PERIYAR ARTS COLLEGE, CUDDALORE -1
PG & RESEARCH DEPARTMENT OF ZOOLOGY
AFFILIATED TO THIRUVALLUVAR UNIVERSITY

STUDY MATERIAL

COURSE:	B.Sc ZOOLOGY	YEAR:III	SEMESTER: V
SUBJECT PAPER	ENDOCRINOLOGY		PAPER CODE:BEZO54B
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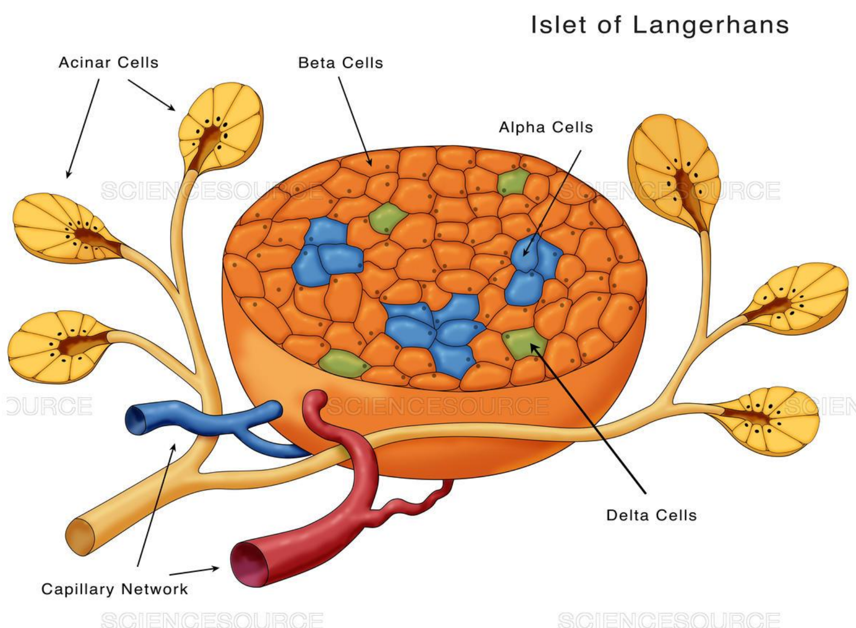
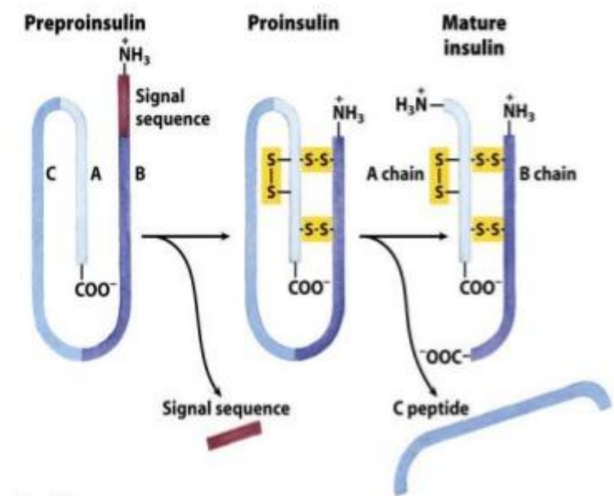
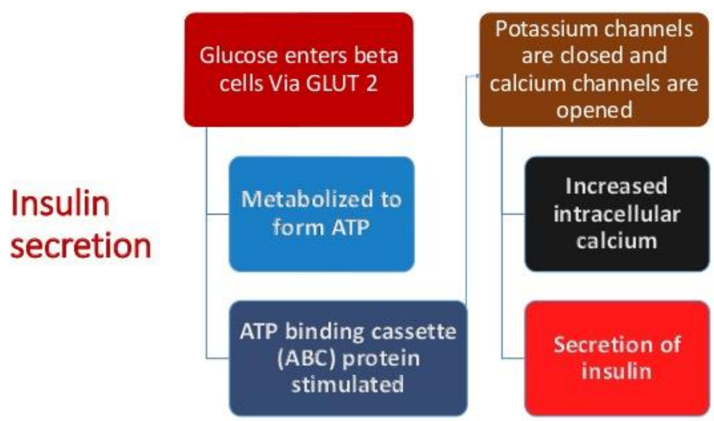
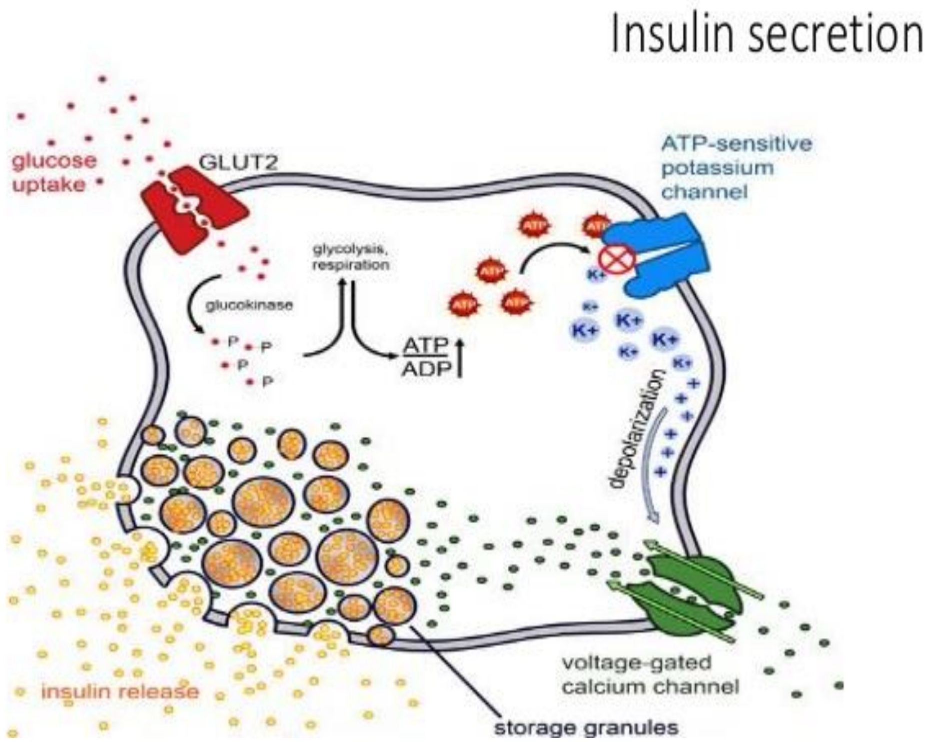
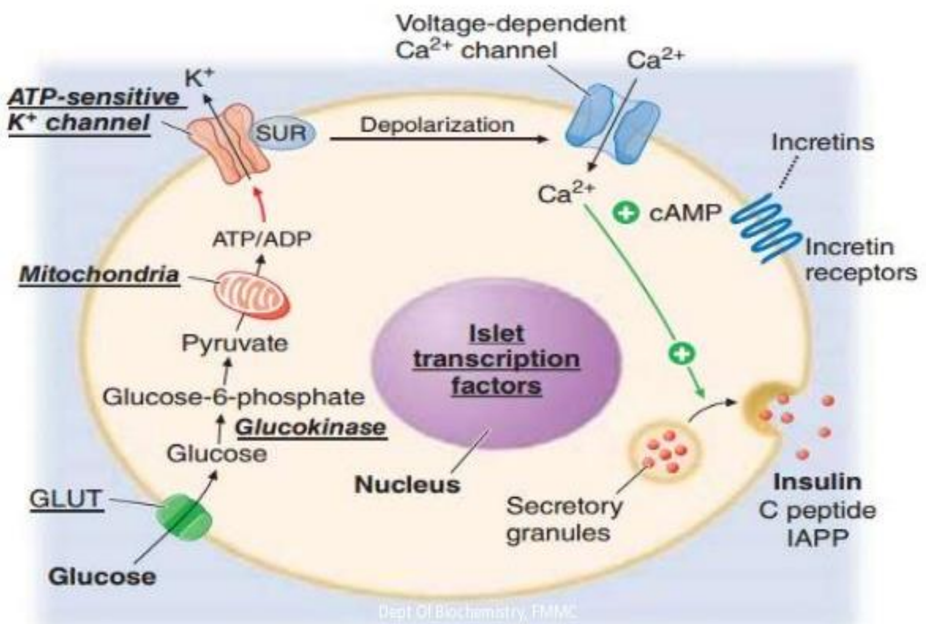
DESIGNATION	ASST. PROFESSOR		
UNITS	IV & V		

