% to 40% chance of fathering children. However, it is best to consider vasectomy a permanent form of contraception.

Other than the methods discussed above, few new contraceptive options have emerged. Let us get to know these newest options.

The newest contraceptive option - the Vaginal Ring

If you want the newest, easy to use, once a month contraceptive method, ask your doctor about the vaginal ring. The vaginal ring is a new contraceptive method that offers protection against pregnancy without the inconvenience of barrier methods, spermicides or remembering to take a daily pill.

How does it work?

The ring is a unique "combined" hormonal contraceptive method which consists of a flexible, transparent, plastic ring of about 2 inches (5.4 cm) in diameter and about 1/8" (4 mm) thick. The ring contains hormones – oestrogen and a progestogen similar to the ones found in combined oral contraceptives (the pill). The ring is inserted into the vagina. The ring is left in place for 3 consecutive weeks, the same number of days that is in one cycle of oral contraceptive pills. During this period, it releases a steady low dose of hormones which prevent pregnancy by stopping the release of a mature egg (ovulation). After three weeks, the ring is removed to make way for a menstrual period, after a ring-free period of 1 week a new ring is inserted for another three weeks and so on.

How effective is it?

When used as directed, the ring provides a reliable and high degree of protection against pregnancy. The reliability is comparable to that of the pill. The exact position of the ring in the vagina is not critical for its action. As long as it feels comfortable, the ring is in the right position and will release the hormones necessary for contraception.

The Male "Pill"

Male contraceptive research is beginning to yield a number of leads in the area of male contraception. Studies are now underway to test hormonal methods of birth control which will provide safe, reliable and reversible male contraception. One method currently under consideration is a combination of two hormones that stop the production of sperm. More studies are being done to determine whether an oral pill, an implant or injection, or a combination of these would be most effective. The promise of male contraception would mean that men will also be able to share the responsibility for birth control with their female partners.

Finally, a word about emergency contraception.

Emergency Contraception

What do you do if you've had unprotected sex or the birth control method you were using failed? Don't panic. Your next step may be the emergency contraceptive pill (ECP) one of the best-kept health secrets of modern contraception. ECP is available from your doctor, hospital or birth control clinic by prescription. ECP can be useful for preventing pregnancy in many situations including:

- a condom slips or breaks
- a diaphragm becomes dislodged or moves out of position
- you forget your usual method of contraception and have unprotected sex

- you missed taking your oral contraceptive pills
- you are forced into having sex
- you miscalculate your most "fertile" days and have sex without birth control

How does emergency contraception work?

There are basically two types of emergency contraception available:

1) *The Emergency Contraceptive Pill (ECP) method* - The ECP method or "morning after pill" uses a high dose of combined oral contraceptives (OCs) to prevent conception. The OC method is effective if used within 72 hours after unprotected intercourse.

2) *The Intrauterine Device (IUD) method* - This method involves the insertion of an IUD into the uterus by your doctor. The IUD creates an unfriendly environment for egg and sperm. The IUD must be inserted within 7 days of unprotected sex.

   Emergency or the "morning after" pill consists of two doses of hormone pills taken as soon as possible within 72 hours after unprotected intercourse. The pill may prevent pregnancy by temporarily blocking eggs from being produced, by stopping fertilization or keeping a fertilized egg from becoming implanted in the uterus. The morning-after pill is reserved for emergency situations and not as a regular method of birth control. Emergencies include being raped, having a condom break or slip off during sex, missing two or more birth control pills during a monthly cycle, and having unplanned sex.

With emergency contraception, we end our study on contraception. In the next section, we will look at the different tests recommended during pregnancy.

Check Your Progress Exercise 5

1) What do you understand by the term 'contraception'?

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2) List any three methods of contraception in the following categories:

   a) Traditional Methods

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   b) Modern Methods

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3) Is vasectomy a permanent sterilization procedure?

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4) Enumerate the two different types of emergency contraception.

