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SUBJECT: LIFE SCIENCE**GRADE: 12****MODULE: 2 - Structure, control and processes in basic life systems of plants and humans****UNIT: Gametogenesis, ovulation and menstruation**

By the end of this unit you should be able to:

- Describe the structure and function of the male reproductive system
- Describe the structure and function of the female reproductive system
- Compare spermatogenesis and oogenesis
- Discuss menopause and hormone replacement therapy

LESSON OVERVIEW: (Knowledge areas)

1. Introduction
2. Gametogenesis
3. Ovulation and the hormone cycle
4. Menopause and hormone replacement therapy

LESSON:**1. Introduction**

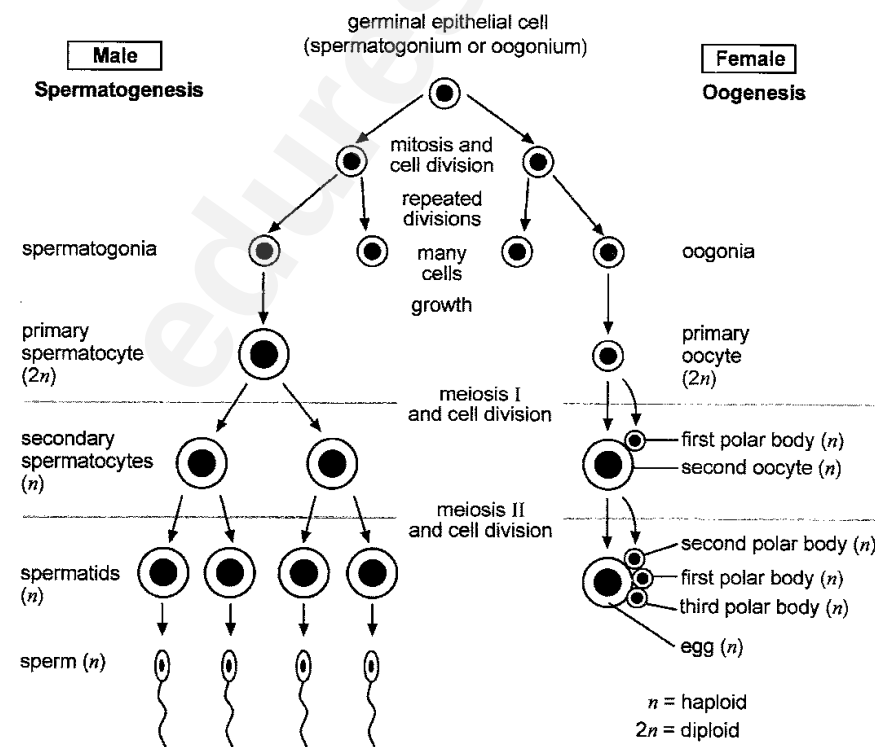
Living organisms reproduce to ensure there is a next generation, to prevent extinction. In Meiosis you learned that sexually mature, diploid adults produce haploid sex cells in special structure. The **gametes fuse** during the process of fertilization, producing a diploid zygote. During fertilization, genetic material from the male and female combine to form a new organism.

2. Gametogenesis (Gameto = from the word gamete, genesis = to create, so the process occurs to create a gamete that is haploid (n) in the male and also in the female.)

Reproduction takes place as three processes:

- **Gametogenesis** – production of the haploid gametes
- **Fertilization** – fusion of the gametes
- **Embryo development** – mitosis of the cells of the zygote for growth and development.