UNIT IV	**Islets of Langerhans: Islets of langerhans histology – hormones Insulin and Glucagon – Biosynthesis of Insulin – Regulation and Mechanism of Action**
Islets of langerhans histology	**Islets of Langerhans**: It was first discovered by Paul Langerhans in the year 1869 It is a small island present in the pancreas which performs the endocrine function. It constitute 1 to 2 % of the total pancreatic mass Nearly 2 million islets are found in the human pancreas The pancreatic islets are small islands of cells that produce hormones that regulate blood glucose levels. Hormones produced in the pancreatic islets are secreted directly into the blood flow by five different types of cells. The endocrine cell subsets are: • **Alpha cells** that produce glucagon, and make up 15–20% of total islet cells. Glucagon is a hormone that raises blood glucose levels by stimulating the liver to convert its glycogen into glucose. • **Beta cells** that produce insulin and amylin, and make up 65–80% of the total islet cells. Insulin lowers blood glucose levels by stimulating cells to take up glucose out of the blood stream. Amylin slows gastric emptying, preventing spikes in blood glucose levels. • **Delta cells** that produce somatostatin, and make up 3–10% of the total islet cells. Somatostatin is a hormone that suppresses the release of the other hormones made in the pancreas. • **Gamma cells** that produce pancreatic polypeptide, and make up 3–5% of the total islet cells. Pancreatic polypeptide regulates both

	the endocrine and exocrine pancreatic secretions. • **Epsilon cells** that produce ghrelin, and make up less than 1% of the total islet cells. Ghrelin is a protein that stimulates hunger. The islets of Langerhans can influence each other through paracrine and autocrine communication. The paracrine feedback system is based on the following correlations: • The insulin hormone activates beta cells and inhibits alpha cells. • The hormone glucagon activates alpha cells which then activate beta cells and delta cells. • Somatostatin hormone inhibits alpha cells and beta cells. 
hormones Insulin	Insulin was first extracted by Banting and Best in the year 1922. The word Insulin was derived from the Latin word Insula means islets. Insulin is a peptide hormone produced by beta cells of the pancreatic islets; it is considered to be the main anabolic hormone of the body. It regulates the metabolism of carbohydrates, fats and protein by promoting the absorption of glucose from the blood into liver, fat and skeletal muscle cells. Glucose production and secretion by the liver is strongly inhibited by high concentrations of insulin in the blood. Beta cells are sensitive to blood sugar levels so that they secrete insulin into the blood in response to high level of glucose; and inhibit secretion of insulin when glucose levels are low.

	It is a protein hormone having two polypeptide chains A and B The A chain has 21 amino acids and B chain has 30 amino acids. The two chains are linked together by two interchain – disulfide links viz A7-B7 and A20-B19
Biosynthesis of Insulin	Insulin is synthesized by ribosomes of the rough endoplasmic reticulum as a large precursor peptide that is then converted in to mature hormone prior to secretion. ▪ Insulin is synthesized in the form of a hmw precursor, preproinsulin (110 aa), processed via an intermediate precursor, proinsulin (86 aa) , to the mature insulin (51 aa) molecule  





Synthesis

Insulin is synthesised in the **Beta cells** of the islets of Langerhans. Firstly, the Insulin mRNA is translated as a single chain precursor called **preproinsulin**. There is then removal of its signal peptide at the N-terminus during insertion at the endoplasmic reticulum. This generates **proinsulin**.

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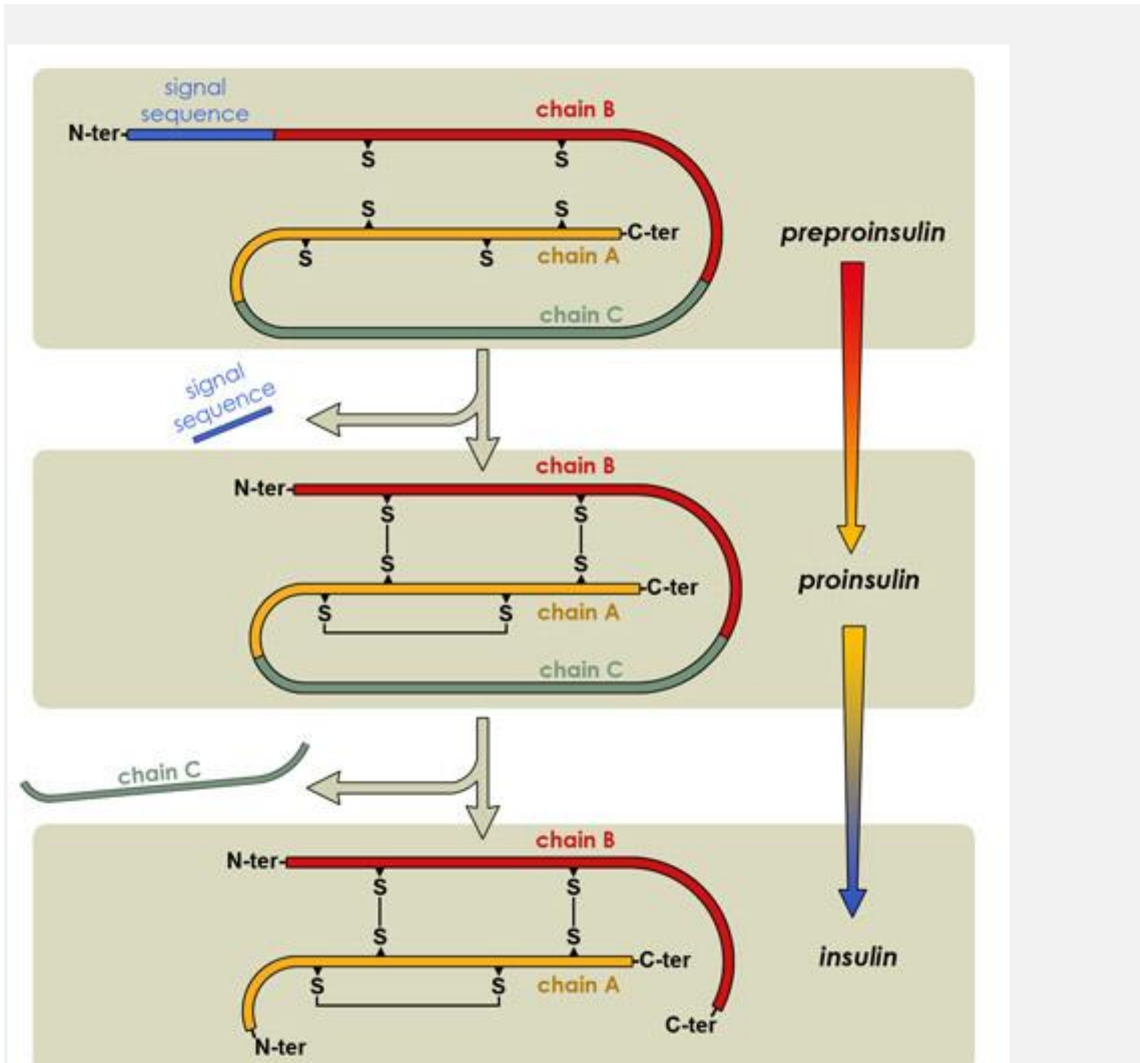
<td>In the endoplasmic reticulum, endopeptidases excise a connecting peptide (c-peptide) between the A and B chains. This breaks the single chain into two strands (A and B) that are held together by disulfide bridges – i.e. this generates the mature form of insulin. Equimolar amounts of insulin and free c-peptide are packaged in the Golgi into storage vesicles which accumulate in the cytoplasm.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<td>Regulation and Mechanism of Action</td>
<td>Regulation of Insulin secretion
Elevation of plasma glucose concentration directly stimulates
- A rapid rise of insulin secretion
- There is an increase in intracellular Calcium, which is responsible for releasing insulin
Insulin secretion by Beta cells decreases as glucose levels decline
Increased amino acid concentrations in plasma increases insulin secretion</td>
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Stimulation of right vagus nerve increases insulin secretion
Sympathetic stimulation decreases release of insulin
Gastrointestinal hormones (gastrin, secretin and gastric inhibitory peptides) increase insulin release
Keto acids increase insulin secretion
Somatostatin secreted by Delta cells decreases insulin secretion
Drugs altered the insulin secretion
Leptin decreases basal and glucose-stimulated insulin release.

