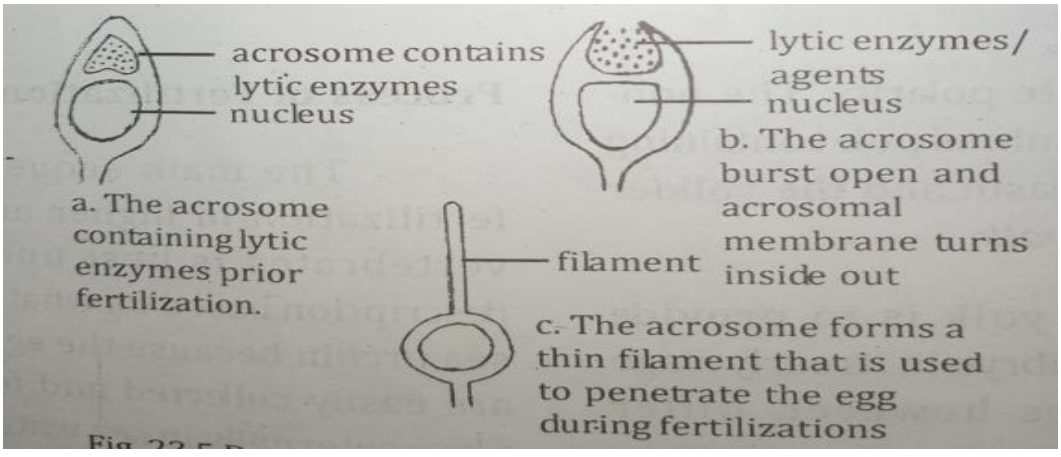
Continuation of BIO 101 (PART B)

FERTILIZATION

Mammals, like other terrestrial animals, have developed a means of bringing the gametes together. In the male, a system of tubes conveys the sperm from their testis to their intromittent organ called penis from which they are introduced into the vagina of the female. The sperms are conveyed to the upper part of the oviduct called fallopian tube which is the exact point of fertilization in mammals.