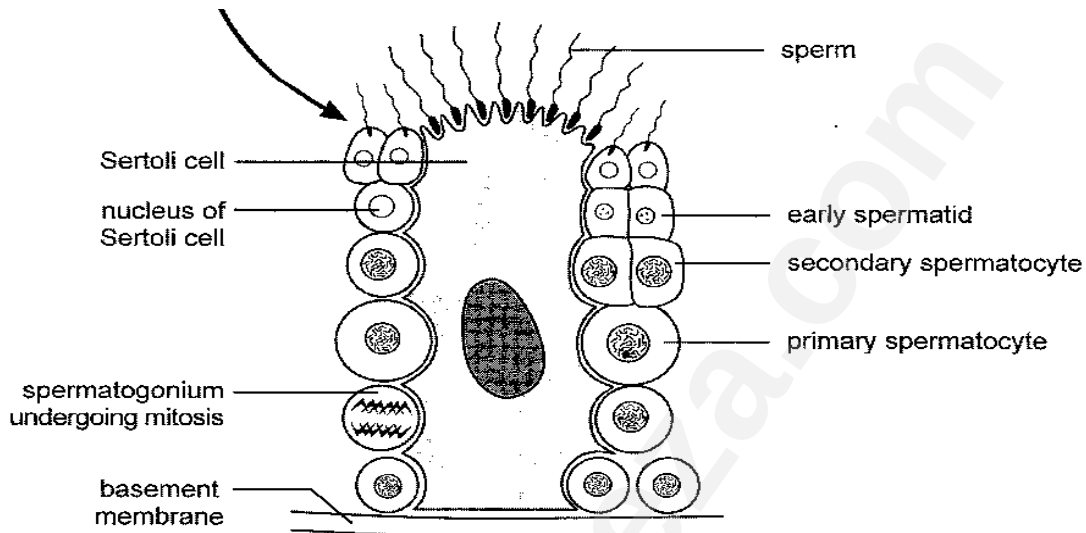
Gametogenesis is the production of haploid gametes in the germinal epithelium by the process of **meiosis**. When gametogenesis takes place to produce sperm cells, the process is called spermatogenesis. When female gametes are produced, the process is called oogenesis.



Schematic representation of gametogenesis

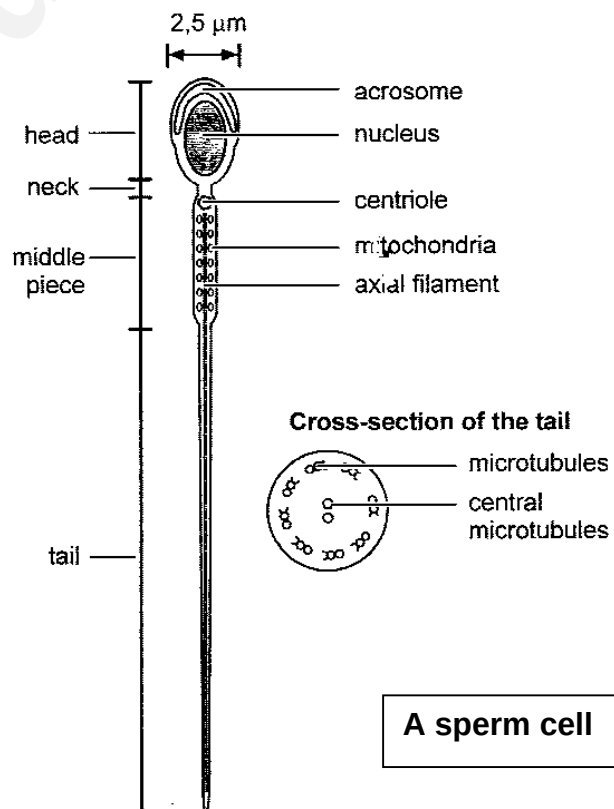
Spermatogenesis: from puberty, a male produces about 120 million sperm per day by the process of spermatogenesis. The germinal epithelium produces **spermatogonia** that develop into the **primary spermatocytes**. The first meiotic division takes place to produce **haploid secondary spermatocytes**. The second meiotic division takes place to produce **spermatids**. Cells of Sertoli provide food for the developing rows of spermatids that move into the seminiferous tubules to mature.