Chemical Regulation of insulin secretion

Beta cells have glucose sensing mechanism activated by

- Entry of glucose into beta cells
- Phosphorylation of glucose by glucokinase
- Upon activation it directly inhibits the ATP-sensitive K^+ channels
- Partial depolarization of the Beta cells
- Increase Ca^{2+} availability
- Exocytotoc release of insulin from storing granules.

Hormonal and Neural Regulation of Insulin

The following hormones show effect in insulin release in response to glucose

- Intra-islet pancreatic interaction
- Growth hormone
- Corticosteroids
- Thyroxine

On stimulation of following nerves the insulin secretion is increased
Adrenergic $beta_2$
Cholinergic
Vagus nerve

Regulators of Insulin Secretion

Stimulators of Insulin Secretion	**Inhibitors of Insulin Secretion**
Serum glucose	Decrease in Glucose level
Serum amino acids	Decrease in Amino acids
Serum free fatty acids	Decrease in Free fatty acids
Serum ketone bodies	Somatostatin
Gastroinhibitory peptide Gastrin Cholecystokinin Secretin Epinephrine (β-receptor) Parasympathetic nervous system	Epinephrine (α-receptor) Leptin Fasting

Glucagon

Glucagon is a catabolic peptide hormone secreted by alpha cells in the pancreas and elevates the concentration of glucose in the blood by promoting gluconeogenesis and glycogenolysis.

	Glucose is stored in the liver in the form of the polysaccharide glycogen, which is a glucan. Liver cells have glucagon receptors and when glucagon binds to the liver cells they convert glycogen into individual glucose molecules and release them into the bloodstream—this process is known as glycogenolysis. As these stores become depleted, glucagon then encourages the liver and kidney to synthesize additional glucose by gluconeogenesis. Glucagon also turns off glycolysis in the liver, causing glycolytic intermediates to be shuttled to gluconeogenesis that can induce lipolysis to produce glucose from fat. Regulation of Secretion Glucagon secretion is directly stimulated by - Low blood glucose concentration - High levels of circulating amino acids - Somatostatin decreases glucagon secretion - Insulin and secretin decreases glucagon secretion - Sympathetic stimulation increases glucagon secretion (β-receptor mechanism) - Vagal stimulation decreases glucagon secretion - All forms of physical stress increases glucagon secretion

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<td>UNIT V</td>
<td>Testes and Ovaries : Male reproductive system – Hormonal control of testes, chemistry and biosynthesis of Testosterone – function of testosterone. Female reproduction system – role of hormones in female sexual cycle, Placental hormones – Parturition - Lactation</td>
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<td>Male reproductive system</td>
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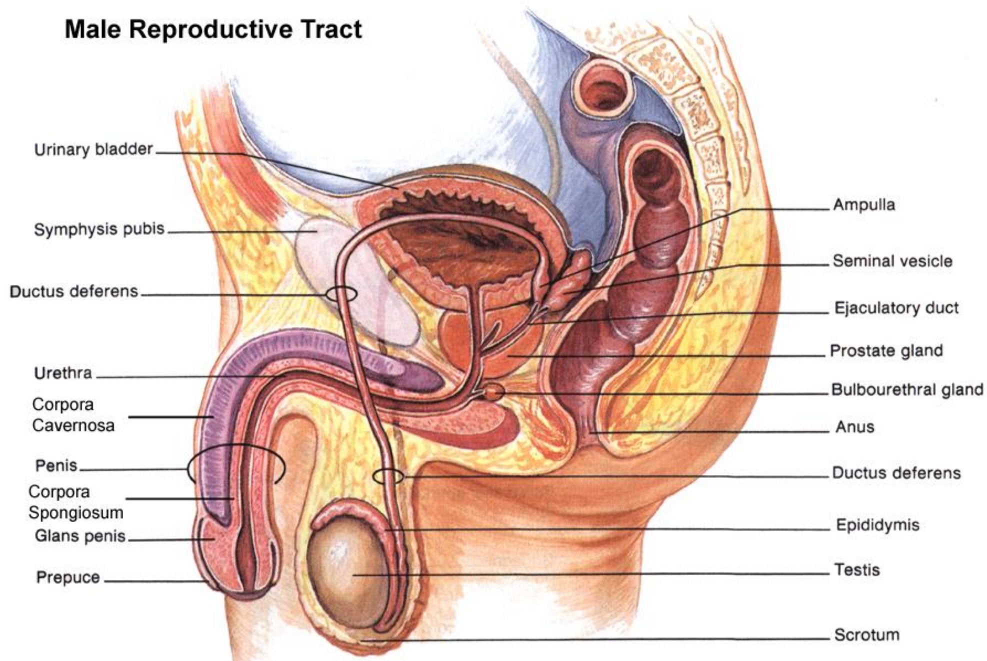
A. Male reproductive tract anatomy and physiology



Modified from Van De Graaff, *Human Anatomy,* Wm. C. Brown: Dubuque, IA, 1988.

