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**UNIT  
05**

**Animal Reproduction**  
Human Development

**SAMPATH  
LANKADHEERA**

B.Sc. (Hons), M.Sc.



Live Biology  
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**SAMPATH LANKADHEERA**

Unit  
**05** **Reproduction**  
**Human Development**

ADVANCED LEVEL

# Biology

Unit - 05

**Animal Reproduction**

o Human Development

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ADVANCED LEVEL

# Biology

**THEORY**  
in English Medium

**New Syllabus**



**Unit  
05**

**Animal Reproduction**

○ Human Development

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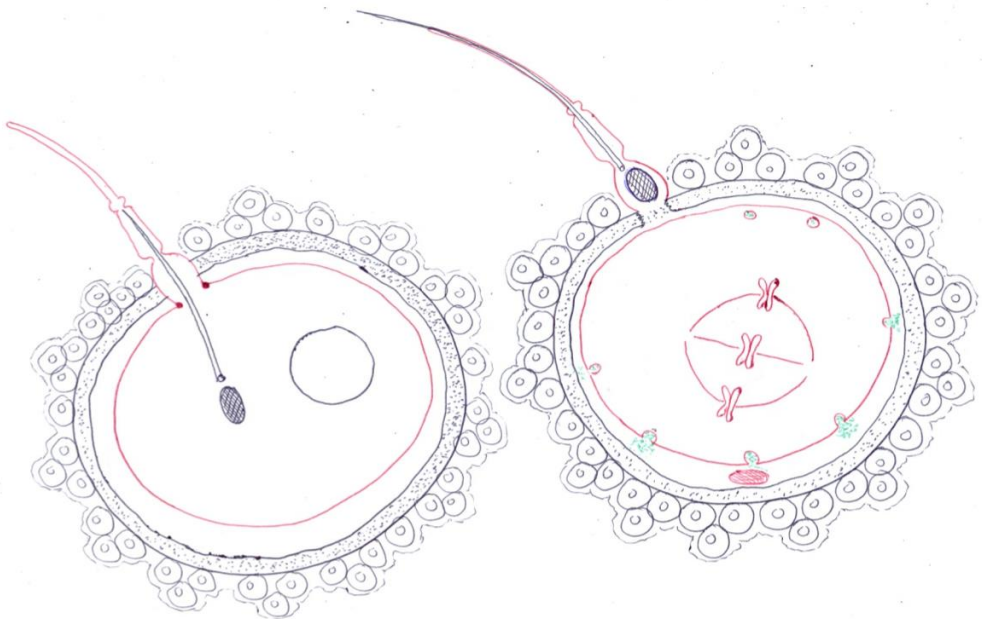
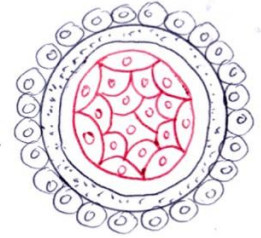
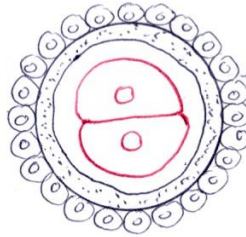
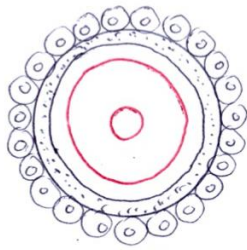
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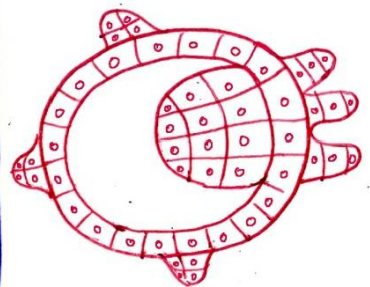
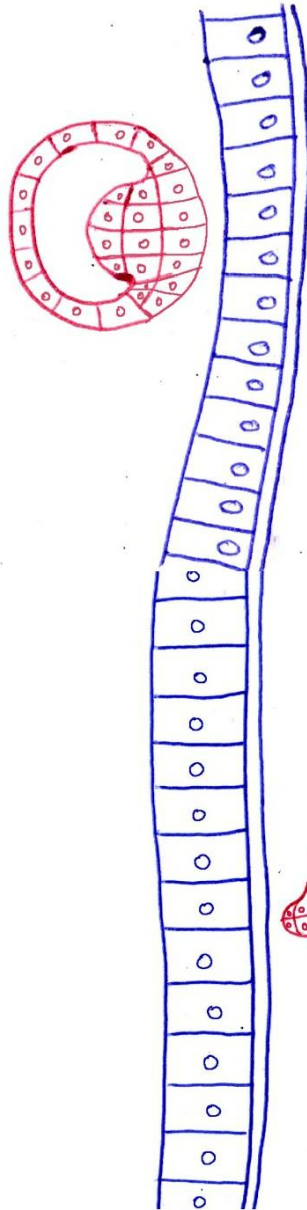
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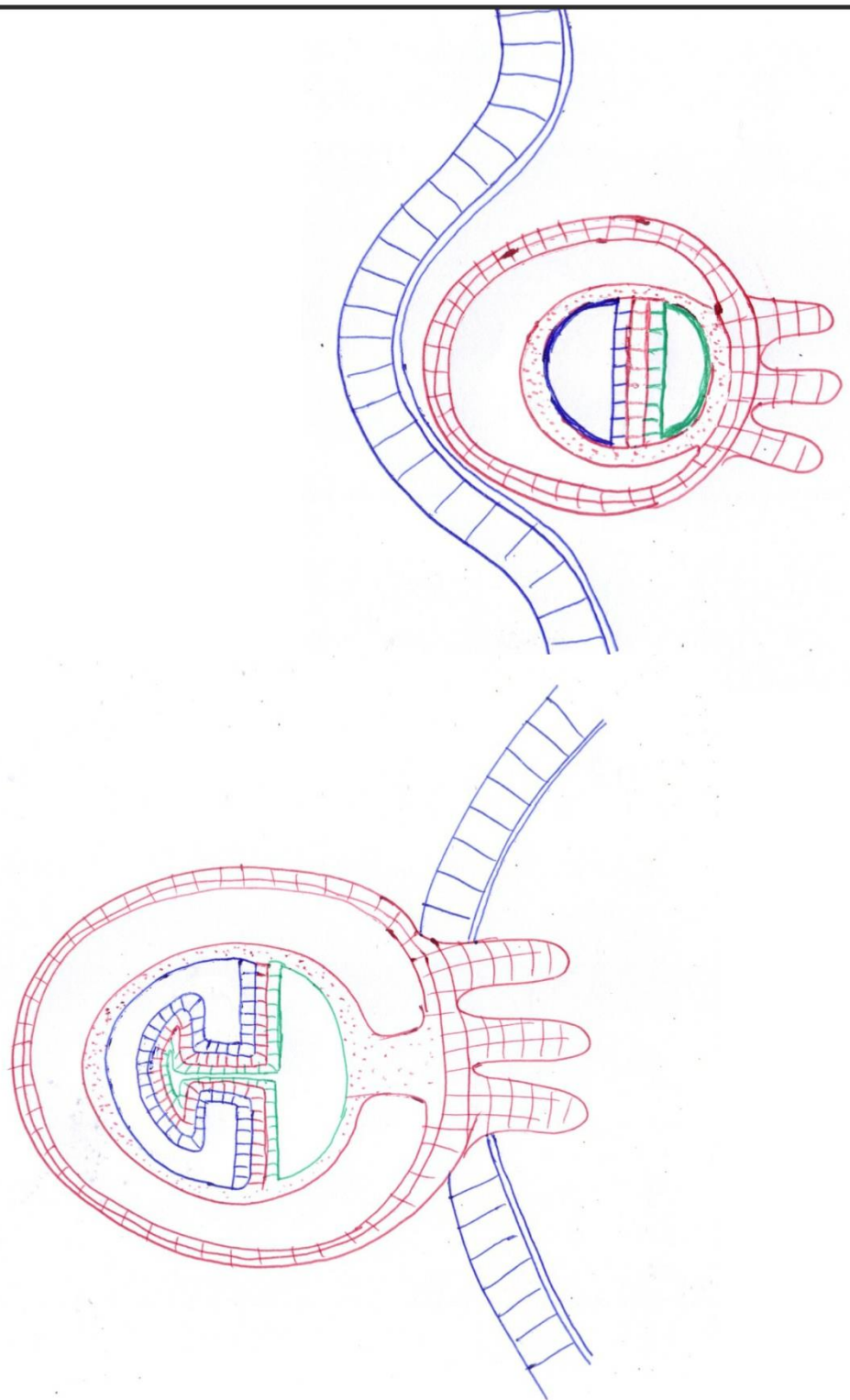
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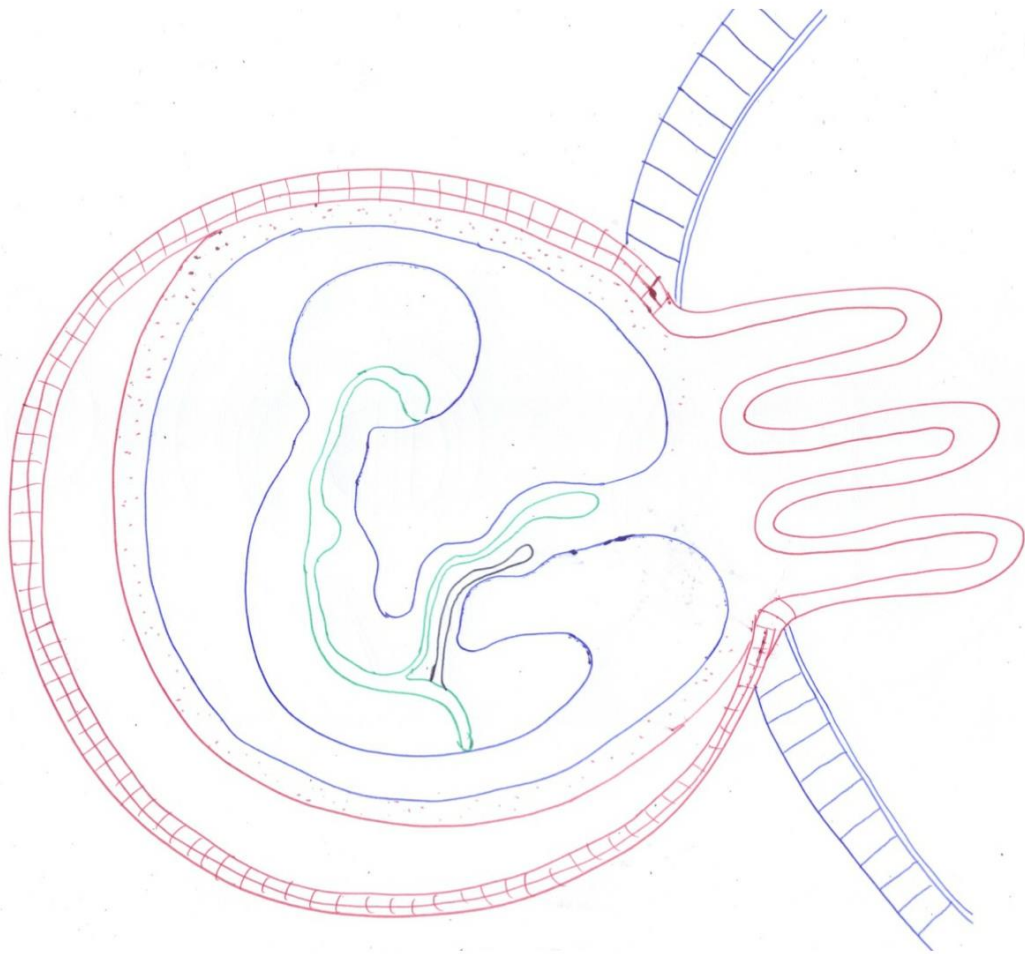
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### 5.8.4 : Inquires into the processes involved in fertilization up to birth