Inside the seminiferous tubule, sperm cells are produced and develop



Structure of part of the seminiferous tubule showing various stages of spermatogenesis

The process of spermatogenesis



A sperm cell

The sperm cell is a very small structure of about 2,5 µm in diameter and 50 µm long. The **haploid sperm cell** consists of a head with a nucleus, a short neck and a long tail to assist with swimming to the egg cell.

Hormonal control of Spermatogenesis:

The hypothalamus releases gonadotrophin-releasing hormone (GnRH), which stimulates the pituitary gland to release two hormones jointly called **gonadotrophins**. The two gonadotrophins are:

- follicle stimulating hormone – **FSH**, which stimulates spermatogenesis
- luteinising hormone – **LH**, which stimulates the synthesis of the hormone testosterone by the Leydig cells in the testes.

3. Oogenesis, Ovulation and the Female Hormone Cycle

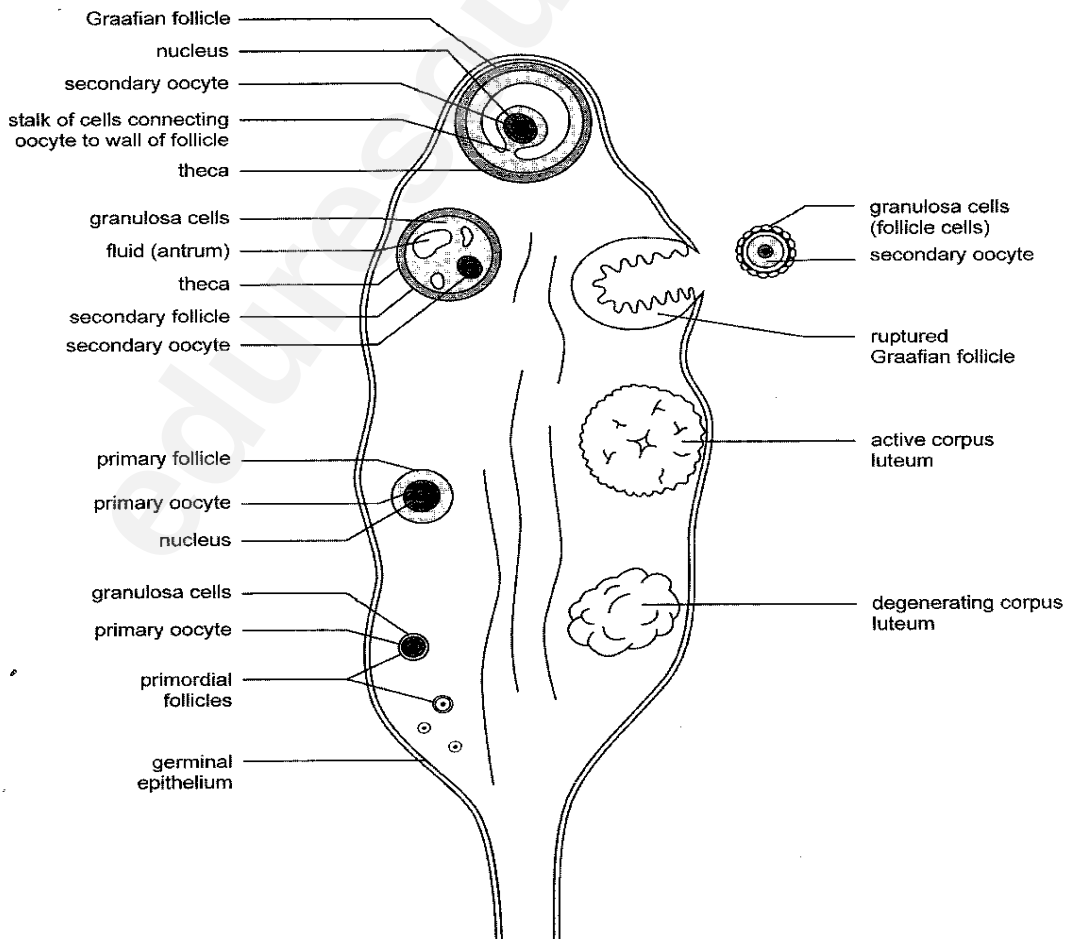
Oogenesis: approximately two million eggs are produced in the female, before birth and only 400 - 450 eggs develop into **secondary oocytes**. The process starts with the oogonia that undergo meiosis resulting in the **primary oocyte**. Each primary oocyte stays in the prophase of meiosis I throughout childhood. Granulosa cells form a structure called the primordial follicle to enclose the **oocyte**. Secondary oocytes develop and are released from the ovary during **ovulation**.

