WELCOME

TO

This is an Education Platform

We Provide PDF Notes for Pharmacy Students

Web Site http://www.fdspharmacy.in/

You tube https://www.youtube.com/c/FDSpharmacy

Telegram https://t.me/Fdspharmacy

App https://play.google.com/store/apps/details?id=com.FDSPharmacyMedia.FDSPharmacy

E-mail fdspharmacyinfo@gmail.com

HUMAN ANATOMY AND PHYSIOLOGY – II

UNIT 5

TOPIC :

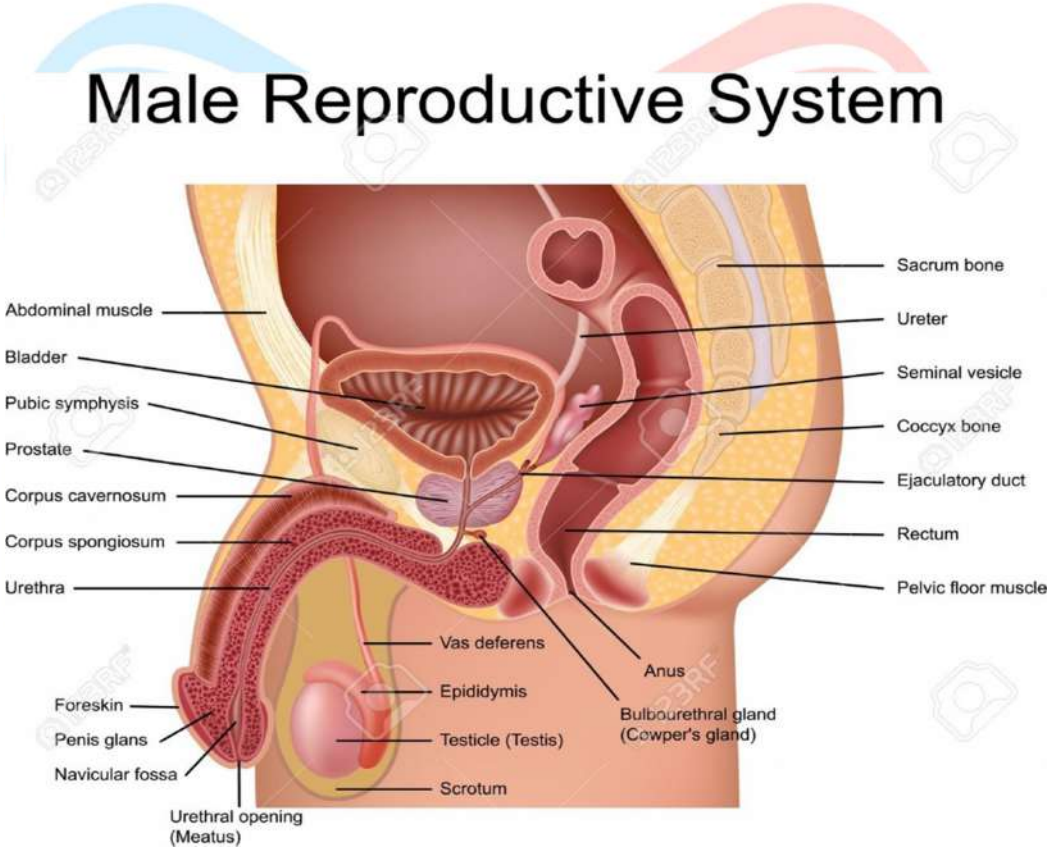
- **Reproductive system**

  Anatomy of male and female reproductive system, Functions of male and female reproductive system, sex hormones, physiology of menstruation, fertilization, spermatogenesis, oogenesis, pregnancy and parturition

Reproductive System

→ Humans are sexually reproducing, unisexual, and viviparous (development of the embryo inside the body of the parent). Both males and females have distinct reproductive organs (gonads), reproductive ducts, and accessory structures.

Anatomy and Physiology of Male Reproductive System



Anatomy and Physiology of Male Reproductive System

- The male reproductive system involves primarily in producing male gametes (ie., sperm) and delivering them to the female reproductive tract.
- The secondary function of male reproductive system is secretion of hormones (e.g., androgens).