#### Learning Outcomes:

- States fertilization
- Briefly states the developmental stages of a zygote
- States what implantation is
- States the types of foetal membranes and functions of each
- Briefly describes the structures of placenta and umbilical cord
- States what pregnancy is and its duration
- Lists down the major foetal changes during pregnancy in each trimester
- Relates the mother's immune tolerance to the embryo
- Briefly describes the process and the role of positive feedback mechanism of parturition
- States what lactation is
- Briefly describes the hormonal and nervous regulation of lactation
- States the composition of human milk
- States the significance of breast feeding
- Appreciates the importance and complexity of fertilization and pregnancy
- Appreciates the importance of breast feeding

#### Human Development

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#### Fertilization/conception and formation of Human Zygote

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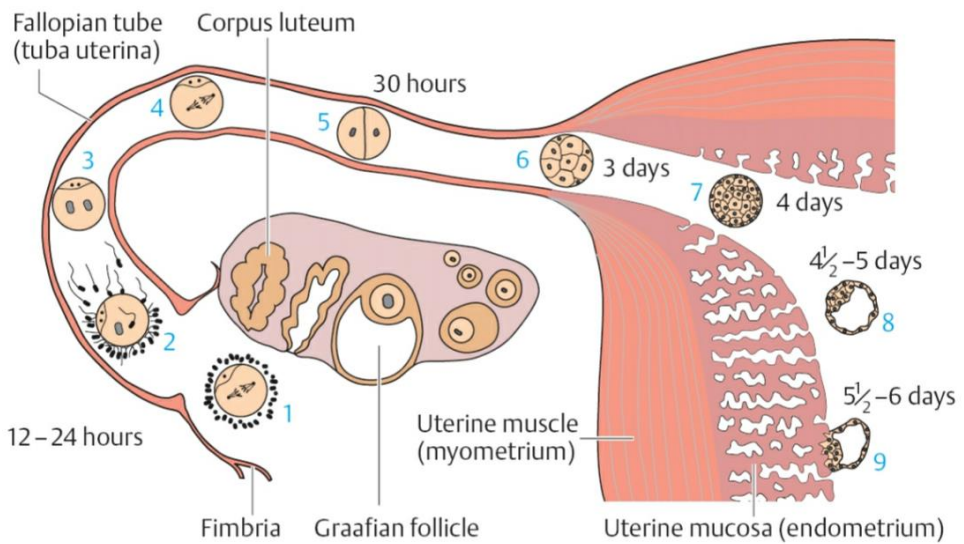
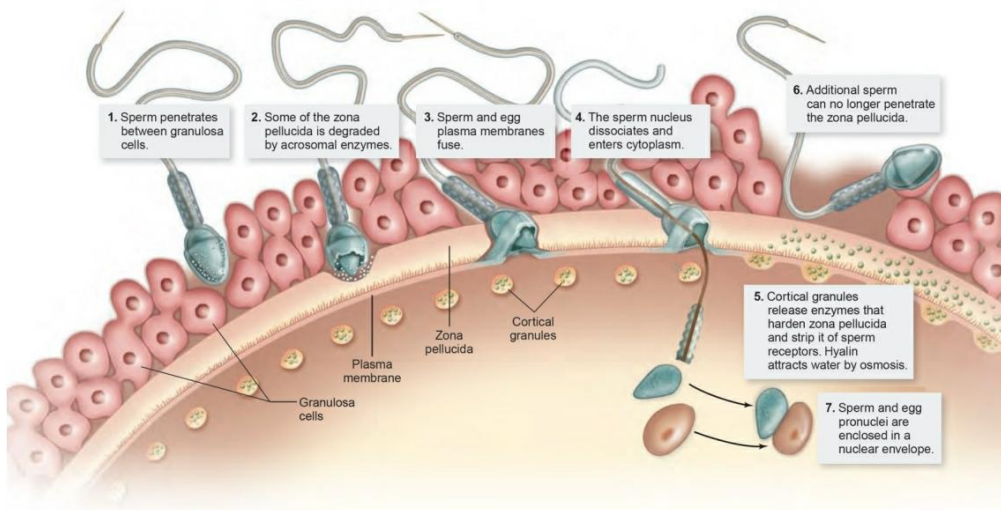
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- During fertilization a sperm enters the secondary oocyte penetrating the epithelial cells surrounding the oocyte, the glycoprotein layer present between the oocyte 's plasma membrane and the surrounding cells.
- Once the sperm enters the secondary oocyte, meiosis II of the oocyte is completed producing the mature ovum.
- Subsequently, the two haploid pronuclei of the mature ovum and the sperm fuse to produce a diploid, single cell referred to as the zygote.
- The fusion of the haploid nuclei of the sperm and the ovum is called fertilization.
- Fertilization takes place in the upper reaches of the oviduct within 12 to 24 hours after ovulation.