A female is fertile from the age of about 12 to 50. Each month, one primordial follicle will develop into a mature **Graafian follicle**. This takes place as follows:

- o Inside the developing follicle, a primary oocyte develops into an egg.
- o The primordial follicle becomes a primary follicle as the granulosa cells multiply and form layers around the primary oocyte.
- o The cells of the stroma of the ovary form more layers called the theca.
- o The theca contains blood vessels and with the granulosa cells, secretes female sex hormones.

The developing follicle moves to the surface of the ovary causing a bulge to develop on the surface. The oocyte now undergoes **meiosis I**. The bulge bursts as fluid accumulates and the egg cell is released to the exterior of the ovary. This process is called **ovulation**.

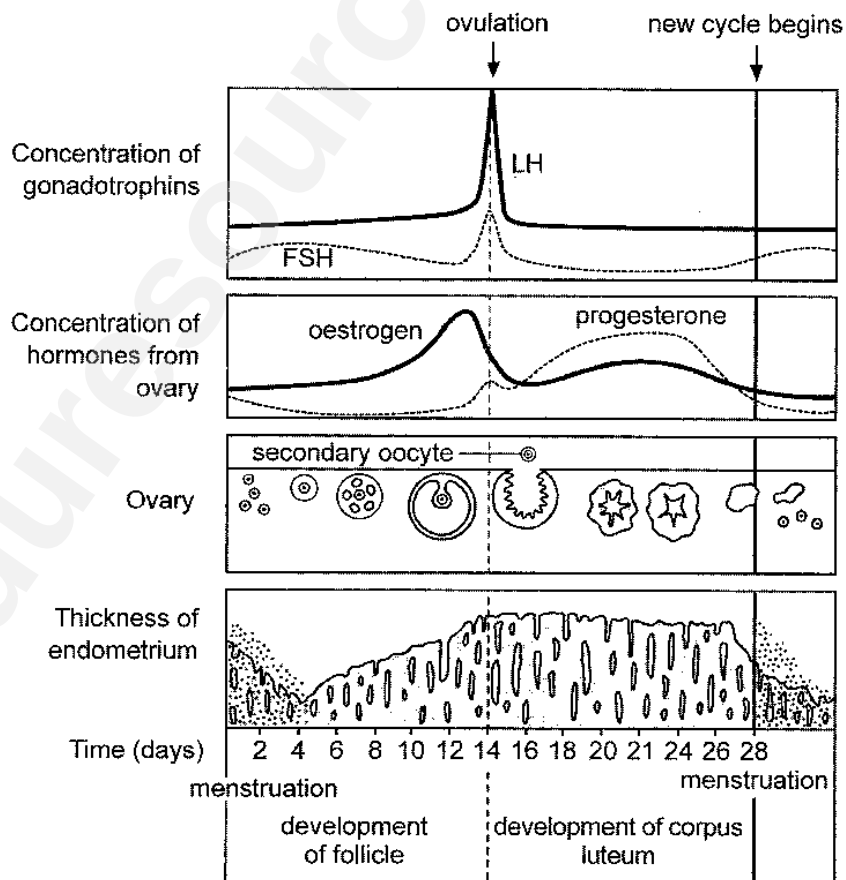
The egg cell enters the infundibulum containing the fimbriae of the fallopian tube. When the egg is released, the Graafian follicle changes into the **corpus luteum**. If the egg cell is fertilized in the fallopian tube, the corpus luteum secretes **progesterone**. If the egg cell is not fertilized, the corpus luteum degenerates.



