Embryology Assignment

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Course: Anatomy - [Embryology]

College: MHS

Department: MBBS

ASSIGNMENT

1.] Discuss Ovulation.

**Ovulation** is the release of [eggs](https://en.wikipedia.org/wiki/Egg_cells) from the [ovaries](https://en.wikipedia.org/wiki/Ovaries). In [women](https://en.wikipedia.org/wiki/Women), this event occurs when the [ovarian follicles](https://en.wikipedia.org/wiki/Ovarian_follicle) rupture and release the secondary oocyte ovarian cells. After ovulation, during the [luteal phase](https://en.wikipedia.org/wiki/Luteal_phase), the egg will be available to be [fertilized](https://en.wikipedia.org/wiki/Human_fertilization) by [sperm](https://en.wikipedia.org/wiki/Sperm). In addition, the [uterine](https://en.wikipedia.org/wiki/Uterus) lining ([endometrium](https://en.wikipedia.org/wiki/Endometrium)) is thickened to be able to receive a fertilized egg. If no conception occurs, the uterine lining as well as blood will be shed during [menstruation](https://en.wikipedia.org/wiki/Menstruation).

In [humans](https://en.wikipedia.org/wiki/Humans), ovulation occurs about midway through the [menstrual cycle](https://en.wikipedia.org/wiki/Menstrual_cycle), after the [follicular phase](https://en.wikipedia.org/wiki/Follicular_phase). The few days surrounding ovulation (from approximately days 10 to 18 of a 28-day cycle), constitute the most fertile phase. The time from the beginning of the [last menstrual period](https://en.wikipedia.org/wiki/Last_menstrual_period) (LMP) until ovulation is, on average, 14.6 days, but with substantial variation among females and between cycles in any single female, with an overall 95% [prediction interval](https://en.wikipedia.org/wiki/Prediction_interval) of 8.2 to 20.5 days.

The process of ovulation is controlled by the [hypothalamus](https://en.wikipedia.org/wiki/Hypothalamus) of the brain and through the release of hormones secreted in the [anterior lobe](https://en.wikipedia.org/wiki/Anterior_pituitary) of the [pituitary gland](https://en.wikipedia.org/wiki/Pituitary_gland), [luteinizing hormone](https://en.wikipedia.org/wiki/Luteinizing_hormone) (LH) and [follicle-stimulating hormone](https://en.wikipedia.org/wiki/Follicle-stimulating_hormone) (FSH). In the [preovulatory](https://en.wikipedia.org/wiki/Follicular_phase) phase of the [menstrual cycle](https://en.wikipedia.org/wiki/Menstrual_cycle), the ovarian follicle will undergo a series of transformations called cumulus expansion, which is stimulated by FSH.

The [follicular phase](https://en.wikipedia.org/wiki/Follicular_phase) (or proliferative phase) is the phase of the menstrual cycle during which the [ovarian follicles](https://en.wikipedia.org/wiki/Ovarian_follicles) mature. The follicular phase lasts from the beginning of [menstruation](https://en.wikipedia.org/wiki/Menstruation) to the start of ovulation. The maturation of the follicle occurs in four stages: the primordial follicle, the growing follicle, the vesicular follicle and the mature vesicular follicle [graafian folliucle].

For ovulation to be successful, the ovum must be supported by the [corona radiata](https://en.wikipedia.org/wiki/Corona_radiata_%28embryology%29) and [cumulus oophorous](https://en.wikipedia.org/wiki/Cumulus_oophorus) [granulosa cells](https://en.wikipedia.org/wiki/Granulosa_cell). At the point of maturation of the graafian follicle there is an abrupt increase in LH that causes the primary oocyte to complete meiosis I and the follicle to enter the preovulatory mature vesicular stage. Meiosis II is also initiated, but the oocyte is arrested in metaphase approximately 3 hours before ovulation.