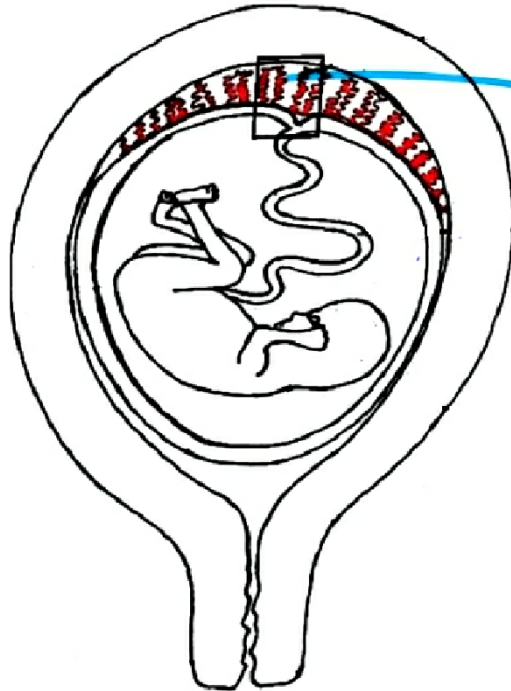


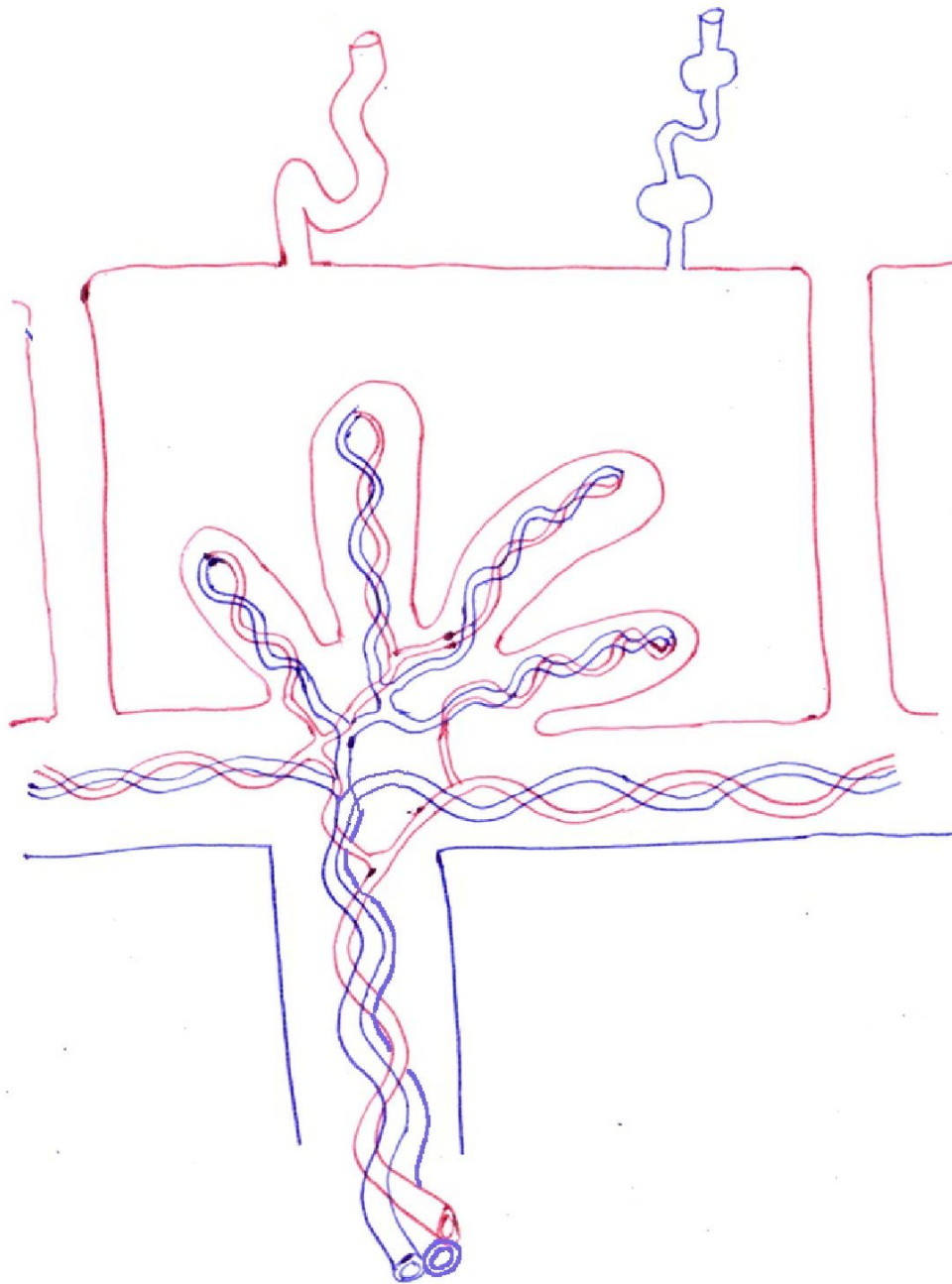






- The placenta supplies oxygen and nutrients to the fetus from the maternal blood stream and excrete waste products from the fetus to the maternal blood stream.
- The placenta also helps to provide immune protection to the developing embryo/fetus. The placenta produces hormones (Eg. hCG, progesterone etc.) needed to sustain the pregnancy.
- Umbilical cord is a flexible cord -like structure containing blood vessels and attaches embryo/fetus to the placenta during gestation.
- Oxygen poor blood from the embryo/fetus travels to the placenta through the two arteries of the umbilical cord and passes through fingerlike projections (chorionic villi) of the placenta where oxygen and nutrients are acquired.
- Fetal blood (oxygen rich blood) leaves the placenta through the umbilical vein leading back to the embryo/fetus.





**Pregnancy and its duration**

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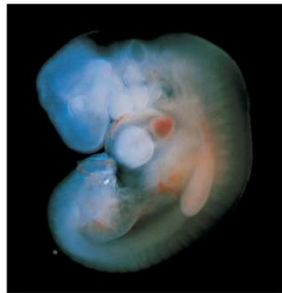


- The nine months of pregnancy are divided into three trimesters of about three months each.
- During the first trimester, the implanted embryo secretes hormones to regulate the mother's reproductive system and to indicate its presence.
- The hCG hormone secreted by the embryo, maintains the corpus luteum in the ovary to secrete progesterone and estrogen.
- Some amount of this hCG passes from the maternal blood to the urine.
- The presence of hCG in pregnant mother's blood and urine can be easily detected and therefore is used as an early pregnancy detection test.
- High levels of progesterone brings about rapid changes in the mother.
- Both ovulation and menstrual cycles stop, the maternal side of the placenta grows, and the breasts and the uterus get larger.
- Mucus in the cervix of the mother forms a plug which prevents the fetus from infections.
- Most mothers experience nausea (morning sickness) during the first trimester.
- By the second trimester, the level of hCG declines and as a result the corpus luteum deteriorates. But the placenta takes over the production of progesterone and estrogens which helps to maintain the pregnancy.
- Mother can feel fetal movements.
- As the fetus grows, mother's abdominal organs become compressed and displaced.
- In the third trimester of pregnancy this may lead to digestive blockage and frequent urination.

### Major fetal changes in each trimester

#### First trimester

- The first trimester is the most critical stage of development during which the rudiments of all major organ systems appear.
- This is the main period of organogenesis (the development of the body organs).
- The heart begins to beat by the 4th week (can be detected at 8 -10 weeks).
- By the 8th week, embryo is said to be the fetus as all the parts of an adult are present in rudimentary form.
- At the end of the 1st trimester, the fetus is well differentiated and about 5 -7 cm long.



a.



b.



c.



d.





## Second trimester

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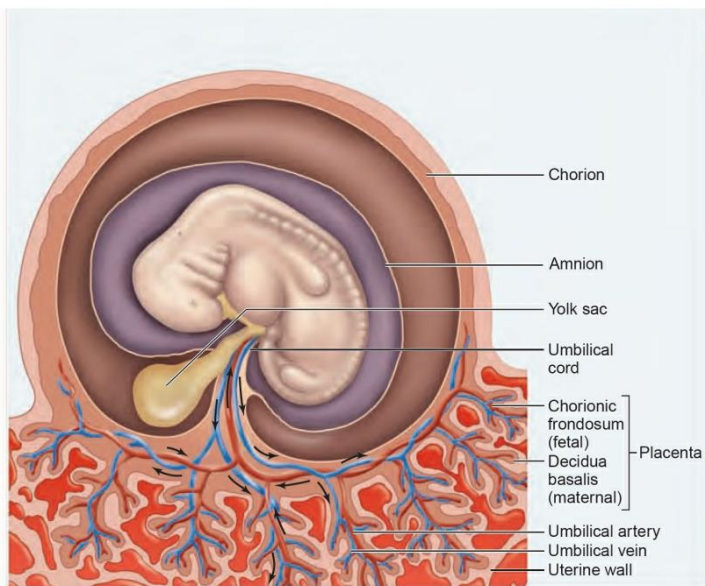
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## Third trimester