1. Testis
    a. Sperm originate in wall of seminiferous tubules
    b. Cells near outer edge of wall differentiate into more mature cells closer to center of wall
    c. Nearly mature sperm are released into hollow center of tubule and travel to epididymis
    d. Interstitial cells between tubules produce testosterone, which promotes sperm maturation
2. Epididymis
    a. Sperm continue to mature in epididymis
    b. Complete maturation of sperm requires about 45 days in the testis and about 18 days in the epididymis (about 63-65 days total)
    c. Mature sperm are composed of head (acrosome with enzymes, DNA), midpiece (mitochondria -> energy), and tail (motility)
3. Vas deferens, ampulla of vas deferens

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4. Seminal vesicles
    a. Produce much of fluid in semen
    b. Nutritional chemicals: fructose, amino acids, lipids
5. Prostate gland
    a. Secretes an alkaline fluid that enters urethra through pores in urethral walls
    b. Components: buffering chemicals, citrate, calcium, spermine
    c. Sperm are both viable and motile at pH 7-8.5, and begin to be less motile and viable below pH 7.0; since normal vaginal pH is 3.8-4.5, sperm must be protected from acidic pH by components of semen
6. Bulbourethral gland (Cowper's gland) (secrete viscous alkaline fluid)
7. Ejaculatory duct
8. Urethra
9. Semen components and normal characteristics
    a. Volume: 2.5 to 5 ml per ejaculation
    b. Sperm (from epididymis, testis)-- 50 to 150 million per ml (less than 20 million suggests infertility)
    c. Nutrients and fluid (from seminal vesicles)
    d. Protective, buffering chemicals (from prostate gland)
    e. Thick, alkaline fluid (from bulbourethral glands)
    f. Color: milky appearance (due to secretions from prostate)
    g. Motility: at least 60% active, showing good forward motion)
    h. pH: slightly alkaline (pH of 7.2 and 7.6 or 7.8)
    i. Specific gravity: 1.028 (slightly denser than water)
    j. Morphology: at least 80% normal
10. Penis
    a. Shaft, glans, coronal ridge
    b. Erectile tissues: corpora cavernosa, corpus spongiosum
    c. Urethra passes through corpus spongiosum to urethral opening
    d.
11. Nervous system control of erection and ejaculation
    a. Brain communicates sexual stimulus to erection reflex center in sacral part of spinal cord
    b. Spinal cord nerves send signals to erectile tissue in penis, arteries dilate, blood pools in erectile tissues, leading to erection

	c. Spinal cord nerves send signals that result in contraction of inner structures (epididymis, vas deferens, seminal vesicles, prostate) d. Semen washes past bulbourethral glands into the lower urethra (emission); sensation of urethral filling is returned to erection complex e. Spinal cord nerves send signals that result in contraction of muscles at base of penis, leading to rhythmic contractions (ejaculation)
Hormonal control of testes	The human male and female reproductive cycles are controlled by the interaction of hormones from the hypothalamus and anterior pituitary with hormones from reproductive tissues and organs. In both sexes, the hypothalamus monitors and causes the release of hormones from the pituitary gland. When the reproductive hormone is required, the hypothalamus sends a **gonadotropin-releasing hormone (GnRH)** to the anterior pituitary. This causes the release of **follicle stimulating hormone (FSH)** and **luteinizing hormone (LH)** from the anterior pituitary into the blood. Note that the body must reach puberty in order for the adrenals to release the hormones that must be present for GnRH to be produced. Other hormones have specific functions in the male and female reproductive systems. **Male Hormones** At the onset of puberty, the hypothalamus causes the release of FSH and LH into the male system for the first time. FSH enters the testes and stimulates the **Sertoli cells** to begin facilitating spermatogenesis using negative feedback,. LH also enters the testes and stimulates the **interstitial cells of Leydig** to make and release testosterone into the testes and the blood. **Testosterone**, the hormone responsible for the secondary sexual characteristics that develop in the male during adolescence, stimulates spermatogenesis. These secondary sex characteristics include a deepening of the voice, the growth of facial, axillary, and pubic hair, and the beginnings of the sex drive.

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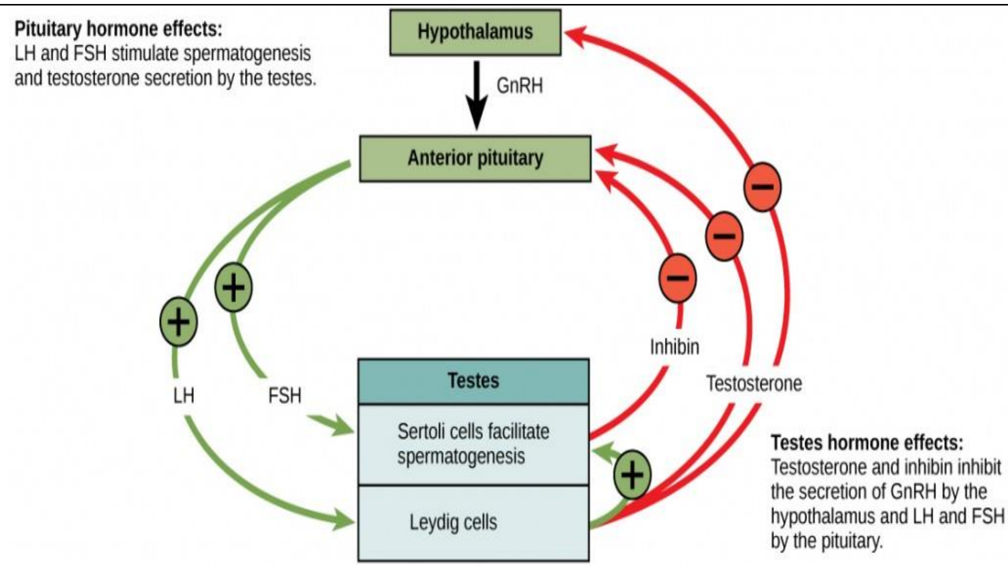

Figure 24.14. Hormones control sperm production in a negative feedback system.

A negative feedback system occurs in the male with rising levels of testosterone acting on the hypothalamus and anterior pituitary to inhibit the release of GnRH, FSH, and LH. The Sertoli cells produce the hormone **inhibin**, which is released into the blood when the sperm count is too high. This inhibits the release of GnRH and FSH, which will cause spermatogenesis to slow down. If the sperm count reaches 20 million/ml, the Sertoli cells cease the release of inhibin, and the sperm count increases.

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Chemistry and biosynthesis of Testosteron

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Testosterone is primary male sex hormone and popularly known as male androgen.
David and his colleagues (1935) isolated pure crystalline hormone from testicular material and named it "Testosterone"
Testosterone is C_{19} steroid and its chemical formula is $C_{19}H_{28}O_2$.
In normal male, 4- 12 mg of testosterone are secreted each day.
Testosterone is secreted by leydig cells of testis. Trace amount is also secreted by Sertoli cells of seminiferous tubule and adrenal cortex.
Cholesterol is the precursor for the synthesis of testosterone.
Cytochrome P_{450} side chain cleavage enzyme of the inner mitochondrial membrane of leydig cells hydroxylates the side chain C_{22} and C_{20} of cholesterol and converts into pregnenolone.
It is then trans-located to smooth ER for conversion to testosterone in two pathways (1) Δ^5 pathway and (2) Δ^4 pathway.
The conversion of pregnenolone to testosterone requires the action of 5-enzymes—(i) 3β-hydroxysteroid dehydrogenase (ii) Δ^{5-4} isomerase, (iii) 1 7α-hydroxylase, (iv) $C_{17\ 20}$ Lyase and (v) 1 7β-hydroxy steroid dehydrogenase.
The secretion of testosterone from leydig cells is predominantly