Section through a human ovary showing the stages in the development of the Graafian follicle, ovulation and the formation and degeneration of the corpus luteum

Hormonal control of Oogenesis:

- Hormones control the 28 day **menstruation cycle**. Usually only one egg is released per cycle. Should both ovaries release an egg cell and both are fertilized, the result is paternal twins (unidentical). The menstruation cycle affects the ovaries and the uterus.
- **Gonadotrophin releasing hormone** (GnRH) stimulates the anterior pituitary gland to release follicle stimulating hormone (FSH) into the blood.
- FSH is transported to the ovaries (target organ) where it stimulates the development of the follicle.
- Granulosa cells in the developing follicle produce **oestrogen**. Oestrogen has two target organs namely the uterus and the anterior pituitary gland.
 - Oestrogen causes the development of the endometrium in the uterus to prepare it for pregnancy.
 - Oestrogen inhibits the secretion of FSH by the anterior pituitary gland so that no further follicles are produced during the pregnancy. High oestrogen levels will trigger the secretion of luteinising hormone (LH).
- LH is released into the blood and is transported to the ovary, causing ovulation. **LH** stimulates the Graafian follicle to develop into the corpus luteum.
- The corpus luteum secretes **oestrogen and progesterone**.
 - Progesterone ensures that the thickening of the **endometrium** is maintained and **glandular activity** is stimulated.
 - Progesterone **inhibits** the anterior pituitary gland from releasing LH. The release of progesterone causes the slight **rise in temperature** just after a female has ovulated.
- If fertilization does not take place, the corpus luteum will **degenerate** causing a decrease in the levels of oestrogen and progesterone. The endometrium breaks down and tears away from the walls of the uterus, causing the bleeding associated with **menstruation**. This lasts for about five days.



Changes occurring during the menstrual cycle, showing levels of the hormones FSH, LH, oestrogen and progesterone

4. Menopause and Hormone Replacement Therapy (HRT)

Menopause represents the end of the **fertile period** in a woman's life (when menstruation stops – no fertile eggs are released). From about the age of 45, a female's menstruation cycle becomes irregular as the number of follicles produced decreases.

Menopause symptoms: hot flushes, night sweats, vaginal dryness, irritability, fatigue and bone softening due to loss of calcium which can result in osteoporosis (brittle, fragile bones). The symptoms can be controlled by **hormone replacement therapy** (HRT). Oestrogen is taken in pill form or implants are made below the skin. A natural remedy for menopause is evening primrose oil because it contains omega-6 essential fatty acids.

REVIEW QUESTIONS:

Multichoice review:

- In mammals, fertilization usually occurs in the
 - Fallopian tubes
 - vagina
 - uterus
 - ovary
- The function of progesterone is to
 - delay the development of sperm
 - prepare the endometrium for the implantation of the blastocyst
 - inhibit the production of thyroxine
 - accelerate the development of the follicles
- The liberation of a mature egg cell from the ovary of a female mammal, is known as
 - ovation
 - ovulation
 - copulation
 - menstruation
- The part of male reproductive system in which sperm cells undergo maturation, is the
 - testis
 - prostate gland
 - gland of Cowper
 - epididymis
- The cells playing a role in the nutrition of the spermatozoa, are the
 - germinal cells
 - cells of Leydig
 - cells of Sertoli
 - spermatogonia
- The cells in the testes that are responsible for the production of the male hormone testosterone, are the.....
 - germinal cells
 - cells of Leydig
 - cells of Sertoli
 - spermatogonia
- The cyclic changes in the endometrium (mucous layer) of the uterus, are known as
 - the ovarian cycle
 - the menstrual cycle
 - menopause
 - oogenesis
- The correct sequence of the developmental stages during oogenesis is
 - primary follicle – corpus luteum – Graafian follicle
 - primary follicle – primary oocyte – corpus luteum
 - oogonium – primary oocyte – egg cell
 - corpus luteum – Graafian follicle – primary follicle