➲ The male reproductive system is located in the pelvis region and consists of

1) Scrotum and a pair of testes,
2) Accessory ducts,
3) Glands, and
4) External

Scrotum and Testes

- The testes (singular testis) are located outside the abdominal cavity within a pouch called scrotum
- which is a deeply pigmented skin, made up of fibrous and connective tissues, and smooth muscles.
- Scrotum has two compartments, each containing a testis, an epididymis, and the testicular end of the spermatic cord.
- Scrotum helps in maintaining the low temperature of testes (2-2.5°C lower than the normal internal body temperature) required for spermatogenesis.
- Testes, the male reproductive glands are the equivalent of female ovaries.
- They are oval-shaped and are 4.5cm in length, 2.5cm in width, and 3cm in thickness.
- The inner area of each testis is divided into 200-300 testicular lobules and within each lobule 1-4 convoluted loops are present.
- These loops are made up of seminiferous tubules (germinal epithelial (cells) which are lined from within by two types of cells, namely:
  1) Male Germ Cells (Spermatogonia): These cells undergo meiotic divisions to form sperm.
  2) Sertoli Cells: These cells provide nutrition to the germ cells.
- The spaces around the seminiferous tubules are known as interstitial spaces, occupied by small blood vessels and interstitial or Leydig cells.

Functions

1) Testes produce sperm.
2) The Leydig cells of testes secrete testosterone.

Accessory Ducts

The accessory ducts included in the male reproductive system are:

1) Rete Testis
2) Vasa Efferentia or Efferent Ductules
3) Epididymis
4) Spermatic
5) Vas Deferens or Ductus Deferens or Deferent Duct
6) Seminal Vesicles
7) Ejaculatory

Glands

The male accessory glands include

1) Prostate Gland
2) Bulbourethral (or Cowper's) Glands

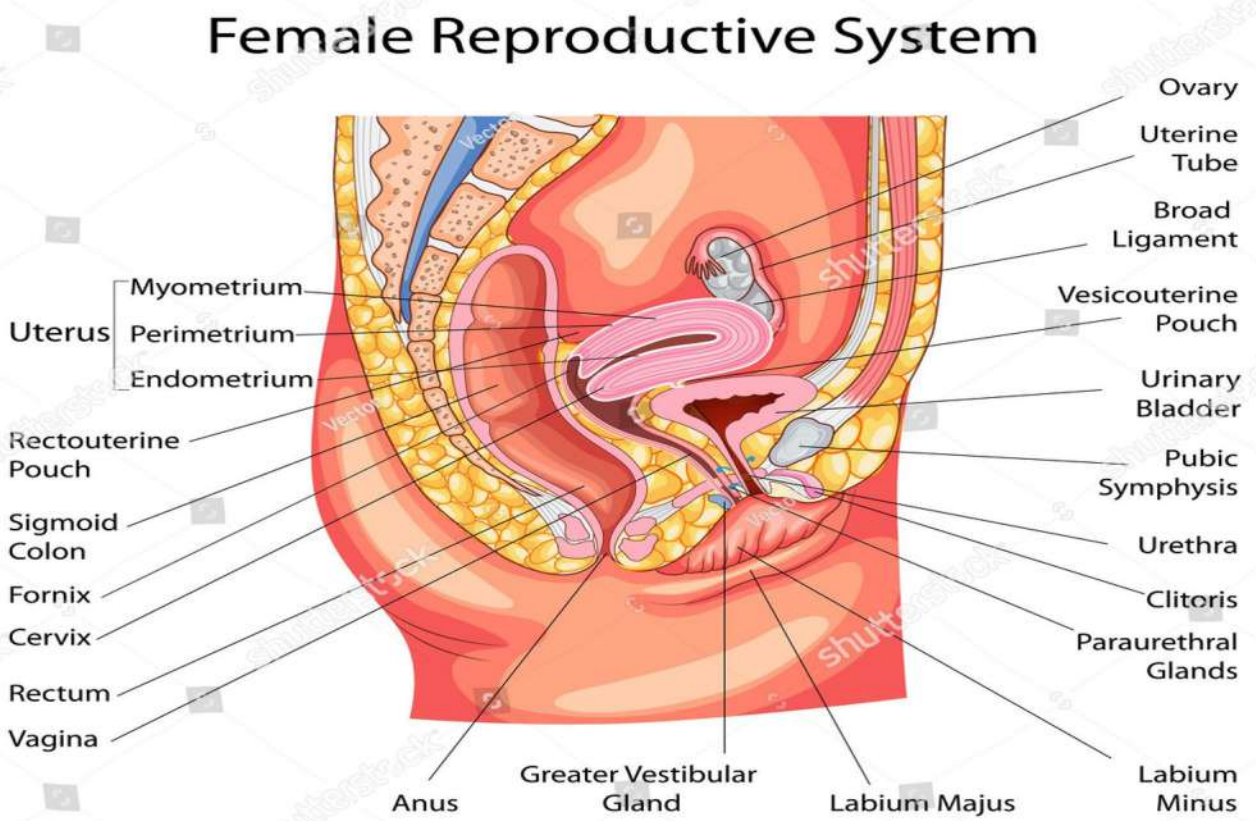
External Genitalia (Penis)