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	regulated by ICSH (LH) adenohypophysis. Pituitary hormone secretion is controlled by ICSH-RH of hypothalamus. Thus hypothalamohypophysial system controls the testosterone secretion. High blood titre of testosterone inhibits both pituitary gonadotrophs and hypothalamic releasing hormone by negative feedback mechanism
Function of Testosterone	Testosterone is the key male sex hormone that regulates fertility, muscle mass, fat distribution, and red blood cell production. When levels of testosterone drop below levels that are healthy, they can lead to conditions like hypogonadism or infertility. There are, however, sources from which people with low testosterone can boost their levels. • Testosterone regulates a number of processes in the male body. • Levels of testosterone tend to drop as men age. • Prohormone supplements do not have any effect on testosterone levels. • Testosterone supplements are prescribed only for specified conditions, and not to counteract the natural, age-related drop in testosterone levels. • Testosterone replacement therapy (TRT) is also available. However, this can carry side effects and risks. In men, testosterone is thought to regulate a number of functions alongside sperm production. These include: • sex drive • bone mass • fat distribution • muscle size and strength • red blood cell production Without adequate amounts of testosterone, men become infertile. This is because testosterone assists the development of mature sperm. Despite being a male sex hormone, testosterone also contributes to sex drive, bone density, and muscle strength in women. However, an excess of testosterone can also cause women to experience male pattern baldness and infertility. The brain and pituitary gland control testosterone levels. Once produced, the hormone moves through the blood to carry out its various

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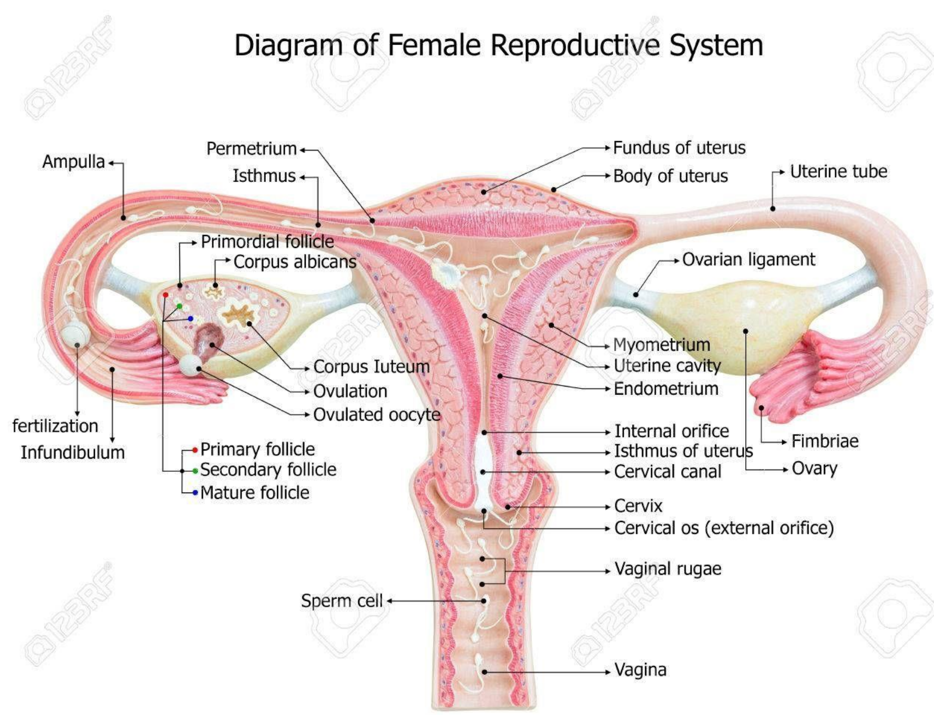
When a man has low testosterone, or hypogonadism, he may experience:
reduced sex drive
erectile dysfunction
low sperm count
enlarged or swollen breast tissue
Over time, these symptoms may develop in the following ways:
loss of body hair
loss of muscle bulk
loss of strength
increased body fat
Chronic, or ongoing, low testosterone may lead to osteoporosis, mood swings, reduced energy, and testicular shrinkage.</td></tr>
<tr><td>Female reproduction system</td><td>The female reproductive organs also known as genitalia, include both external and internal organs



The external genitalia or vulva consist of labia majora, labia minora, clitoris, vaginal orifice, vestibule, hymen and the vestibular glands.
• Labia majora:- these are the two large folds that forms the boundary</td></tr>
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	of vulva. They are composed of skin, fibrous tissue and consist of large no. of sebaceous and eccrine sweat gland. Posteriorly they merge with the skin of perineum and anteriorly it joins in front of pubic symphysis. • ***Labia minora:-*** these are two smaller folds of skin between the labia minora and contains sebaceous glands. The cleft between the labia minora is the vestibule. • ***Clitoris:-*** these are like penis in males and contains sensory nerve endings and erectlie tissue. • ***Vestibular glands:-***these are situated one on each side of vaginal opening, their ducts open into the vestibule. They secrete mucous that keeps the vulva moist. The internal genitalia lie in the pelvic cavity and consist of vagina, uterus, uterine tubes and two ovaries. • ***VAGINA:-***the vagina is a tube of muscular and fibrous tissue and is lined with stratified squamous epithelium and opens into the vestibule at the distal end. In adults, the anterior wall is about 7.5cm long and the posterior wall is of 9cm. the difference in length is due to the angle of insertion of cervix through the anterior wall. Hymen is a thin layer of mucous membrane which partially blocks the opening of vagina The vaginal wall has 3 layers- the outer layer is of areolar tissue, the middle layer is of smooth muscle and the inner layer is of stratified squamous epithelium. It does not have any secretory glands but the surface is moist due to the cervical secretions. The vagina acts like a container for the penis during the sexual intercourse and also provides a passageway through which the baby passes during childbirth. • ***UTERUS:-*** it is a hollow pear shaped organ which is almost flat and lies in the pelvic cavity between the bladder and the rectum. It is about 7.5cm long , 5cm wide and weighs 30-40 gm. There are three parts of uterus- 1. Fundus- it is dome shaped part above the opening of uterine tubes. 2. Body- it is the main part of the uterus 3. Cervix- also known as neck of the uterus and passes through the anterior wall of vagina. The wall of uterus have 3 layers- the outer layer known as perimetrium, middle layer is myometrium and inner layer is endometrium. The uterus is supported by surrounding organs, muscles and ligaments. The ligaments that supports are broad ligaments, round ligaments and uterosacral ligaments etc. • ***UTERINE TUBES:-*** *a*lso known as fallopian tubes are about 10cm long and extends from the uterus between the body and fundus. The end of each tube has fingerlike projections called fimbriae.

	The uterine tubes are covered with broad ligaments , middle layer of smooth muscle and are lined with ciliated epithelium. The tubes propel the ovum from ovary to the uterus through peristalsis and ciliary movement, fertilization of ovum takes place in the tubes. . Two **ovaries**, B. Two **oviducts** (also called the **uterine tubes** or **fallopian tubes**) 1. **Infundibulum -** funnel shaped opening of the fallopian tube next to the ovary. Note that the fallopian tube is not conected to the ovary. 2. **Fimbria -** finger-like projections extending from the edge of the infundibulum. C. **Uterus** 1. **Uterine horns -** points where the fallopian tubes connect on the left and right sides. 2. **Fundus or body of uterus** 3. The uterine wall 4. **Cervix -** bulbus end of the uterus that projects into the vagina 5. Os - a passageway from the vaginal canal into the uterine cavity. D. **vagina** E. External genitalia, the labial lips, are not shown in this drawing. II. The **ovary** A. Covered by modified mesothelium called **germinal epithelium**. 1. This name is a misnomer since the germ cells (i.e. the oocytes) do not arise from it. 2. This mesothelial covering is a simple cuboidal epithelium in young woman, and becomes a simple squamous epithelium in older woman. B. Just below germinal epithelium is a poorly defined region of dense connective tissue called the **tunica albuginea** of the ovary 1. Recall that the penis also is surrounded by a tunica albuginia. 2. These tunics have the same developmental derivation in males and females C. The ovarian tissue within the tunica albuginia can be divided into medullary and cortical regions. 1. **Cortex** a. Composed of **ovarian follicles** that are surrounded by a primitive