The spike of LH increases collagenase activity, resulting in the digestion of collagen fibers surrounding the follicle. Prostagladin levels also increase leading to increase in contractions and eventually rupturing the ovarian follicle releasing the oocyte from the ovary

2.] Differentiate between meiosis I and meiosis II

Meiosis I is the first cell division of meiosis. There is interphase before meiosis I. It runs for a longer time. Meiosis I consists of four sub-phases namely Prophase I, Metaphase I, Anaphase I, and Telophase I. During prophase I, chromosomes condense and pair up and align with the homologous chromosomes.

Meiosis II is the second phase of meiosis, in which longitudinal division of the duplicated chromatids and further cell division take place. During meiosis II, daughter cells produced by meiosis I continue their further division so that each daughter cell coming from meiosis I produces two gametes. Similar to meiosis I, meiosis II also has four subphases namely Prophase II, Metaphase II, Anaphase II and Telophase II. These phases are very much similar to the sub-phases of meiosis I. Meiosis II resembles the mitotic cell division. Furthermore, meiosis II is shorter than the meiosis I

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| Meiosis I | Meiosis II |
|  Meiosis I is the first cell division of meiosis | Meiosis II is the second cell division of meiosis |
| Subphases: prophase I, anaphase I, metaphase I, telophase I | Subphases: prophase II, metaphase II, anaphase II, telophase II |
| Two cells are produced | Four cells are produced |
| Chromosome number becomes half | Chromosome number remains the same |
| Heterotypic division | Homotypic division |
| Crossing over and genetic recombination occurs | Crossing over and genetic recombination does not occur |
| It takes a longer time | It takes a shorter time |

3.] Discuss the stages involved in fertilization.

**Human fertilization** is the union of a human [egg](https://en.wikipedia.org/wiki/Ovum) (female gamete) and [sperm](https://en.wikipedia.org/wiki/Spermatozoon) (male gamete), usually occurring in the [ampulla of the fallopian tube](https://en.wikipedia.org/wiki/Ampulla_of_fallopian_tube). The result of this union is the production of a [zygote](https://en.wikipedia.org/wiki/Zygote) cell, or fertilized egg, initiating [prenatal development](https://en.wikipedia.org/wiki/Prenatal_development). Spermatozoa are not able to frertilize the oocyte upon arrival in the female genital tract but must undergo i.) capacitation ii. ) the acrosome reaction to acquire this capability

**Capacitation** is the penultimate step in the maturation of [mammalian](https://en.wikipedia.org/wiki/Mammal) [spermatozoa](https://en.wikipedia.org/wiki/Spermatozoon) and is required to render them competent to [fertilize](https://en.wikipedia.org/wiki/Fertilization) an [oocyte](https://en.wikipedia.org/wiki/Oocyte).[[2]](https://en.wikipedia.org/wiki/Capacitation#cite_note-2) This step is a biochemical event; the sperm move normally and look mature prior to capacitation. [*In vivo*](https://en.wiktionary.org/wiki/in_vivo), capacitation occurs after [ejaculation](https://en.wikipedia.org/wiki/Ejaculation), when the spermatozoa leave the vagina and enter the superior [female reproductive tract](https://en.wikipedia.org/wiki/Female_reproductive_tract). The [uterus](https://en.wikipedia.org/wiki/Uterus) aids in the steps of capacitation by secreting sterol-binding [albumin](https://en.wikipedia.org/wiki/Albumin), [lipoproteins](https://en.wikipedia.org/wiki/Lipoprotein), and [proteolytic](https://en.wikipedia.org/wiki/Proteolytic) and [glycosidasic](https://en.wikipedia.org/wiki/Glycosidasic) [enzymes](https://en.wikipedia.org/wiki/Enzymes) such as heparin

**Acrosome reaction** is the reaction that occurs in the [acrosome](https://en.wikipedia.org/wiki/Acrosome) of the sperm as it approaches the tsperm's head, exposing the contents of the acrosome. The contents include surface antigens necessary for binding to the egg's cell membrane, and numerous enzymes which are responsible for breaking through the egg's tough coating and allowing fertilization to occur.