Penis is the male external genitalia. which suspends anterior and lateral to the pubic arch and contains the greater part of urethra. When flaccid it is cylindrical-shaped, but when erect it appears as a triangle having round angles, one side of which forms a dorsum, Penis consists of special tissue that helps in its erection, thus facilitate insemination. The enlarged end of the penis is called the glans penis, which is covered by a loose fold of skin called foreskin.

Functions

1) Penis provides a passage for urine.
2) It also releases sperm in the female reproductive tract to fertilise ovum.

Anatomy and Physiology of Female Reproductive System



The different parts of female reproductive system are enlisted below :

1) External genitalia (vulva),
2) Internal genitalia
   i) Vagina,
   ii) Uterus,
   iii) Uterine tubes, and
   iv) Ovaries.

External Genitalia (Vulva)

The external genitals of females are collectively known as vulva and include the following parts:

- The mons pubis is a pad of fatty tissue present towards the anterior, over the pubic bone. It gets covered with pubic hair after puberty,
- The labia majora are folds of hair-covered skin which extend posteriorly from the monus pubis and surround the vaginal opening
- The labia minora are more pigmented, paired folds of tissue under the labia majora. They protect the female urethra and the entrance of female reproductive tract,
- The clitoris (or glans clitoris) is a small finger like structure, present at the upper junction of the
- two labia minora above the urethral opening. This organ is made up of the same cells as the glans penis.
- Hymen is a thin membrane which partially covers the vaginal opening (located between the urethral opening and anus.
- The borders of vaginal opening have outlets to the Bartholin's glands (or greater vestibular glands).

Internal Genitalia

Following are the internal genitals of the female lying in the pelvic cavity:

1) A vagina,
2) A uterus,
3) Two uterine tubes, and
4) Two ovaries.

Vagina

Vagina is an elastic, muscular tube which joins the uteri cervix with the vulva opening outside the body.

It is located in the pelvic region posterior to the (urinary bladder and anterior to the rectum.

It is around 31 inches long and less than an inch in diameter.

Vagina is capable of becoming several inches longer and many inches wider during sexual intercourse and childbirth.

The inner lining of vagina is made of non-keratinised stratified squamous epithelial tissue, providing protection against friction to the underlying vaginal layers.

Functions

1) Vagina receives the penis during intercourse.
2) It provides for a passage blood during menstruation.
3) It also provides a passage for the baby to pass during partuntion.

Uterus

- Uterus is present within the pelvic region between the bladder and rectum,
- It is a hollow muscular organ having thick walls.
- Fallopian tubes drain into the upper portion of the uterus on both the sides while vagina is connected with its hollow part.
- The released ovum reaches the uterine cavity via fallopian fertilised ovum implants itself the uterus for completion of prenatal growth.
- The length and breadth of upper part and the thickness of uterus is 7.5cm. 5cm, and 2.5cm, respectively. The weight of uterus is 30-40gm

Uterus is made up of the following three Parts

- Fundus: It is the uppermost rounded between the two uterine tubes.
- Body: It is the part extending from the fundus to the cervix
- Cervix: It is the lower narrow part continuous with the body through internal os (mouth) and with through external

The thick uterus wall is made up of three layers

1) Perimetrium or Peritoneum
2) Myometrium
3) Endometrium

Functions

1) Uterus receives the fertilised ovum, retains the foetus during pregnancy, and providing nourishment
2) expels the foetus at the end of pregnancy by contracting its muscular walls.
3) It is also involved in menstruation.