	connective tissue composed of spindle shaped fibroblasts. * The follicles are sperical structures that are each composed of somatic cells (called **follicle cells**) that surround an **oocyte**. * In addition to the spindle shaped fibroblasts, the stroma of the cortex also contains collagen and reticular fibers. 2. **Medulla** a. Blood vessels (helical arteries and veins) and nerves in a dense stroma of supporting tissue. b. The blood vessels and nerves enter/leave the ovary through a hilus of connective tissue. D. There are four types of follicles. 1. **Primordial follicles** a. One incomplete layer of flattened follicle cells surrounding a central oocyte (immature egg) b. These follicles are located just beneath the tunica albuginia and form groups of primordial follicles called egg nests. c. The oocyte is about 40 um in diameter. 2. **Primary follicles** a. These are follicles that have begun to mature at the beginning of the most recent menstrual cycle. b. Consist of 1 - 7 layers of cuboidal follicle cells that surround a central oocyte. c. There are no fluid filled spaces between the follicle cells. d. During the primary follicle stage the oocyte grows to about 110 um in diameter. * It develops a thick acellular layer of glycoproteins, called the **zona pellucida**, that completely surrounds the oocyte. * The plasmalemma of the oocyte and the adjacent plasmalemma of the the adjacent layer of follicle cells develop many microvilli that extend into the zona pellucida and interdigitate with one and other. ** This interdigitation of microvilli increases the surface area of contact between the oocyte and its adjacent follicle cell layer. ** Thus, the area over which nutrients can pass into and wastes out of the oocyte is increased. ** The layer of follicle cells that is directly adjacent to the zona pellucida is

	called the **corona radiata**. e. **Theca interna** forms from stromal cells that surround the original follicle cell layers. 3. **Secondary follicles** (also called an **antral** or **vesicular follicle**) a. Consist of 8 - 12 layers of follicle cells surrounding the central oocyte b. Major characteristic is that fluid-filled spaces have formed between some of the layers of follicle cells. * These spaces will enlarge and fuse with each other to form the **antrum** of the mature follicle. c. **Theca folliculi** is identifiable * Consists of two major stratified layers of cells that are derived from the stromal cells * These layers are the **theca interna** and **theca externa** 4. **Graafian follicle** a. Has a well developed antrum filled with a fluid called **liquor folliculi** (or follicular liquor). b. Oocyte located within a hillock of multiple layers of follicle cells that projects into the antral cavity - called the **cumulus oophorus.** c. The follicle cells directly adjacent to oocyte form the corona radiata that will remain associated with oocyte after ovulation. E. **Ovulation -** release of oocyte from ovary. 1. Takes place about 14th of menstral cycle in humans. 2. Occurs in response to a peak in production of **leutinizing hormon**e by cells called **gonadotrophs** that are located in the anterior lobe (pars distalis) of the pituitary gland. a. As the Graafian follicle reaches full maturity it presses against the tunica albuginia surrounding the ovary. b. Approximately 24 hr after a peak in the production of luteinizing hormone by the pituitary gland, the follicle and the portion of the tunica albuginia it abutts against (called the **stigma**), rupture and the oocyte, including a few surrounding layers of follicle cells, is expressed into the peritoneal cavity near the infundibulum of the adjacent oviduct. 3. Exactly how the follicle is ruptured and the oocyte expressed into the peritoneal cavity is not fully understood, but may involve, a. An increase in fluid pressure in the antrum.

	b. Contraction of smooth muscle cells located in the theca folliculi. c. A weakening of ovarian tissues overlying point of rupture. 4. At ovulation, the oocyte is released into the peritonial cavity and nearly always enters the infundibulum of the oviduct. a. This movement of the oocyte into the infundibulum and oviduct proper is aided by currents produced by cilia within the oviduct. 5. If fertilization occurs, it will take place in the upper oviduct, sperm having been transported there by means of ciliary currents and perhaps smooth muscle contractions of oviduct. 6. The fertilized egg (now diploid in terms of genetic content) is called a **zygote** (earliest embryonic stage). F. Events in the ovary following ovulation 1. Once ovulation has occurred, this does not spell the end of the follicle cells of the Graafian follicle. 2. The cells of the **stratum granulosum** and **theca interna** increase in size and undergo differentiation to form an endocrine gland called the **corpus luteum**. 3. This glandular tissue within the ovary secretes **progesterone** and **estrogen** that are necessary to maintain the uterine lining in readiness for implantation of the embryo should the oocyte be fertilized. 4. If fertilization and implantation do occur, cells that are part of the developing placenta of the embryo will produce a hormone called **chorionic gonadotropin**. a. This hormone will support the continued existance of the corpus luteum throughout pregnancy, though the structure will degenerate considerably after the 6 month of pregnancy. 5. If fertilization does not occur, the corpus luteum will degenerate by the beginning of the next menstrual cycle. a. After pregnancy, corpus luteum will degenerate completely leaving scar of dense connective tissue called the **corpus albicans**. G. Most ovarian follicles and their contained oocytes degenerate as a female matures (only a small fraction are ever ovulated). This process of degeneration is called **atresia**. The degenerating follicles are called **atretic follicles.** III. The **oviducts** (also called **uterine tubes** or **fallopian tubes**)

A. These tubes are about 12 cm long and extend to the ovaries on the left and right sides of the body.

B. They are highly mobile due to a layer of smooth muscle in wall.

C. The oviducts can be divided into 4 segments

1. **intermural portion** (**pars interstitialis**) **-** portion of the oviduct that lies within the uterine wall, opens into the uterus at distal end.

2. **isthmus -** portion of tube adjacent to uterus

3. **ampulla -** more dialated portion that extends to infundibulum

4. **infundibulum -** funnel shaped, next to ovary, has finger like processes called **fimbria**.

D. The wall of the oviduct has 3 layers

1. A **mucosa** adjacent to the oviduct lumen.

a. Consists of long, longitudinal folds that are most numerous in the ampulla.

b. These folds decrease in size and number as you move toward intramural portion of oviduct where they are reduced to small bulges.

c. The mucosal epithelium is simple columnar and contains two types of cells.

Columnar ciliated cells

Cilia act to move viscous fluid film that covers mucosa toward the uterus.

This helps to prevent bacteria from getting into peritoneal cavity via the infundibulum.

There are also a few ciliary tracts that beat in the opposite direction and that are believed to assist sperm transport to upper oviduct.

Secretory cells **- peg cells**.

Thought to secrete mucus

2. A **muscularis -** muscular layers

a. Inner circular and outer logitudinal layer of smooth muscle.

b. Only the inner circular layer is well developed.

c. Considerable connective tissue is intersperced between the muscle cells.

3. An outer **serosa**

a. A layer of connective tissue containing blood vessels and a nerve plexus that supplies innervation to the smooth muscle layers.

b. An outer mesothelium that covers the oviduct and is adjacent to the peritoneal cavity.

IV. The **uterus**

A. A pear shaped organ that consists of

1. the **uterine horns** (where the oviducts attach)

2. the **fundus** (or **body**), and

3. the **cervix** that bulges into vaginal cavity.

B. The thick wall of the uterus consists of 3 layers.

1. The innermost layer, next to the uterine cavity, is the **endometrium.**

a. **This is effectively the mucosa of the uterus**. It is composed of,

A simple columnar epithelium (with or without cilia).