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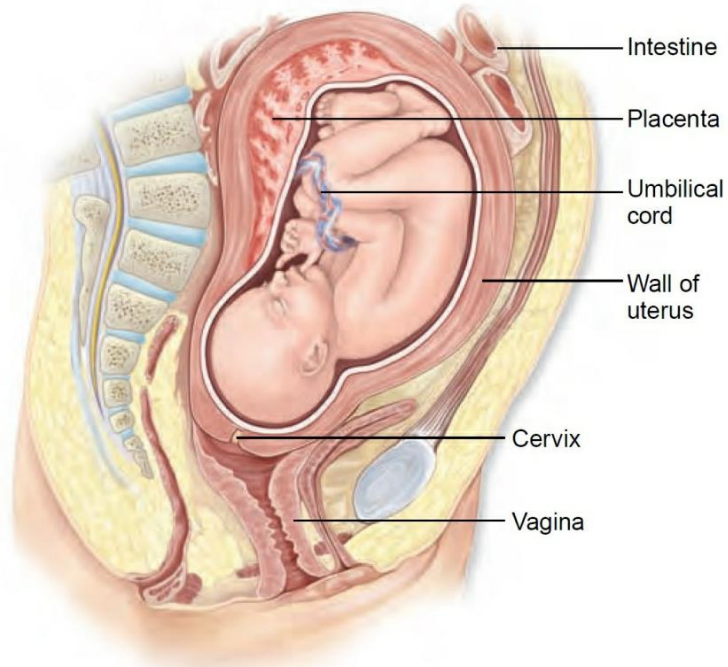
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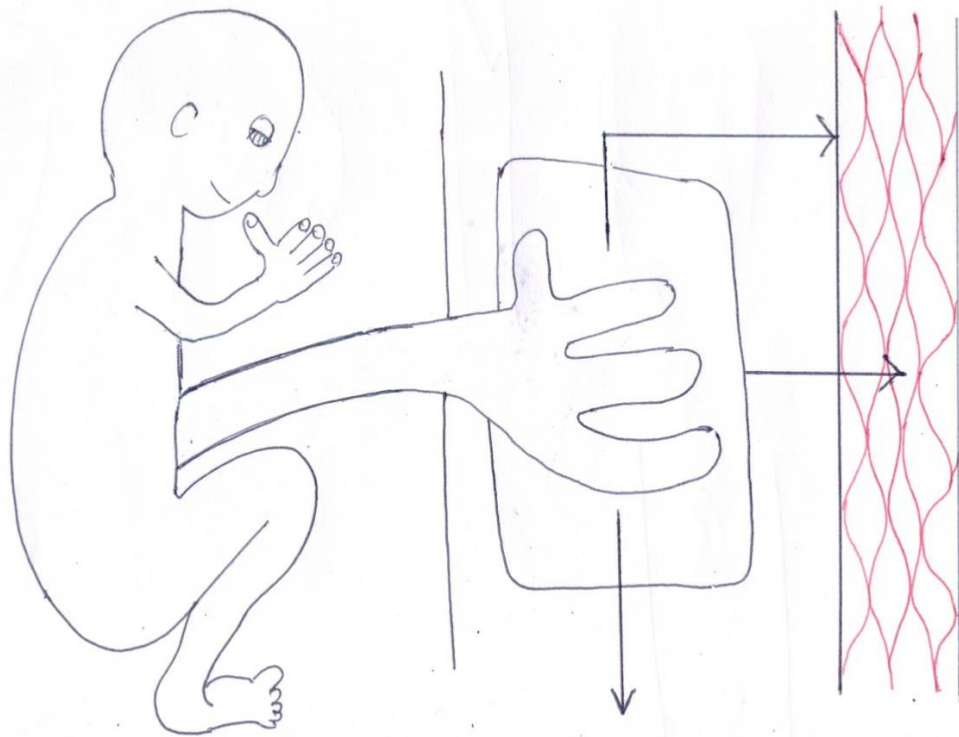
#### Maternal immune tolerances of the embryo and fetus

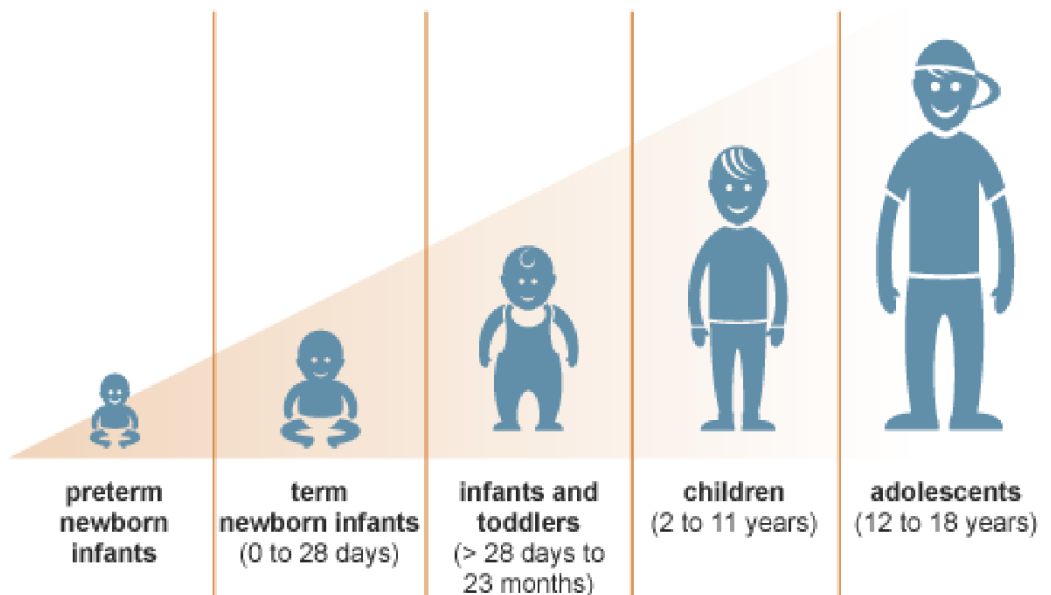
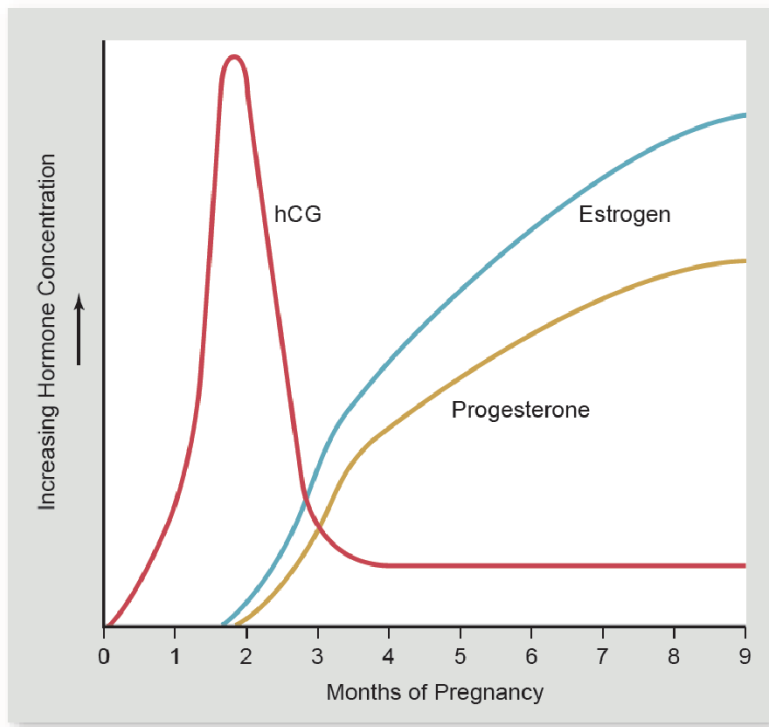
- During pregnancy the overall regulation of the mother's immune system changes.
- These changes allow the mother to keep the embryo in her uterus without rejecting as a foreign body even though half the embryo's genes are inherited from the father and many chemical markers on the surface of the embryo are foreign to the mother.