Uterine/ Fallopian Tubes (Oviduct)

- Each fallopian tube is around 10-12cm long and Icm in diameter that extends from the periphery of each ovary to the uterus. The paired fallopian tubes are present on the upper margin of broad ligament on either side. They range from the superior angle of the uterus to the side of pelvis.
- Fallopian tubes are divided into three parts
    1) Isthmus
    2) Ampulla
    3) Infundibulum

Functions

1) Fallopian tubes collect the released ovum and carry it to the uterus with the help of cilia present on the inner surface.
2) They also convey the fertilised egg to the uterus for implantation.
3) They provide the site of fertilisation.
4) They secrete a fluid which nurtures the ovum while it travels into the uterus cavity.

Ovaries

Ovaries are oval-shaped paired organs present on either side of the uterus in the pelvis.
These are the primary female sex organs and produce the female gamete (ovum).
Several steroid hormones (ovarian hormones) are also secreted by ovaries.
Each ovary is about 2-4cm long and is positioned on each side of the lower abdomen.
The inner side of the ovaries is covered by a thin epithelium

Functions

1) Ovaries release the female gametes or ovum.
2) They secrete cestrogens and progestine.
3) They also secrete inhibin which participates in feedback control of pituitary FSH production

SEX HORMONES

→ Sex hormones are steroid hormones produced primarily by the gonads (testes in males and ovaries in females) and to a lesser extent by the adrenal glands.
→ They are responsible for the development and regulation of reproductive functions, secondary sexual characteristics, and sexual behavior.

Types of Sex Hormones:

Class	Hormones	Primary Source	Main Role
Androgens	Testosterone, Dihydrotestosterone (DHT)	Testes (Leydig cells), adrenal cortex	Male sexual development, spermatogenesis
Estrogens	Estradiol (E2), Estrone (E1), Estriol (E3)	Ovaries (granulosa cells), placenta, adrenal cortex	Female sexual development, menstrual cycle
Progestogens	Progesterone	Corpus luteum, placenta	Prepares uterus for implantation, maintains pregnancy

Functions of Sex Hormones:

In Males (Androgens – especially Testosterone):

- ✓ Development of **male reproductive organs** (penis, testes, prostate)
- ✓ Development of **secondary sexual characteristics** (deep voice, facial hair, muscle mass)
- ✓ **Spermatogenesis** in testes
- ✓ Libido and sexual behavior
- ✓ Bone and muscle growth

- ✓ Regulation of **gonadotropin** secretion via feedback mechanism

In Females (Estrogens & Progesterone):

Estrogens:

- ✓ Development of female reproductive organs (vagina, uterus, fallopian tubes)
- ✓ Development of secondary sexual characteristics (breast development, fat distribution)
- ✓ Regulation of menstrual cycle and ovulation
- ✓ Maintenance of vaginal epithelium and uterine lining (endometrium)
- ✓ Bone health and cardiovascular protection

Progesterone:

- ✓ Prepares endometrium for implantation of fertilized egg
- ✓ Maintains pregnancy
- ✓ Suppresses uterine contractions during pregnancy
- ✓ Promotes development of mammary glands for lactation

Physiology of Menstruation

- ➲ Menstrual cycle or menstruation involves physiological changes occurring periodically in females.
- ➲ Menarche is the first menstruation which begins at puberty, Le.. between 8-16 years of age.
- ➲ Menopause is the phase when menstruation stops permanently at the end of a woman's reproductive life. In females, the cycle is repeated at an (average interval of about 28/29 days. During the middle of each menstrual cycle, ovulation occurs, thus one ovum is released.

The major events of the menstrual cycle are

i. **Menstrual Phase:** This phase is characterised by vaginal bleeding, known as menstruation (or menstrual bleeding, menses, or periods) occurring in non-pregnant women only. It starts on every 28th day and lasts for 3-5 days. If the mature egg does not gets fertilized, the level of progesterone and estrogen decreases in the body, thus releasing the oxytocin hotmone. This hormone stimulates contractions and leads to drainage of blood out of the The innermost layer of uterus, ite.. endometrium, also sheds off and comes out with the blood.

ii. **Follicular Phase:** This phase starts from the 6th day and ends on the 14th day. During this phase, the uterus lining becomes thick due to the increasing amounts of oestrogen. The development of ovarian follicles is stimulated by a complex interaction between the hormones.