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12.10 COMMON TESTS DURING PREGNANCY

Pregnancy, as you may have realized, is a period of physiological stress. To ensure a successful pregnancy, few common tests are recommended. The following are some of the more common tests performed during pregnancy:

- alpha-fetoprotein screening (multiple marker screening)
- amniocentesis
- chorionic villus sampling
- foetal monitoring
- glucose tolerance test
- Group B strep culture
- ultrasound
- genetic screening

Let us get to know them.

What is an alpha-fetoprotein screening (AFP)?

This is a blood test that measures the level of alpha-fetoprotein in the mothers' blood during pregnancy. AFP is a protein normally produced by the foetal liver and is present in the fluid surrounding the foetus (amniotic fluid), and crosses the placenta into the mother's blood. The AFP blood test is also called MSAFP (maternal serum AFP).

Abnormal levels of AFP may signal the following:

- open neural tube defects (ONTD) such as spina bifida
- Down syndrome
- other chromosomal abnormalities
- defects in the abdominal wall of the foetus
- twins - more than one foetus is making the protein
- a miscalculated due date, as the levels vary throughout pregnancy

AFP screening may be included as one part of a 2-, 3-, or 4-part screening, often called a multiple marker screen. The other parts are:

- *HCG* - human chorionic gonadotropin hormone (a hormone produced by the placenta).
- *estriol* – a hormone produced by the placenta.
- *inhibin* – a hormone produced by the placenta.

Abnormal test results of AFP and other markers may indicate the need for additional testing. Usually an ultrasound is performed to confirm the dates of the pregnancy and to look at the foetal spine and other body parts for defects. An amniocentesis may be needed for accurate diagnosis.

Multiple marker screening is not diagnostic. This means it is not 100 percent accurate, and is only a screening test to determine who in the population should be offered additional testing for their pregnancy. There can be false-positive results – indicating a problem when the foetus is actually healthy or false negative results – indicating a normal result when the foetus actually does have a health problem.

How is an alpha-fetoprotein test performed?

Although the specific details of each procedure vary slightly, generally, an alpha-fetoprotein test follows this process:

- Blood is usually drawn from a vein between the 15th and 20th weeks of pregnancy (16th to 18th is ideal).
- The blood sample is then sent off for laboratory analysis.
- Results are usually available within one to two weeks or less, depending on the laboratory.

What is an amniocentesis?

An amniocentesis is *a procedure used to obtain a small sample of the amniotic fluid that surrounds the foetus to diagnose chromosomal disorders and open neural tube defects (ONTDs) such as spina bifida.* Testing is available for other genetic defects and disorders depending on the family history and availability of laboratory testing at the time of the procedure. An amniocentesis is generally offered to women between the 15th and 20th weeks of pregnancy who are at increased risk for chromosome abnormalities, such as women who are over 35 years of age at delivery, or those who have had an abnormal maternal serum screening test, indicating an increased risk for a chromosomal abnormality or neural tube defect.

What is a chorionic villus sampling (CVS)?

Chorionic villus sampling (CVS) is a prenatal test that involves taking a sample of some of the placental tissue. This tissue contains the same genetic material as the foetus and can be tested for chromosomal abnormalities and some other genetic problems. Testing is available for other genetic defects and disorders depending on the family history and availability of laboratory testing at the time of the procedure. In comparison to amniocentesis, CVS does not provide information on neural tube defects such as *spina bifida.* For this reason, women who undergo CVS also need a follow-up blood test between 16 to 18 weeks of their pregnancy, to screen for neural tube defects.

Some women may not be candidates for CVS or may not obtain results that are 100 percent accurate, and may therefore, require a follow-up amniocentesis. In some cases, there is an active vaginal infection such as herpes or gonorrhea, which will prohibit the procedure. Other times, the physician obtains a sample that does not have enough tissue to grow in the laboratory such that results are incomplete or inconclusive.

What is foetal monitoring?

During late pregnancy and during labour, a physician may want to monitor the foetal heart rate and other functions. Foetal heart rate monitoring is a method of checking the rate and rhythm of the foetal heartbeat. The average foetal heart rate is between 110 and 160 beats per minute. The foetal heart rate may change as the foetus responds to conditions in the uterus. An abnormal foetal heart rate or pattern may mean that the foetus is not getting enough oxygen or there are other problems. An abnormal pattern may also mean that an emergency or cesarean delivery is needed.