PROCESS OF FERTILIZATION

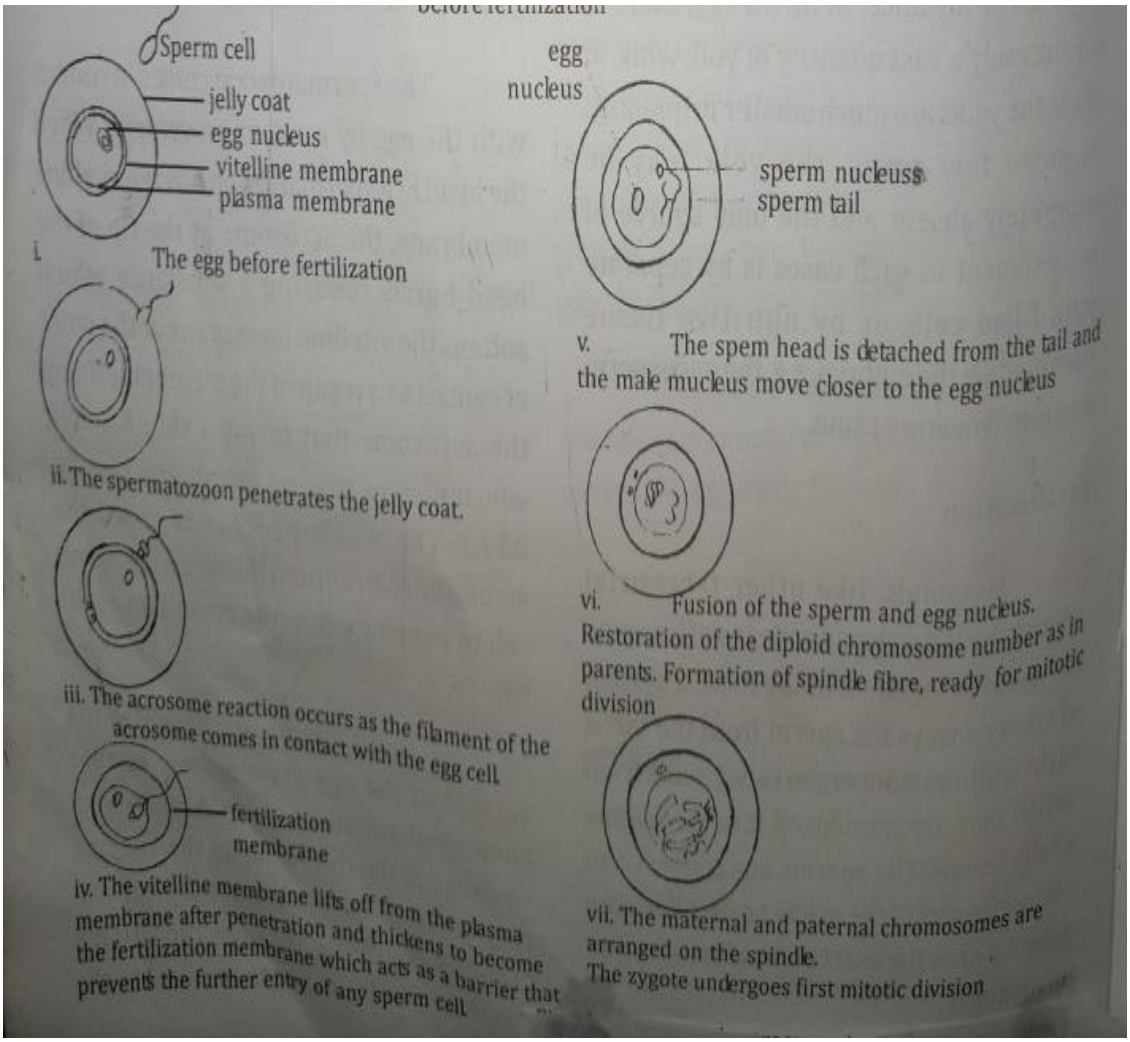
The spermatozoon comes in contact with the egg by random movement. When the egg of a spermatozoon hits the vitelline membrane, the **acrosome** at the tip of the head bursts releasing a substance which softens the vitelline membrane at the point of contact as a result of the membrane lining the acrosome that forms a thin filament which pierces the egg membrane. The whole process is called the **acrosome reaction** and this helps the sperm cell to penetrate into the cytoplasm of the egg.



Description of the acrosome reaction before fertilization

A rapid chemical change at the surface of the egg prevents any further entrance of any other sperm. A visible sign observed is thickening of the vitelline membrane. This result from the cortical granules migrating through the plasma membrane and applying themselves to the inner surface of the vitelline membrane and there is accumulation of fluid immediately beneath the newly

formed thickened vitelline membrane with the result that the vitelline membrane appears to lift off from the egg surface to form a fertilization membrane. This serves as a barrier to the entry of the other spermatozoon.



The stepwise processes involved in fertilization

After a spermatozoon has penetrated the egg, the tail is detached while the head and middle piece are pushed through the cytoplasm towards the egg nucleus. There is variation in the way the two nuclei fuse, but usually , the nuclear membrane breaks down the splindle fibres are formed so that the sperm and the egg chromosomes are made visible, i.e the paternal and maternal chromosomes respectively. Hence, the diploid chromosome number is restored and the **fertilized egg** called **zygote** can undergo the first mitosis to form the embryo.