iii. After some days, one or sometimes two follicles become dominant and the non-dominant ones die. The dominant follicle undergoes ovulation. The matured follicles secrete estradiol (an oestrogen) in increasing amounts. A new endometrium layer the proliferative (histologically identified endometrium) develops in the uterus under the influence of estradiol.

iv. **Ovulation Phase:** In this phase, a matured egg secretes estradiol in amounts sufficient enough to trigger Luteinizing Hormone (LH) release. Flow of this hormone begins around the 12 day of menstrual cycle and lasts for 48 hours. The release of LH weakens the walls of ovarian follicles, thus they rupture and release the mature ovum. The

released ovum is captured by the fallopian tube which is the fertilisation site for divum und sperm The eps if remain unfenilised disintegrates or dissolves in the uterus with time.

v. Luteal Phases In this prise, corpus luteum is formed. After ovulation, the pituitary hormones convert the residual follicle into corpus luteum, which produces progesterone and oestrogens for next 2 works Progesterone converts the proliferative endometrium into a secretory lining for implantation and supporting the early pregnancy. A fertilised egg in the form of an early blastocyst passes through the fallopian tube and implants itself in the uterine cavity after 6-12 days of ovulation.

vi. Fertile period (tline with the highest possibility of pregnancy) ranges from 5 days before ovulation till 12 days after ovulation. In an average 28 days cycle.with a 14 day luteal phase, this begins from the 2nd or the 3rd week of the cycle

Fertilisation.

- Fusion of sperm (male gamete released into the vaginal during intercourse) with the egg is termed fertilisation
- Fertilisation occurs in the ampulla of the fallopian tube. Semen is released into the vagina during copulation (or (coitus) Around 300 million sperms are present in the semen, out of which only a few hundreds of them travel to the ampulla by their tail movements and uterus peristaltic action.
- Sperms take 5 minutes to reach the fallopian tube, survive for 1-3 days, and fertilise the released ovum within. 12-24 hours of ovulation.

Spermatogenesis

→ Production of male gametes or sperm is termed spermatogenesis, which consists of two processes:

- **Meiosis :** Diploid stem cells present at the outer edge. of seminiferous tubules are termed spermatogonia, which undergo repeated mitosis before puberty to produce large number of other spermatogonia; while spermatogonia undergoing repeated mitosis at puberty A and B results in the formation of types A and spermatogonium. To prevent the spermatogonia from getting depleted, type A spermatogonium remains at the tubule periphery; while the type B undergoes meiotic division in which its DNA replicates resulting in a primary spermatocyte. This spermatocyte further undergoes meiosis 1 to produce two haploid secondary spermatocytes. These spermatocytes then undergo meiosis II to produce. four haploid spermatids (round cells with no tail).
- **Spermiogenesis :** The converting process of spermatids mature sperm is termed process only involves into spermiogenesis.

Oogenesis

- Oogenesis is initiated during the embryonic development stage of the female child, and Primordial Gamete Cell (PGC) undergoes mitotic division to form oogonia (i.e., diploid stem cells of ovaries).
- During the embryonic development stage, millions of oogonia are formed within each foetal ovary; no more oogonia are formed after birth.
- The oogonia start dividing and enter into prophase-I of the meiotic division, forming primary oocytes (chromosome number 2N).
- From birth to puberty, a large number of these follicles get degenerated and thus at the time of puberty only 60,000-80,000 primary follicles are left in each ovary.
- The primary follicles get surrounded by more layers of granulosa cells and a new then, and are called secondary follicles.
- The secondary follicle transforms into a tertiary follicle, characterised by a fluid-filled cavity called antrum.
- The theca layer becomes double layered, namely an inner theca interna and an outer theca externa.
- At this stage, the primary oocyte within the tertiary follicle grows in size and completes its first meiotic division.
- It is an unequal division resulting in the formation of a large haploid secondary oocyte and a small first polar body.
- The secondary oocyte possesses bulk of the nutrient rich cytoplasm of the primary oocyte.
- The first polar body undergoes either meiosis II to yield two smaller polar bodies or simple disintegration, while the secondary oocyte waits to complete meiosis 11 until is fertilised by a sperm.
- If sperm does not impregnate the secondary oocyte, it completes meiosis II and yields an ovum and a second polar body. The process of oogenesis results in 4 haploid cells, out of which only one (i.e. the ovum) is a functional gamete.