What is a glucose tolerance test?

A glucose tolerance test, usually conducted in the 24 to 28 weeks of pregnancy, measures levels of sugar (glucose) in the mother's blood. Abnormal glucose levels may indicate gestational diabetes.

How is a glucose tolerance test performed?

Although the specific details of each procedure vary slightly, generally, a glucose tolerance test follows this process:

- The mother-to-be may be asked to only drink water on the day the glucose tolerance test is given.
- An initial fasting sample of blood is drawn from a vein.
- Then the subject is given a special glucose solution to drink.
- Blood will be drawn several times over the course of several hours to measure the glucose levels in the body.

What is a Group B strep culture?

Group B Streptococcus (GBS) are bacteria found in the lower genital tract of 15 to 40 percent of all women. GBS infection usually causes no problems in women before pregnancy, but can cause illness in the mother during labour. GBS may cause *chorioamnionitis* (a severe infection of the placental tissues) and *postpartum infection.*

GBS is the most common cause of life-threatening infections in newborns, including pneumonia and meningitis. Newborn babies usually contract the infection from the mother's genital tract during labour and delivery.

Treatment of mothers with certain risk factors or positive cultures may reduce the risk of transmission of GBS to the baby. However, no treatment has been shown to completely prevent early onset of GBS.

What is an ultrasound?

An ultrasound scan is a *diagnostic technique which uses high-frequency sound waves to create an image of the internal organs.* A screening ultrasound is sometimes done during the course of a pregnancy to check normal foetal growth and verify the due date. Ultrasounds may be performed at various times throughout pregnancy for different reasons, which we shall not dwell upon in this unit.

Ultrasound is a technique that is constantly being improved and refined. As with any test, results may not be completely accurate. However, ultrasound can provide valuable information for parents and health care providers to help manage and care for the pregnancy and foetus.

What is genetic screening?

Many genetic abnormalities can be diagnosed before birth. A physician may recommend genetic testing during the pregnancy if you or your partner have a family history of genetic disorders and/or you have had a baby with a genetic abnormality.

Examples of genetic disorders that can be diagnosed before birth include the following:

- cystic fibrosis
- duchenne muscular dystrophy
- hemophilia A
- thalassemia
- sickle cell anaemia
- polycystic kidney disease, and
- Tay-Sachs disease

What do genetic screening methods include?

Genetic screening methods may include the following:

- ultrasound scan
- alpha-fetoprotein test (AFP) or multiple marker test

- chorionic villus sampling (CVS)
- amniocentesis, and
- percutaneous umbilical blood sampling (withdrawing a small sample of the foetal blood from the umbilical cord).

Check Your Progress Exercise 6

1) Enumerate the various tests performed during pregnancy.

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2) What is 'amniocentesis' and what does it indicate?

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3) What does a CVS test indicates? What are the various conditions when a CVS is not feasible or successful?

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4) What is the average foetal heart rate? What does an abnormal pattern indicate?

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5) Give at least five examples of genetic disorders that can be diagnosed before birth.

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12.11 LET US SUM UP

In this unit, we learnt about physiology of reproductive system, where we got an in-depth knowledge about female and male reproductive organs. We saw the role of hormones involved in development and functioning of these organs. Various physiological changes occurring during pregnancy and lactation were also emphasized. The various disorders of both female and male reproductive systems that could affect their normal functioning were also discussed in this unit.

Further, the unit focused on the issue of contraception – the different folk, traditional, modern and latest methods along with their drawbacks and benefits. Finally, in the last section, we learnt about various pregnancy determination tests.

12.12 GLOSSARY

Amniotic fluid : liquid that surrounds unborn child within the membranes inside the uterus.

Benign-neoplasm : a tumor-like overgrowth of tissue normally found in the area.

Catheterization : a procedure done to examine the structure and contents of chambers.

Chancroid : a disease known to be spread solely through sexual contact.

Chlamydiasis : sexually transmitted infection caused due to bacteria *Chlamydia trachomatis.*

Chorion : one of the membranes that encloses the foetus within the uterus.