DEVELOPMENT OF ZYGOTE

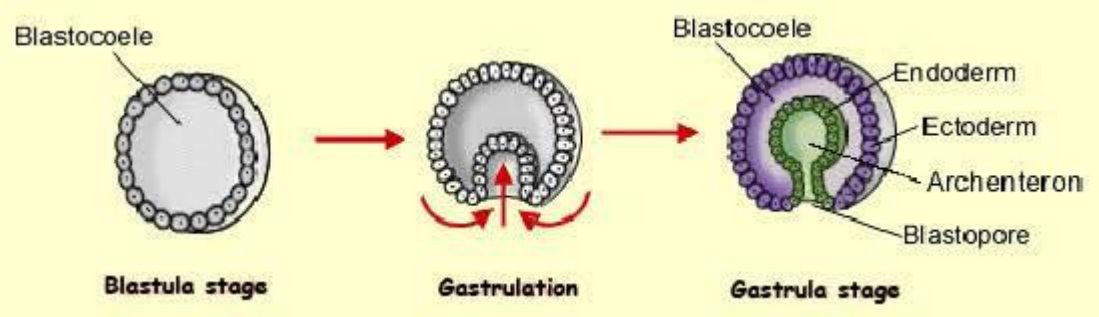
After fertilization, the zygote is propelled down the oviduct by peristaltic contraction. The lining of the oviduct is ciliated but the cilia are so small that they probably play no part in propelling the zygote. Immediately, the zygote reaches the uterus (it takes up to a week in humans), it has already undergone mitotic division to form hollow sphere of cells called **blastocyst**.

There are four stages of embryonic development:

1. **Germinal stage**:- i. Fertilization :- the fusion of haploid gametes, egg and sperm to form the diploid zygote.

ii. Cleavage :- 1. the series of synchronized mitotic cell divisions of the fertilized egg that results in the formation of the blastomeres and changes the single-celled **zygote** into multicellular **embryo** also: one of these cell divisions. 2.the splitting of a molecule into simpler molecules.

iii. Blastulation:- This is the stage in early animal embryonic development



that produces the blastula. Embryonic development begins with a sperm fertilizing an egg cell to become a **zygote**, which undergoes many cleavages to develop into a ball of cells called a **morula**.

iv. Implantation:- This is the stage of pregnancy at which the embryo adheres to the wall of the uterus.

v. Embryonic disc:- The embryonic disc forms the floor of the amniotic cavity

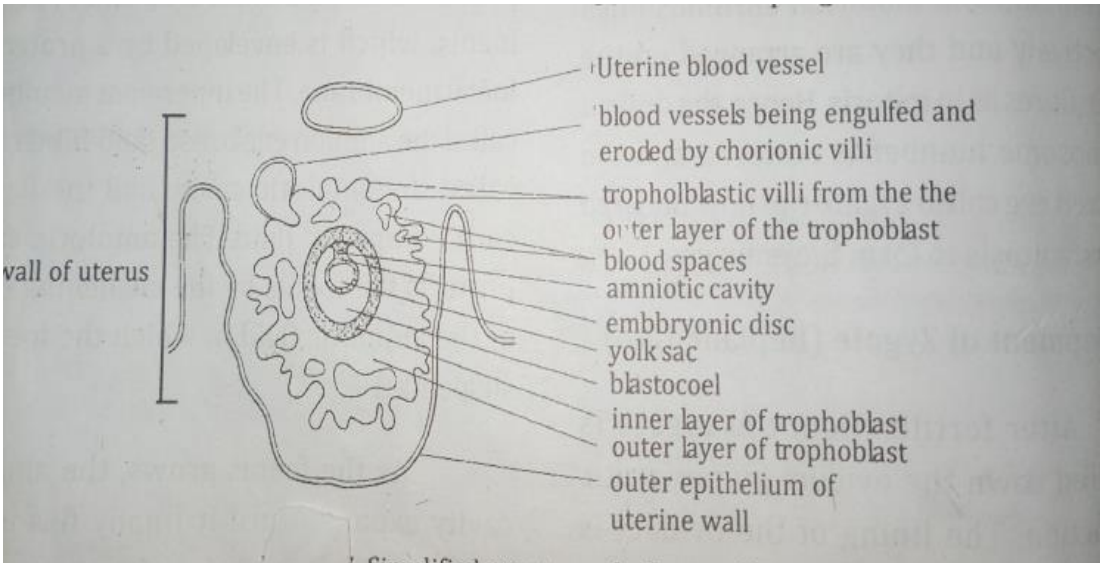
2. **Gastrulation:-** is the process during embryonic development that changes the embryo from a blastula with a single layer of cells to a gastrula containing multiple layers of cells. Gastrulation typically involves the blastula folding in upon itself or dividing which creates two layers of cells.
3. **Neurulation:-** This is a stage which involves the transformation of the neural plate into the neural tube. The embryo at this stage is termed the **neurula.**
4. **Development of organs and organ system.**