The phases of fertilization includes:

Phase 1:penetration of the corona radiata

Phase 2: penetration of the zona pellucida

Phase 3: fusion of the oocyte and sperm cell membranes

Phase 1:penetration of the corona radiata

The first stage is the penetration of corona radiata, by releasing hyaluronidase from the acrosome to digest cumulus cells surrounding the oocyte and exposing acrosin attached to the inner membrane of the sperm. Capacitated sperm pass freely through the corona cells, thus only one of these fertilizes the egg.

Phase 2: penetration of the zona pellucida

Acrosin digests the zona pellucida and membrane of the oocyte. Part of the sperm's cell membrane then [fuses](https://en.wikipedia.org/wiki/Fertilization) with the egg cell's membrane, and the contents of the head sink into the egg. In the mouse it has been demonstrated that ZP3, one of the proteins that make up the zona pellucida, binds to a partner molecule (to the β1,4-galactosyl transferase receptors) on the sperm. This lock-and-key type mechanism is species-specific and prevents the sperm and egg of different species from fusing.

Phase 3: fusion of the oocyte and sperm cell membranes

1. Cortical and zonal reactions: After the sperm enters the cytoplasm of the oocyte (also called ovocyte), the tail and the outer coating of the sperm disintegrate and the cortical reaction takes place, preventing other sperm from fertilizing the same egg. The oocyte now undergoes its second meiotic division producing the haploid ovum and releasing a polar body. The sperm nucleus then fuses with the ovum, enabling fusion of their genetic material.
2. Resumption of the second meiotic division: The [oocyte](https://en.wikipedia.org/wiki/Oocyte) completes its [second meiotic division](https://en.wikipedia.org/wiki/Meiosis). This results in a mature [ovum](https://en.wikipedia.org/wiki/Ovum). The nucleus of the oocyte is called a [pronucleus](https://en.wikipedia.org/wiki/Pronucleus) in this process, to distinguish it from the nuclei that are the result of fertilization.
3. Metabolic activation of the egg: The activating factor is probably carried out by the spermatozoon. Activation encompasses the initial cellular and molecular events associated with early embryogenesis.
	* + The pH rises from 6.8 to 7.2 within 1 minute by an exchange of H+ for Na+ across the membrane.
		+ The pH increase is sufficient for later events because adding NH4Cl alone can activate the egg to increase protein synthesis.
		+ Increase in DNA synthesis. After 45 minutes the DNA doubles in the pronuclei before fusion of the two pronuclei unite to form the zygote nucleus.

 The main results of fertilization is as follows:

* Restoration of the diploid number of chromosomes
* Determination of the sex of the new individual of cleavage
* Initiation of cleavage

4.] Differentiate between monozygotic twins and dizygotic twins.

Dizygotic or fraternal twins are “non-identical” twins or dissimilar twins. The two eggs are independently fertilized by two different sperm cells, and the fertilized eggs are implanted in the uterus wall at the same time and become two zygotes. Hence, the term becomes dizygotic, and the result is fraternal twins.

Monozygotic twins are “identical” twins. Identical twins occur when one zygote divides into two separate [embryos](https://www.differencebetween.com/difference-between-blastocyst-and-vs-embryo/#Embryo). Hence, the term becomes monozygotic. In natural monozygotic twinning, the twins are formed when the blastocyst collapses splitting the [progenitor cells](https://www.differencebetween.com/difference-between-progenitor-cells-and-vs-stem-cells/#What%20are%20Progenitor%20Cells) into the half, and the genetic material divides into two on opposite sides of the embryo. Eventually, these two separate fetuses develop.

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| Monozygotic twins | Dizygotic twins |
| Monozygotic twins are two offsprings developed from one zygote | Dizygotic twins are two offsprings developed from two zygote |
| They share the same DNA | They do not share the same DNA |
| They share the outer layer of the amniotic sac and the have separate placentas | They have separate amniotic sac, chorion and placenta |
| It is caused by the random splitting of the zygote into two embryos | It is caused by the fertilization of two different eggs by two sperms |
| They are usually identical  | They are usually unidentical |
| Not hereditary | Usually hereditary |
| They have the same gender | Gender is different |
| Blood type is the same | Blood type is different |
| 1/3 (33%) of twins in the world are monozygotic | 2/3 (67%) of twins in the world are dizygotic |