Down syndrome : a combination of birth defects caused by the presence of an extra chromosome.

Fibroids : non-cancerous growth in or within the walls of the uterus.

Gametes : the reproductive cells in multicellular organisms that unite during sexual reproduction.

Graafian follicle : a vascular body in a mammalian ovary enclosing a developing egg.

Gynaecomastia : an excessive development of the breasts in males, usually results from hormonal imbalance.

Lactiferous ducts : ducts of the mammary gland that carry milk to the nipple.

Neural Tube Defect : birth defects that occur very early in pregnancy leading to abnormalities in the development of spinal cord and brain.

Polyp : a structure consisting of a rounded head which grows outward from a broad base or stalk.

Pyelonephritis : the inflammation of the drainage system of the kidneys, one of the causes of kidney failure.

Spina bifida : a birth defect in which the neural tube fails to close during fetal development and a portion of the spinal cord and nerves fail to develop properly.

Syphilis : a disease usually transmitted by sexual contact that can cause malformation in an unborn baby.

Vestibule : a body cavity leading to another cavity.

12.13 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1) 1-Fallopian tube, 2-uterus, 3-cervix, 4-vulva, 5-vagina, 6-ovary.

2) a) The uterus helps the growth of foetus during the 40 week gestation period, at the end of which the baby is born. It receives, nourishes and protects a fertilized ovum. It provides the right environment for the embryo and foetal growth. During labour, the uterine contractions become stronger and more frequent. The uterus muscles contract and expels the foetus and the placenta.

   b) Fertilization takes place in the uterine tubes, then the zygote moves into the uterus. The fallopian tubes assist in transporting the ovary and spermatozoa. The mucous helps in smooth movement of ova and spermatozoa.

3) The three phases of menstrual cycle are the proliferative phase (10 days), secretory phase (14 days) and menstrual phase (4 days).

   During menopause, the ovaries become less responsive to the FSH and LH and ovulation and menstrual cycle becomes irregular, eventually ceases. Other changes are vasodilatation, sweating palpitations, discomfort and disturbance in normal sleep and shrinking of breasts, atrophy of sex organs, eccentric behaviour occurs etc.

4) a) Oestrogen and progesterone are responsible for stimulating changes in ovaries. They are responsible for the development of sex characteristics.

   b) Oestrogen and prolactin are responsible for stimulating changes in mammary glands. Oestrogen promotes formation of mammary glands, while testosterone inhibits it. Prolactin, which is stimulated by oestrogen, acts on the mammary glands to produce milk (lactation).

Check Your Progress Exercise 2

1) 1-Testicle, 2-Penis, 3-Glans penis, 4-Scrotum, 5-Vas deferens, 6-Prostrate.

2) a) The epididymis provides for the storage, transmission and maturation of sperm. Apart from this, it facilitates the transport of spermatozoa along the duct and protects spermatozoa from harmful substances.

   b) Vas deferens is a long muscular tube that passes upward alongside the testicles and carries spermatozoa from the epididymis to the ejaculatory duct and transports the sperm-containing fluid called semen. During ejaculation, the wall of the vas deferens thickens and thins itself, thus propelling the sperm.

   c) Prostrate gland produces some of the parts of semen and secretes a thin lubricating fluid.

3) Semen is the fluid ejaculated from urethra. It consists of (a) Spermatozoa, (b) Viscid fluid, which nourishes the sperm, (c) thin lubricating fluid from prostrate glands, and (d) Mucus by the glands of urethra.

4) Spermatogenesis is the process of sperm development that takes place in the seminiferous tubules (ducts) of the testes. Each spermatogenesis cycle consists of six stages and takes about 16 days to complete. Approximately five cycles, or 2 ½ months, are needed to produce one mature sperm.

   The FSH stimulates the seminiferous tubules of testes to produce male germ cells, the spermatozoa.

5) The hormonal changes that take place during male puberty are:

- growth of bones, muscles, increases in height and weight.
- enlargement of larynx and deepening of the voice.
- growth of hair on the face, maxillae, chest, abdomen and pubis.
- enlargement of penis, scrotum and prostrate gland.
- maturation of seminiferous tubules and production of spermatozoa.