After several days, the blastocyst becomes embedded in the lining of the uterus by the process called **implantation**, where it continues its development. The **trophoblast**, which is the outer layer of cells surrounding the blastocyst develops small finger-like outgrowths known as **trophoblastic villi**. This helps to protect the surrounding tissues of the uterine wall, while the villi help to absorb nutrient.

As development proceeds, the product of implantation is an embryo called foetus, which is enveloped by a protective foetal membrane. The innermost membrane called the **amnion** encloses a fluid-filled cavity called the **amniotic cavity** and the fluid is called **amniotic fluid**. The amniotic cavity protects the foetus by the cushioning effect of the amniotic fluid in which the foetus is suspended.

As the foetus grows, the amniotic cavity expands until it finally fills up the entire uterus while the two other membranes in the cavity unite to form the **placenta** which develops in connection with the uterine wall and it is connected to the foetus by a cord called the umbilical cord. Within the placenta, foetal and maternal blood i.e. the blood of the foetus and that of the mother come in contact with each other, and across the borders between them, exchange of respiratory gases, food materials and nitrogenous wastes take place. Antibodies also pass across so that foetus is protected against diseases. The **umbilical cord** and the **placenta** are both referred to as the foetus life line.

To accommodate the growing foetus during the period of pregnancy, the uterus expands coupled with the thickening of its wall and a great increase in vascular tissues. When the foetus reaches a certain sizes of birth, parturition takes place.



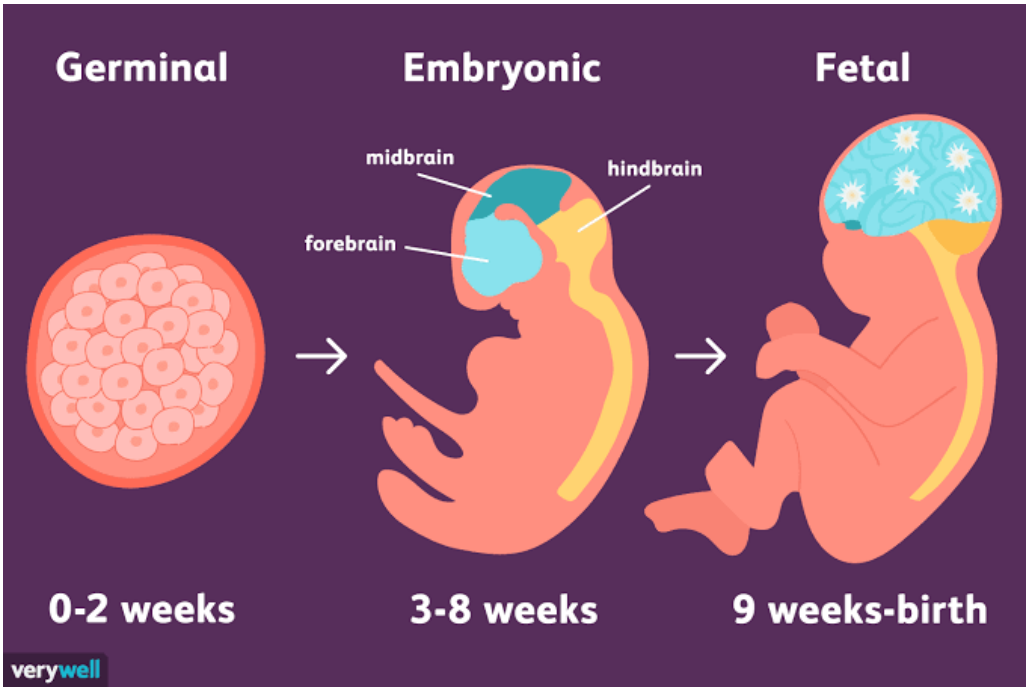
Simplified structure of a Human blastocyst that is just implanted in the endometrium of the uterus; The chorion produced by the outer layer of the trophoblast break down the blood vessels of the endometrium, thereby forming spaces containing blood vessels which are used in the nourishment and excretion of the blastocyts