A thick lamina propria.

Rich in cells and ground substance (collagen).

Also contains straight and specially coiled ateries (helicene arteries) that provide nutrition.

Tubular glands that extend deep into lamina propria.

b. The endometrium can be divied into two layers.

Lamina functionalis (also called the **decidua**)

Contains **uterine glands** that extend to its base.

Contains **helicene arteries** that will provide blood to the placenta during pregnancy.

This is the portion of the endometrium that is sloughed off at the end of each menstrual cycle and then is regrown during the next.

It forms the tissues in which the embryo will implant.

The functionalis regenerates from cells in the bases of the uterine glands. These cells divide and migrate over the exposed connective tissue of the basalis after the functionalis is shed. They act as stem cells that replace the lost cells of the shed functionalis by repeated mitosis.

Lamina basalis (also called the **basalis**)

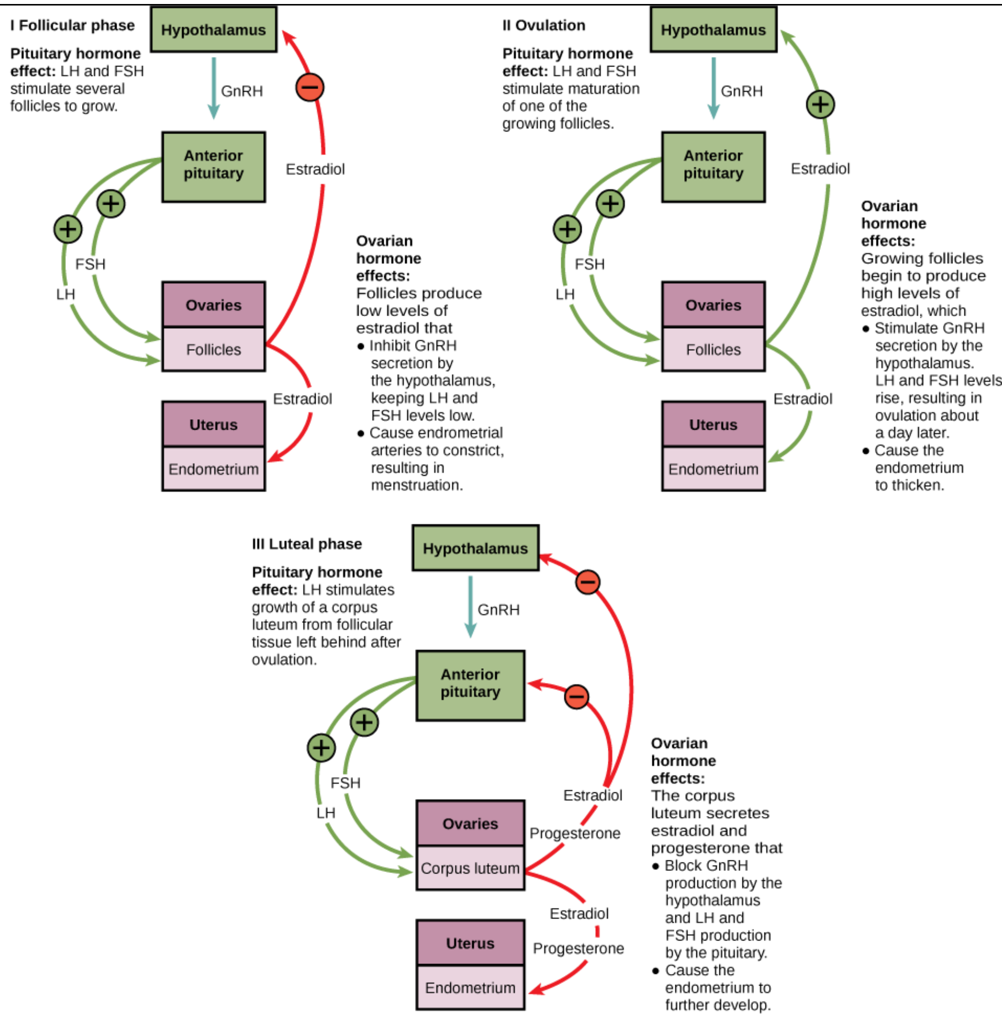
This is the permanent portion of the endometrium.

Contains **straight arteries** that provide oxygen and nutrients to the cells of this layer.

c. **The lamina functionalis will interact with tissues of the developing embryo to form the placenta.** Placental structure is described on pp. 465 - 466 of your text and will be discussed in more detail in Vertebrate

	Embryology ZOOL 0302 (Soon to be called Vertebrate Development, BIOL 4410). 2. The **myometrium** a. A tunic of smooth muscle that surrounds the endometrium. b. Thickest layer of the uterine wall. c. Consists of 4 poorly defined layers of smooth muscle. d. Increases in thickness during pregnancy due to both division of smooth muscle cells and increase in cell size. e. Decreases in thickness after pregnancy has ended. 3. An outer serosa called the **perimetrium** a. Thin outermost layer of uterus b. Consists of a serosa of connective tissue containing blood and lymph vessels, nerves, and sympathetic ganglia that is covered by the mesthelium of the peritoneal cavity.
role of hormones in female sexual cycle	The control of reproduction in females is more complex. The anterior pituitary hormones cause the release of the hormones FSH and LH. In addition, estrogens and progesterone are released from the developing follicles. **Estrogen** is the reproductive hormone in females that assists in endometrial regrowth, ovulation, and calcium absorption; it is also responsible for the secondary sexual characteristics of females. These include breast development, flaring of the hips, and a shorter period necessary for bone maturation. **Progesterone** assists in endometrial re-growth and inhibition of FSH and LH release. In females, FSH stimulates development of egg cells, called ova, which develop in structures called follicles. Follicle cells produce the hormone inhibin, which inhibits FSH production. LH also plays a role in the development of ova, induction of ovulation, and stimulation of estradiol and progesterone production by the ovaries. Estradiol and progesterone are steroid hormones that prepare the body for pregnancy. Estradiol produces secondary sex characteristics in females, while both

	estradiol and progesterone regulate the menstrual cycle. **The Ovarian Cycle and the Menstrual Cycle** **The ovarian cycle** governs the preparation of endocrine tissues and release of eggs, while the **menstrual cycle** governs the preparation and maintenance of the uterine lining. These cycles occur concurrently and are coordinated over a 22–32 day cycle, with an average length of 28 days. The first half of the ovarian cycle is the follicular phase. Slowly rising levels of FSH and LH cause the growth of follicles on the surface of the ovary. This process prepares the egg for ovulation. As the follicles grow, they begin releasing estrogens and a low level of progesterone. Progesterone maintains the endometrium to help ensure pregnancy. The trip through the fallopian tube takes about seven days. At this stage of development, called the morula, there are 30-60 cells. If pregnancy implantation does not occur, the lining is sloughed off. After about five days, estrogen levels rise and the menstrual cycle enters the proliferative phase. The endometrium begins to regrow, replacing the blood vessels and glands that deteriorated during the end of the last cycle.



Following ovulation, the ovarian cycle enters its luteal phase, and the menstrual cycle enters its secretory phase, both of which run from about day 15 to 28.

The luteal and secretory phases refer to changes in the ruptured follicle.

The cells in the follicle undergo physical changes and produce a structure called a corpus luteum.

The corpus luteum produces estrogen and progesterone. The progesterone facilitates the regrowth of the uterine lining and inhibits the release of further FSH and LH.