#### Process of parturition

- Child birth begins with the labor. The labor is a series of strong, rhythmic uterine contractions that push the fetus and placenta out of the body.
- When labor begins, local regulators (prostaglandins) and hormones (mainly estradiol and oxytocin) induce and regulate further contractions of the uterus.
- This is a positive feedback mechanism as uterine contractions stimulate secretion of oxytocin which stimulates further contractions of the uterus.
- The labor can be divided into three stages. The first stage is the thinning and opening up (dilation) of the cervix.
- The second stage is the delivery of the baby. In this stage, continuous and strong contractions force the fetus out of the uterus and expel through the vagina.
- Delivery of the placenta is the final stage of labor.

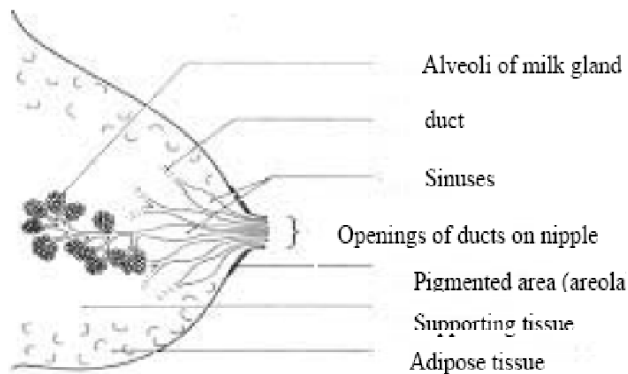






## Lactation

- The lactation which is unique to mammals begins as post natal care.
- Lactation is the secretion and ejection of mother 's milk from the mammary glands.
- Lactation is subjected to nervous and hormonal regulation.
- The main hormone in promoting milk synthesis and secretion is prolactin.
- In response to suckling by the new born baby (which initiates nerve impulses from touch receptors in the nipples) and decrease in estradiol and progesterone levels in the mother 's blood after birth, the hypothalamus send impulses to the anterior pituitary to secrete prolactin hormone which stimulates the mammary glands to produce milk.
- Suckling also stimulates the secretion of oxytocin hormone from the posterior pituitary gland and triggers the release (ejection) of milk from the mammary glands.
- This is a positive feedback mechanism as milk availability encourages continuous suckling, so touch sensation on the nipple and oxytocin release continue further ejecting milk from the mammary glands.







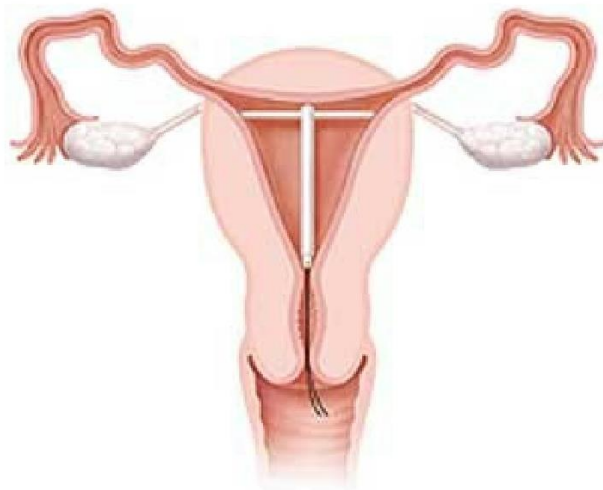
### Condoms for males:

- Barrier devices which prevent sperm entry



### IUD (loop ) for females:

- A device placed in the uterus which interferes with fertilization and prevents implantation of a fertilized ovum



### Depo-Provera injection for females:

- Periodic injection of a synthetic progesterone which thicken cervical mucus and prevents sperm entry.
- If fertilization occurs it prevents implantation by making the endometrium thin.



c.

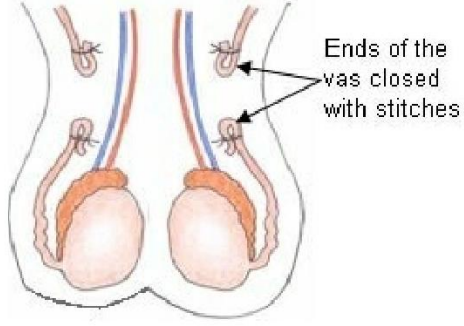
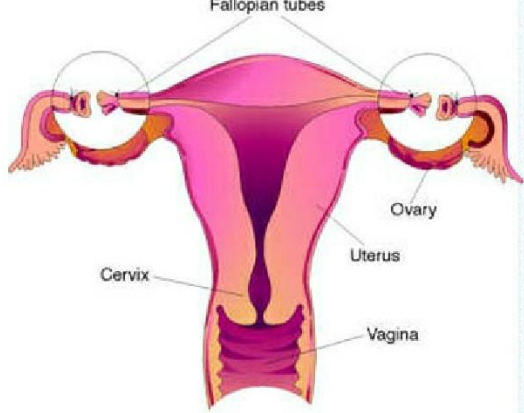
d.