The period time from fertilization to birth is called gestation period. It lasts for 18 days in mice, while it may take as long as 18 months ($1^{1/2}$ years) in elephants. Birth or parturition occurs after approximately 36 weeks or 9 months (gestation period of man). in humans, birth begins with a series of strong rhythmic contraction of the uterine musculature called **labour**. The exact signal that triggers birth is not fully understood in humans but placental **corticotropin-releasing hormone (CRH)** initiate the process of birth. Secretion of **estrogen** that enhances uterine contraction increases, while secretion of **progesterone**, which inhibits uterine contraction falls. This removes the "**progesterone block**" that maintains the uterus quiscent throughout the period of pregnancy. Prostaglandins, a very complex group of hormones is also very high at this time, making the uterus more irritable.

Finally, stretching of the cervix stimulates neural reflexes that stimulates and promotes the secretion of **oxytocin**, from the posterior pituitary gland. Oxytocin also stimulates the smooth muscles of the uterus to undergo **labor contraction** more frequently and strongly. Secretion of oxytocin during birth is influenced by

positive feedback. Immediately child birth occurs, secretions and hormonal actions are brought to a halt.

Child birth occurs in **three main stages**. In the first, the cervix is enlarged by the pressure created by the baby in its sac of amniotic fluid, which may burst at this time; this is called **dilation**. The second, occurs as the baby is forced out of the uterus and through the vagina to the outside, this is termed **expulsion**, while in the third and final, the placenta is expelled from the mother's body within 10 minutes after the birth of the baby; this is called **placental delivery**.



Stages in the development of foetus.

At birth, the mammary glands which have been developing greatly during pregnancy start to secret milk by the process called **lactation**. Which helps to provide the body with nourishment and a continued source of antibodies during t

he first few months of life. The first milk released immediately after birth is called **colostrum.**

NOTE:- Men can produce sperm throughout their life time even until old age but women stop ovulating at about 45-50 years when they reach the stage called menopause and they are capable of producing about 400 eggs in their life time.

Multiple Births

Many mammals give birth to more than one child or offspring at a time called **multiparous**, each member of multiple births are products from a separate egg. However, **uniparous** animals have only one offspring at a time.