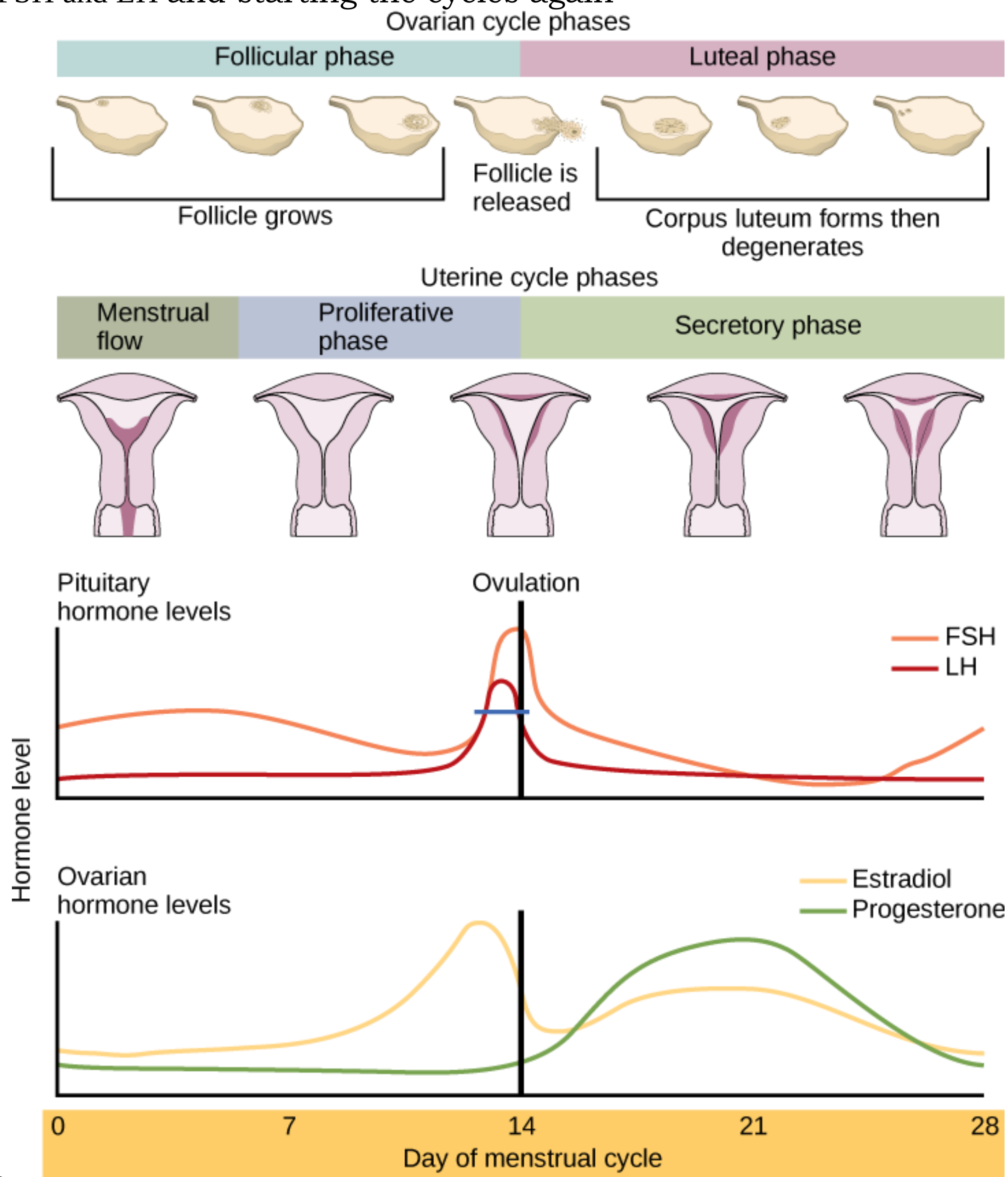
The uterus is being prepared to accept a fertilized egg, should it occur during this cycle.

The inhibition of FSH and LH prevents any further eggs and follicles from developing, while the progesterone is elevated.

The level of estrogen produced by the corpus luteum increases to a steady level for the next few days.

If no fertilized egg is implanted into the uterus, the corpus luteum

<table>
<tr>
<td></td>
<td>degenerates and the levels of estrogen and progesterone decrease.
The endometrium begins to degenerate as the progesterone levels drop, initiating the next menstrual cycle. The decrease in progesterone also allows the hypothalamus to send GnRH to the anterior pituitary, releasing FSH and LH and starting the cycles again



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<tr>
<td>Placental hormones</td>
<td>The placenta is an organ formed in the uterus of a pregnant woman. The term Placenta comes from the Latin language and means flat cake.
It is a temporary organ. It functions as a connection between the mother and the fetus during fetal development.
The placenta is the organ that provides the transfer of oxygen and carbon dioxide, as well as nutrients and wastes, between the mother and the fetus.</td>
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</table>

	After delivery, the placenta is expelled from the mother's body as part of the afterbirth, and any hormones that were produced by the placenta fade from the mother's bloodstream. • The first hormone released by the placenta is called the Human Chorionic Gonadotropin hormone (HCG). This is responsible for stopping the process at the end of menses when the Corpus luteum ceases activity and atrophies. • If HCG did not interrupt this process, it would lead to spontaneous abortion of the fetus. The corpus luteum also produces and releases progesterone and estrogen, and HCG stimulates it to increase the amount that it releases. • HCG is the indicator of pregnancy that pregnancy tests look for. These tests will work when menses has not occurred or after implantation has happened on days seven to ten. HCG may also have an anti-antibody effect, protecting it from being rejected by the mother's body. HCG also assists the male fetus by stimulating the testes to produce testosterone, which is the hormone needed to allow the sex organs of the male to grow. • Progesterone helps the embryo implant by assisting passage through the fallopian tubes. It also affects the fallopian tubes and the uterus by stimulating an increase in secretions necessary for fetal nutrition. Progesterone, like HCG, is necessary to prevent spontaneous abortion because it prevents contractions of the uterus and is necessary for implantation. • Estrogen is a crucial hormone in the process of proliferation. This involves the enlargement of the breasts and uterus, allowing for growth of the fetus and production of milk. Estrogen is also responsible for increased blood supply towards the end of pregnancy through vasodilation. The levels of estrogen during pregnancy can increase so that they are thirty times what a non-pregnant woman mid-cycles estrogen level would be. • Human placental lactogen is a hormone used in pregnancy to develop fetal metabolism and general growth and development. Human placental lactogen works with Growth hormone to stimulate Insulin-like growth factor production and regulating intermediary metabolism. In the fetus, hPL acts on lactogenic receptors to modulate embryonic development, metabolism and stimulate production of IGF, insulin, surfactant and adrenocortical hormones. HPL values increase with multiple pregnancies, intact molar pregnancy, diabetes and Rh incompatibility. They are decreased with toxemia, choriocarcinoma, and Placental insufficiency.

Parturition - Lactation	**Parturition** It is the process of the contraction of the uterus at regular intervals that helps in the delivery of the baby at the end of pregnancy. The signals that the fully developed fetus sends through the placenta for ejection is called Foetal ejection reflex. These signals induce muscular contractions. The time period from fertilization to childbirth is called the gestation period. **Lactation** It is the process of production of milk by the mammary glands at the end of pregnancy. The milk produced initially by the glands is called colostrum. This milk is crucial for the baby as it provides the child with the initial immunity.
REFERENCES	Online source : Medical News Today, Lecture Notes, Biology 203, Human Sexuality and Reproduction, Press Books BC campus