Pregnancy

- Pregnancy is the physiological state of a female carrying a developing embryo or fetus within her uterus. It begins with fertilization and ends with parturition (childbirth). A typical human pregnancy lasts about 40 weeks (9 months) from the last menstrual period

Phases of Pregnancy

Trimester	Duration	Major Events
First Trimester	0–12 weeks	Fertilization, implantation, organogenesis, hormonal changes
Second Trimester	13–26 weeks	Fetal growth, movement felt (quickening), uterus enlarges
Third Trimester	27–40 weeks	Rapid fetal growth, maturation of organs, preparation for birth

Key Processes in Pregnancy

1. **Fertilization:**
   - Union of sperm and ovum in the **fallopian tube**
   - Forms a **zygote** (single-celled embryo)
2. **Implantation:**
   - Around day 6–7 post-fertilization, the zygote becomes a **blastocyst**
   - It implants in the **endometrial lining** of the uterus
3. **Placenta Formation:**
   - Temporary organ connecting mother and fetus
   - Supplies **oxygen, nutrients**; removes **wastes**
   - Produces hormones like **hCG, estrogen, progesterone**
4. **Embryonic Development:**
   - Weeks 1–8: organ systems begin to form
   - From week 9 onward, the organism is called a **fetus**

Maternal Physiological Changes

- ❖ Uterus enlarges to accommodate fetus
- ❖ Breast enlargement (preparation for lactation)
- ❖ Increased blood volume and cardiac output
- ❖ Increased respiration rate and renal function
- ❖ Morning sickness, fatigue (early pregnancy)

Diagnosis of Pregnancy

- ⅄ Missed menstrual period
- ⅄ Urine pregnancy test (detects hCG)
- ⅄ Blood test (serum hCG – more accurate)
- ⅄ Ultrasound – confirms fetal heartbeat and development
- ⅄ Physical examination – uterus enlargement, fetal movements

Parturition/Childbirth

- Parturition is the process of delivering the baby and placenta from the uterus to the outside world through the birth canal. It marks the end of pregnancy and is triggered by hormonal, mechanical, and neural factors.
- It usually occurs around 40 weeks (280 days) of gestation.

Key Hormones Involved

Hormone	Source	Function in Parturition
Oxytocin	Posterior pituitary	Stimulates strong uterine contractions during labor
Estrogen	Placenta	Increases oxytocin receptors in uterine muscles
Progesterone	Placenta	Maintains pregnancy; levels fall before labor
Relaxin	Placenta & ovaries	Relaxes cervix and pelvic ligaments for delivery
Prostaglandins	Placenta, uterus	Aid in cervical dilation and uterine contractions

Mechanism of Parturition

1. Initiation of Labor:

- Fetal signals (especially from fetal adrenal cortex) initiate the process
- Estrogen levels rise while progesterone levels fall
- Uterus becomes more excitable (increased oxytocin receptors)

2. Uterine Contractions Begin:

- Oxytocin from the maternal posterior pituitary stimulates strong rhythmic contractions of the uterine wall

- Prostaglandins also help in enhancing contractions

3. Cervical Dilation:

- Relaxin and prostaglandins soften and dilate the cervix
- Uterine contractions push the baby downward, increasing cervical stretch

4. Positive Feedback Loop:

- Cervical stretching sends signals to the brain
- Brain releases more oxytocin → stronger contractions → more stretching → more oxytocin
- This continues until delivery is complete

5. Delivery:

- Once cervix is fully dilated (~10 cm), strong uterine and abdominal contractions expel the fetus

6. Expulsion of Placenta:

- After the baby is delivered, continued contractions lead to separation and expulsion of the placenta (afterbirth)

Stages of Labor

Stage	Duration	Events
1st Stage – Dilation	~6–12 hours (varies)	Onset of contractions → full cervical dilation (10 cm)
2nd Stage – Expulsion	~30 minutes to 2 hours	Delivery of the baby
3rd Stage – Placental	~15–30 minutes	Expulsion of the placenta

Signs of Labor

- Regular and strong uterine contractions
- Lower back pain and cramping
- Rupture of amniotic sac ("water breaks")
- Bloody vaginal discharge (mucus plug loss)
- Effacement and dilation of cervix