9. The fusion of an egg cell and a sperm is known as
 - A copulation
 - B cleavage
 - C fertilization
 - D ovulation
10. The correct sequence of stages in the menstrual cycle is
 - A ovulation – follicle stage – corpus luteum – menstruation
 - B follicle stage – ovulation – corpus luteum - menstruation
 - C follicle stage – corpus luteum – ovulation – menstruation
 - D corpus luteum – ovulation – follicle stage – menstruation

EXERCISES:

EXERCISE 1:

Read the passage and answer the questions that follow:

A Dr Li in Los Angeles has stated that women should always work to maintain an ideal body weight as there is evidence that overweight women have a worse prognosis when diagnosed with certain cancers and they are more likely to develop some types of cancer. In his studies it was noted that overweight women were more likely to be diagnosed at stage 1 of ovarian cancer than women of normal weight, but overweight patients with more advanced cancer had a shorter overall survival rate.

Dr Li stated it was possible that the fat may secrete factors or hormones that accelerate tumour growth. Dr Li and his colleagues are still currently investigating the development of tumours related to obesity.

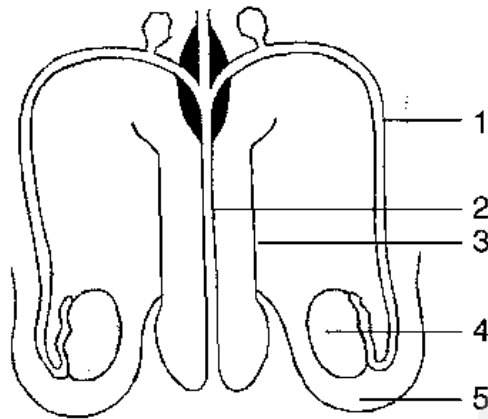
1. Why do you think it is a good idea for women to maintain an ideal body weight?
2. What suggestions would you make to an obese woman with regard to her body weight?
3. What factors are Dr Li and his colleagues investigating with regard to tumour growth?
4. What chance does an obese woman have of surviving ovarian cancer if she was diagnosed with ovarian cancer after stage 1?

HOMEWORK:

1. Match column A with the statements in column B.

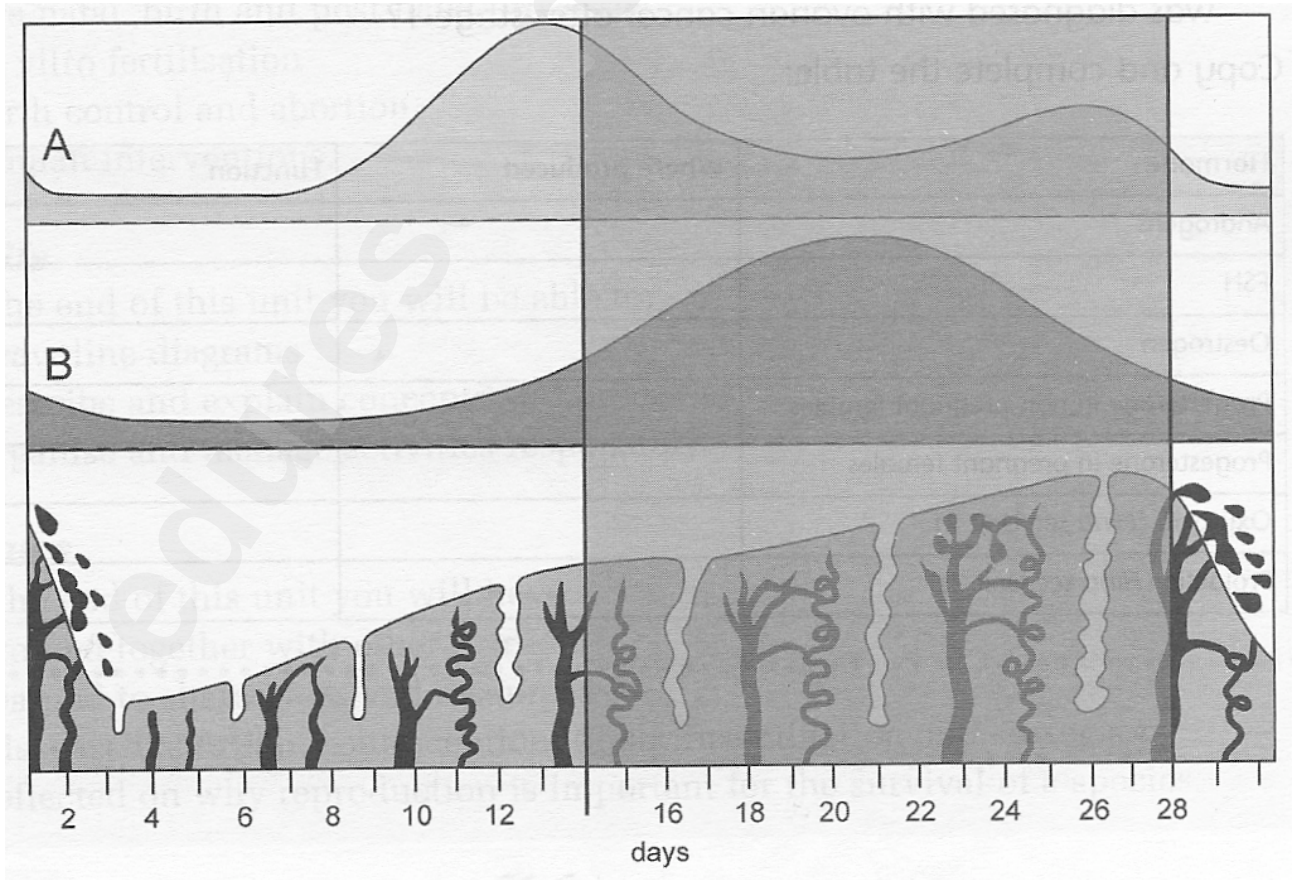
Column A	Column B
1. uterus	A. the external opening of the vagina
2. Fallopian tube	B. releases the egg cell during ovulation
3. testis	C. produces the hormone testosterone
4. cervix	D. development of the foetus takes place here
5. ovary	E. develops into the Graafian follicle
6. corpus luteum	F. organ enclosed by a scrotum
7. primary follicle	G. secretes progesterone
8. cells of Sertoli	H. provides nutrition of the sperm cells
9. epididymus	I. deposits sperm cells into the female
10. penis	J. transports egg cells from the ovary to the uterus
	K. region in the female that separates the vagina and the uterus
	L. produced by the Cowper's gland
	M. region where the sperm cells mature before release

2. Study the diagram below and answer the questions that follow:



- 2.1. Provide labels 1 to 5.
- 2.2. Where are the testes located at the time of birth?
- 2.3. Describe the seminiferous tubules.
- 2.4. How are sperm cells formed?
- 2.5. Why is it necessary for a male to produce such a large quantity of sperm cells?
- 2.6. Name one function of the epididymis.
- 2.7. Why is it important that the testes are located outside of the abdominal cavity?
- 2.8. Name the three glands of the male reproductive system and provide one function of each.
- 2.9. What does the term semen refer to?

3. Study the graph showing the levels of the two hormones produced in the ovary:



- 3.1. Name the hormones represented by A and B.
- 3.2. Explain the shape of graph B.
- 3.3. Name the process that occurs in a woman's body shortly after 14 days.
- 3.4. Explain the shape of graph A.