Check Your Progress Exercise 3

1) a) Hyperplasia is the the enlargement of an organ or tissue because of an increase in the number of cells in that organ or tissue.

b) The enlargement or overgrowth of an organ or a tissue due to an increase in size of its cells is referred to as hypertrophy.

c) The onset of copious milk secretion around parturition, triggered by a fall in plasma progesterone levels is termed as lactogenesis.

2) The various roles of placenta are: nourishes the foetus, removes waste and protective barrier.

The hormones produced by it are humanchronionic Gonadotorpin, progesterone, hyman placental lactogen and chorionic somatomammotropin.

3) Three stages of foetal development are the zygote, embryo and foetus. Zygote is the newly fertilized ovum which implants itself in the uterine wall. Embryo doubles its size after overy 24 hours. During this stage, various organs and organ systems start developing. Foetus is the growing embryo at 7 months with each organ reaching maturity.

4) The basic components of the mammary gland are the alveoli. These alveoli join up to form lactiferous ducts that drain into openings in the areola. Leading these dilatations there are narrow ducts which open onto the surface at the nipple.

Oxytocin and prolactin instigate the lactation process. Prolactin is responsible for milk production and oxytocin is involved in milk ejection from the breast.

5) a) Progesterone reduces gastric motility, favours maternal fat deposition, increases sodium excretion, reduces alveolar and arterial CO_2, interferes with folic acid metabolism.

b) Oestrogen reduces serum proteins, increases hydroscopic properties of connective tissue, affects thyroid function, interferes with folic acid metabolism.

c) Parathyroid promotes calcium resorption from bone, increases calcium absorption, promotes urinary excretion of phosphate.

Check Your Progress Exercise 4

1) Diseases that affect the reproductive system, although not necessarily as a consequence of reproduction are referred to reproductive morbidity. Reproductive morbidity can be subdivided into three broad categories: obstetric/maternal morbidity, gynaecological morbidity and contraceptive morbidity.

2) Gynaecological morbidity can be divided into reproductive tract infections, endocrine disorders, infertility, gynaecological cancers, congenital malformations or birth defects, injuries, sexual dysfunction, menopausal symptoms and others.

Reproductive tract infections include three different types of infection that affect the reproductive tract. The reproductive tract infection includes sexually transmitted infections (gonorrhoea), endogenous infections (vaginosis) and iatrogenic infections (IUD insertion).

3) a) Penis: Inflammation of the glands and the prepuce (a fold of skin covering the tip of the clitoris) can be specific or non-specific. In the non-specific, it could be due to lack of personal hygiene.

   b) Urethra: Gonococcal urethritis is the most common specific type of infection. Non-specific infection may be spread from bladder (cystitis), or can occur due to catheterization, cytoscopy or surgery.

   c) Epididymis and testes: Non-specific epididymitis and orchitis are usually due to infection from the urethra, followed by prostratectomy.

   d) Prostrate gland: Non-specific infections from urethra, bladder, catheterization, cytoscopy, urethral dilatation, partial resection of glands etc. causes prostatitis i.e. inflammation of the prostrate gland.

4) Infertility is the inability to conceive (reproduce) after at least one year of unprotected intercourse. The 5 causes of male infertility are (any 5 of the following):

   Cryptorchidism, cystic fibrosis, ductal obstruction, hemochromatosis, hormone dysfunction, drugs, retrograde ejaculation, sexually transmitted diseases, sickle cell anaemia, systemic disease, testicular cancer, testicular trauma and varicocele.

Check Your Progress Exercise 5

1) Birth control by the use of devices (diaphragm, intrauterine device, condom etc.) or drugs or surgery is referred to as contraception.

2) a) The traditional methods include condoms, vaginal spermicides and diaphragm.

   b) The modern methods include oral contraceptives (the "pill"), progestin-only oral contraceptive, progestin implants (such as Norplant).

3) Vasectomy is a simple, permanent sterilization procedure for men. The operation requires cutting and sealing the vas deferens. It can sometimes be reversed through a vasovasectomy, an operation to reattach and open the vas deferens. It is best to consider vasectomy a permanent form of contraception.