### Surgical Sterilization (preventive methods of gamete release)

- Vasectomy for males - Prevents release of sperms
- Tubal ligation for females - Prevents ovum from entering uterus

Males (Vasectomy)	Females (Tubal ligations) LRT
<ul style="list-style-type: none"><li>• Prevents release of sperms</li></ul>  <p>Ends of the vas closed with stitches</p>	<ul style="list-style-type: none"><li>• Prevents ovum from entering uterus.</li></ul>  <p>Fallopian tubes Ovary Uterus Cervix Vagina</p>

### Abortion

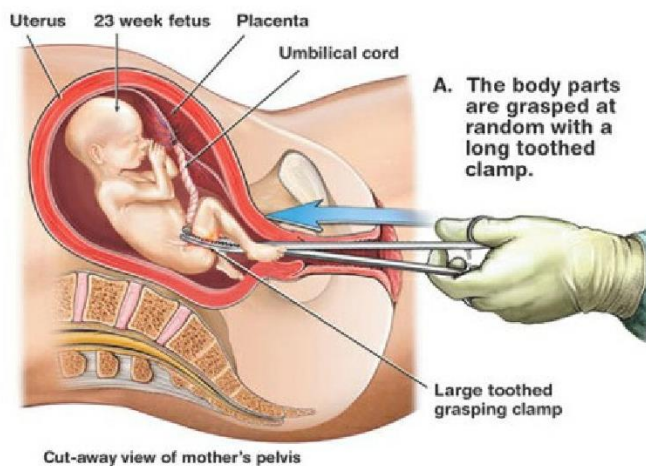
- Abortion is the premature termination of a pregnancy in progress.

#### Miscarriage:

- Spontaneous abortion which occurs naturally.

#### Induced abortion

- Induced abortion is intentionally performed (surgical or non-surgical).
- Certain drugs can induce abortion non -surgically within the first 7 weeks after conception.
- They block progesterone receptors in the uterus thereby preventing progesterone from maintaining the pregnancy.



## Sexually transmitted infections

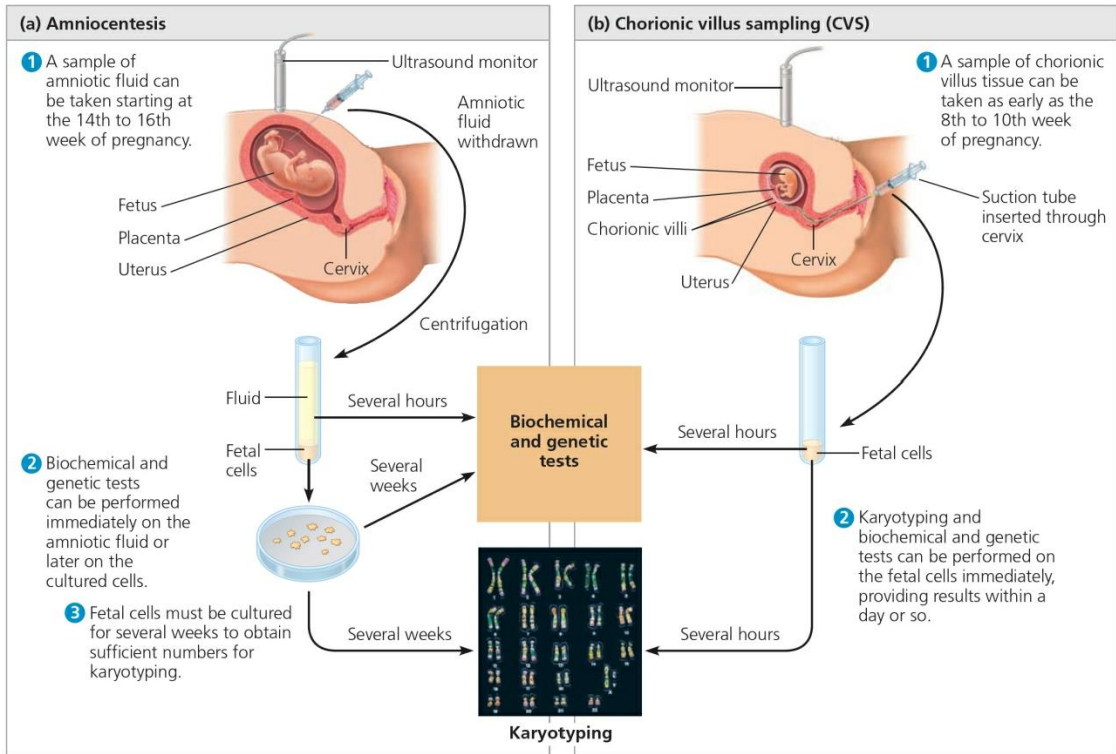
Infection	Pathogen	Main mode of transmission	Main symptoms
Gonorrhoea	<i>Neisseria gonorrhoeae</i> (Bacterium)	<ul style="list-style-type: none"> <li>Sexual contact,</li> <li>Mother to child at birth</li> </ul>	<ul style="list-style-type: none"> <li>In males-burning feeling/ discomfort when passing urine, yellow discharge with pus from genito-urinary tract.</li> <li>Accompanied by fever, headache.</li> <li>Females—Fallopian tubes become filled with pus.</li> </ul>
Syphilis	<i>Treponema pallidum</i> (Bacterium)	<ul style="list-style-type: none"> <li>Sexual contact,</li> <li>Mother to child at birth</li> </ul>	<ul style="list-style-type: none"> <li>Sores or painless ulcers on any part of the body (vagina, lips, fingers, nipples), fever, skin rashes</li> </ul>
AIDS (acquired immunodeficiency syndrome)	HIV (Human immunodeficiency virus)	<ul style="list-style-type: none"> <li>Sexual contact</li> <li>Transfer of body fluids (blood, serum)</li> <li>Use of unsterilized needles</li> <li>Mother to fetus/Child : during pregnancy, at birth and during lactation</li> </ul>	<ul style="list-style-type: none"> <li>Loss of appetite and weight, fever, persistent dry cough, Lymphoma (cancer in lymphatic system), pneumonia and other disease resulting from breakdown of the immune system</li> </ul>
Genital herpes	Herpes simplex 2 (Virus)	<ul style="list-style-type: none"> <li>Sexual contact</li> </ul>	<ul style="list-style-type: none"> <li>Itchy, painful sores around genital area, fever in some cases</li> </ul>

### Detecting disorders during pregnancy

- Many development problems and genetic disorders can be diagnosed during the gestation period.
- Ultrasound images can be used to analyze the size and condition of the fetus.
  - Amniocentesis and chorionic villi sampling - A needle is used to obtain fetal cells from amniotic fluid or tissue surrounding the embryo.
  - Genetic analysis can be done with these samples.
  - Newest method is to use a pregnant mother 's blood to analyze the genome of the fetus as the mother 's blood contains fetal DNA.
- But all detectable disorders are untreatable when the embryo is in the uterus and many cannot be corrected even after birth.
  - However, parents can take informed decisions with the help of these tests.







## Infertility

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### Modern reproductive technology for resolving infertility problems

- Some infertility problems are resolved by recent scientific and technological advances. This includes hormone therapy, surgery and assisted reproductive technology.