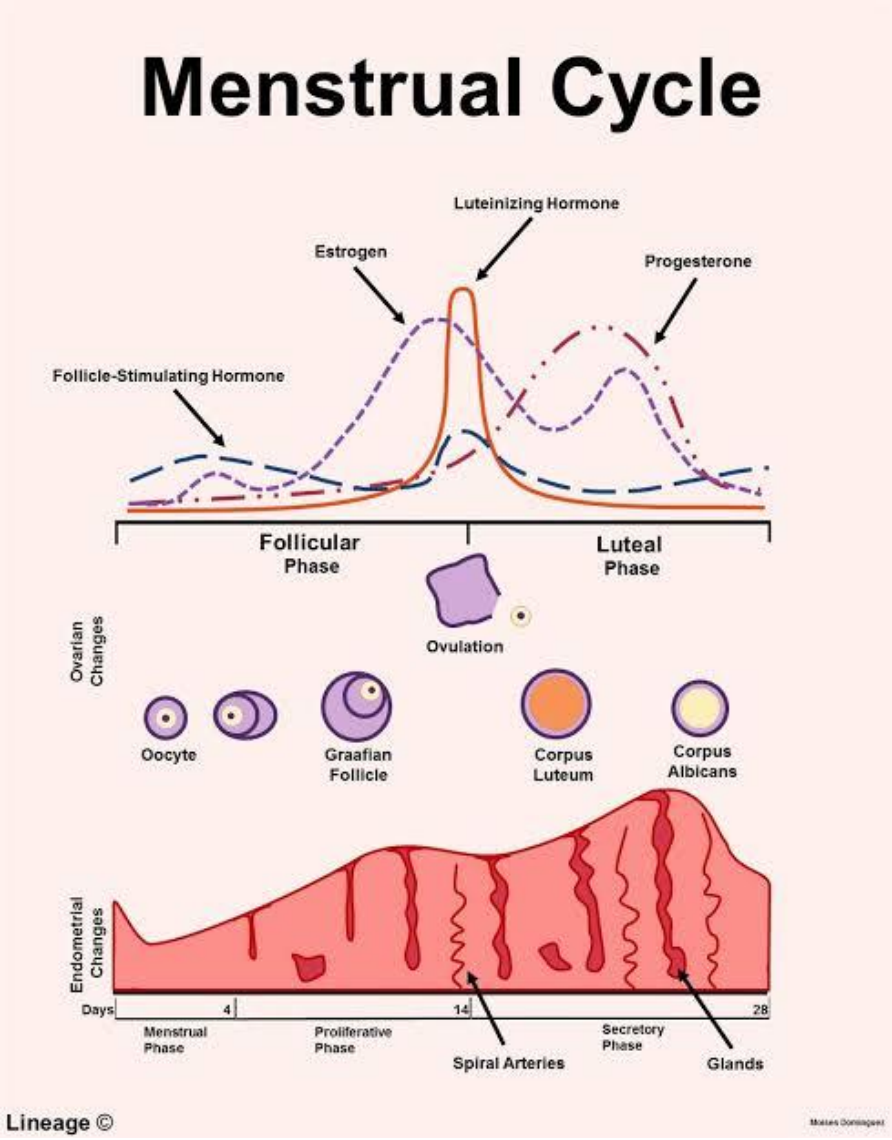
Twins in human may be product of the zygote, for identical or monozygotic twins or they may come from two zygotes called **non-identical, dizygotic or fraternal twins.** All other identical twins have a common placenta, indicating that separation or splitting occurred after the formation of the inner cell mass. However, if splitting occurs after the formation of placenta, but the formation of the amnion, the twins would have individual or separate amniotic sacs, as seen in vast majority of identical twins.

The Menstrual Cycle:- Before ovulation take place, the uterine stalls to prepare itself for implantation immediately the fertilized egg arrived the uterus, the lining is ready to receive it. Similarly, changes in the structure of the uterine wall during pregnancy and the onset of lactation at birth at the right moment and they are controlled by a cycle called the **sexual** or **menstrual cycle.**

The events that take place in the cycle follow a definite pattern that are regulated by hormones. These **hormones** are secreted from the pituitary gland and the ovary itself. On the onset of pregnancy, the normal cycle is interrupted and only one third source of the hormones comes into play, i.e. the placenta. In the human female, the most obvious but rather tiresome manifestation of the sexual cycle is the monthly discharge of blood called menstruation. But this completely marks the end of a whole series of physiological changes that have taken place in them during the previous 28 days.

The Stages of Menstruation

During the first 14 days following the beginning of a menstrual discharge, the **graafian follicle** develops**.** After ovulation, the follicle undergoes certain changes. The follicle cells enlarge considerably and a yellow pigment accumulates. Eventually, they fill the cavity of the original follicle turning into a **corpus luteum.** If the egg is not fertilized, the corpus luteum persists in the ovary for about 14 days and then degenerates. While the follicle and corpus luteum are developing, the wall of the uterus prepares itself to receive a **blastocyst.** The inner layer called



the **endometrium** becomes thickened and permeated with numerous blood vessels and glands getting ready for **implantation.**

However, if fertilization does not occur, the unfertilized egg never become implanted and simply degenerates. Under this condition, the corpus luteum degenerates while the endometrium of the uterus breaks down. The discharge of the endometrium is usually accompanied by loss of blood which occurs continuously for 5-7 days and menstruation is said to have taken place.