4) The two types of emergency contraception are: the emergency contraceptive pill (ECP) method wherein a high dose of combined oral contraceptives (OCs) is used to prevent conception and intrauterine device (IUD) which involves the insertion of an IUD into the uterus.

Check Your Progress Exercise 6

1) Alpha-fetoprotein screening (multiple marker screening), amniocentesis, chorionic villus sampling, fetal monitoring, glucose tolerance test, Group B strep culture, ultrasound, genetic screening are some of the tests performed during pregnancy.

2) An amniocentesis is a procedure used to obtain a small sample of the amniotic fluid that surrounds the foetus. It is used to diagnose chromosomal disorders and open neural tube defects (ONTDs) such as spina bifida.

3) Chorionic villus sampling (CVS) is used for testing chromosomal abnormalities and some other genetic problems. The various conditions when a CVS is not feasible or successful are neural tube defects such as spina bifida, active vaginal infections such as herpes or gonorrhea.

4) The average fetal heart rate is between 110 and 160 beats per minute. An abnormal foetal heart rate or pattern may mean that the foetus is not getting enough oxygen or there are other problems. An abnormal pattern also may mean that an emergency or cesarean delivery is needed.

5) Examples of genetic disorders that can be diagnosed before birth includes the following (any five): cystic fibrosis, duchenne muscular dystrophy, hemophilia A, thalassemia, sickle cell anaemia, polycystic kidney disease and Tay-Sachs disease.

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LIST OF ABBREVIATIONS

ACE	Angiotensin Converting Enzyme
ACTH	Adreno Cortico Tropic Hormone
ADH	Anti Diuretic Hormone
AMIS	Antibody Mediated Immune System
ANS	Autonomic Nervous System
APC	Antigen Presenting Cell
ATP	Adenosine Triphosphate
BP	Blood Pressure
BUN	Blood Urea Nitrogen
cAMP	Cylic Adenosine Monophosphate
CCK	Cholecystokinin- Pancreozymin
CMIS	Cell Mediated Immune System
CNS	Central Nervous System
CO	CardiacOutput
CRF	Corticotropin Releasing Factor
CSF	Cerebro Spinalfluid
DCT	Distal Convoluted Tubule
DNA	Deoxyribonucleic Acid
DRG	Dorsal Root Ganglion
ECG	Electrocardiogram
ECG	Electrocorticogram
EEG	Electroencephalogram
ER	Endoplasmic Reticulum
FSH	Follicle Stimulating Hormone
GABA	Gamma Amino Butyric Acid
G-CSF	Gametocyte-Colony Stimulating Factor
GFR	Glomerular Filtration Rate
GH	Growth Hormone
GIP	Gastric Inhibitory Peptide
GnRH	Gonadotrophin Releasing Hormone
GRF	Gonadotrophin Releasing Factor
GTH	Gonadotropic Hormone
Hct	Haematocrit
HT	Hydroxytryptamine
Ig	Immunoglobulins
IL	Interleukin
ITP	Idiopathic Thrombocytopenic Purpura
LH	Luteinizing Hormone

MCHC	Mean Corpuscular Hemoglobin Concentration
M-CSF	Macrophages-Colony Stimulating Factor
MCV	Mean Corpuscular Volume
MHC	Major Histocompatability Complex
PAH	Paraamino Hippuric Acid
PCT	Proximal Convoluted Tubule
PCV	Packed Cell Volume
PIF	Prolactin Release Inhibiting Factor
PNS	Peripheral Nervous System
PR	Peripheral Resistance
PRF	Prolactin Releasing Factor
RBC	Red Blood Cell
RER	Rough Endoplasmic Reticulum
RNA	Ribonucleic Acid
SER	Smooth Endoplasmic Reticulum
TCA	Tricarboxylic Acid
THSC	Totipotent Hematopoietic Stem Cell
TNF	Tumor Necrosis Factor
TRF	Thyrotropin Releasing Factor
TSH	Thyroid Stimulating Hormone
VIP	VasoactiveIntestinal Peptide
WBC	White Blood Cells

NOTES