#### Hormone therapy

- Sometimes, hormone therapy can increase sperm production in the infertile male or egg production in the infertile female.

#### Surgery:

- The ducts in the reproductive system that are formed improperly or have become blocked can be corrected surgically to resolve infertility.



## Assisted reproductive technology

### In vitro fertilization (IVF):

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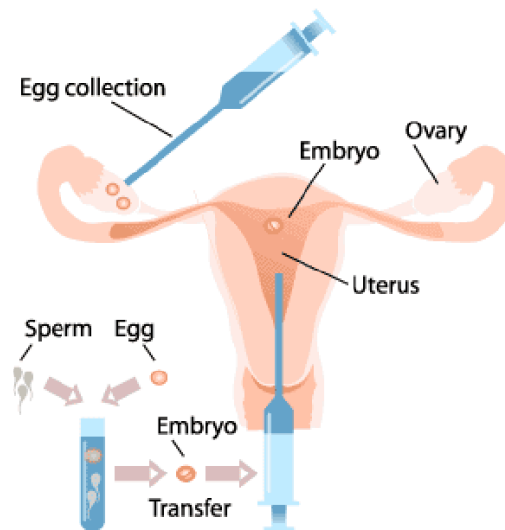
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- The fertilized eggs are incubated until they reach at least 8 cells and then these embryos are transferred to the woman's uterus for implantation and to continue its development.
- Conventional IVF needs between 50000 and 100 000 of sperm from the male per one oocyte in order to achieve the fertilization.
- This is due to the fact that in IVF, acrosome reaction has to take place and thousands of sperm cells have to be involved.



### Intra-cytoplasmic sperm injection (ICSI):

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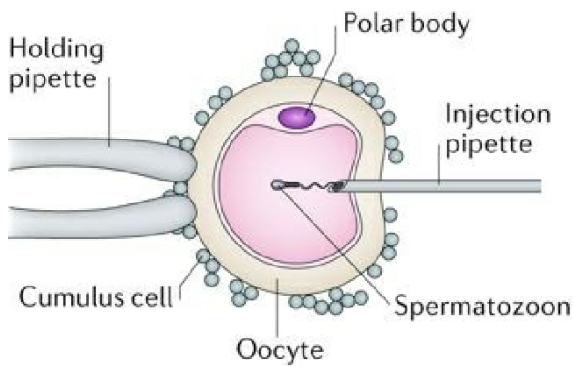
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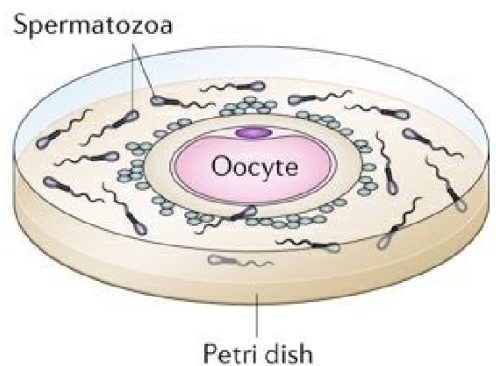
- Unlike in conventional IVF, the sperm which will be inserted into a particular oocyte is already selected in ICSI.

- The fertilized egg can then be returned to the woman's uterus for implantation.

**a ICSI**



**b Conventional IVF**



**Questions**

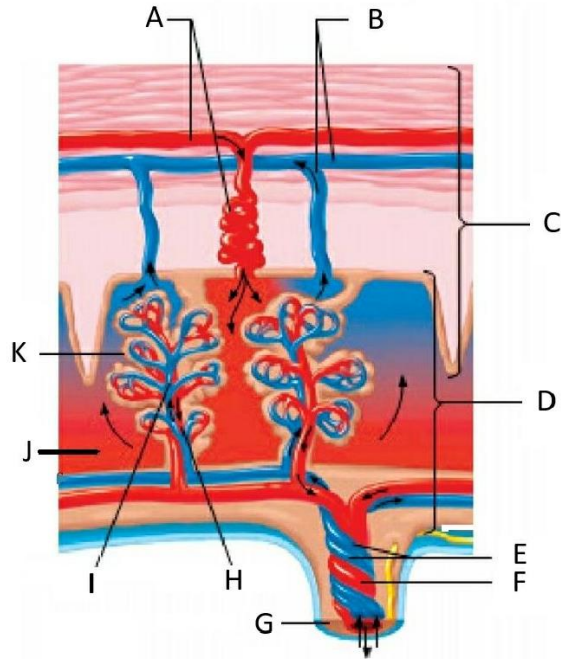
1. What is fertilization  
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2. What is cleavage.  
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3. How long it takes after fertilization to begin cleavage.  
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4. What is implantation  
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5. What is the structure to begin the production of (hCG) hormone  
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6. What is the role of hCG hormone.  
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7. States the types of foetal membranes and functions of each  
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8. What is the function of the placenta?

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9. Following diagram shows the structure of placenta. Label it.



10. What are the materials exchanged through placenta.

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11. What are the maternal parts of the placenta and what are the foetal parts of the placenta.

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12. What are the hormones produced by placenta.

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13. State what pregnancy is and its duration

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14. What is the period of transition of embryo to foetus?

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15. What is the size and weight of a normal foetus at the end of pregnancy?

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16. What is the hormone involve in child delivery and milk release.

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17. States what lactation is

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18. What is colostrum? How long it is produces.

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19. What is milk let-down hormone?

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20. What is the composition of human milk

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21. States the significance of breast feeding

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22. What is contraception

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23. What are different methods to achieve contraception.

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24. State surgical sterilization methods for males and females.

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25. What is an abortion

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26. What is the difference between miscarriage and induced abortion.

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27. State symptoms of following STD

Gonorrhea

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Syphilis

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38. What are methods of transmission of HIV from one person to another.

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29. What are the methods available for detection disorders in pregnancy.

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30. What is infertility

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31. What are different Modern reproductive technology for resolving infertility problems

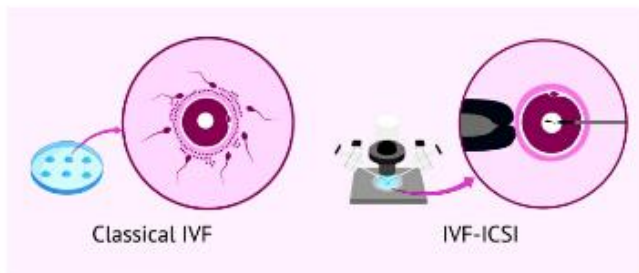
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32. State different assisted reproductive techniques

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33. Briefly describe the difference between IVF and ICSI.



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### Structured Essay

2009

D. (i) What foetal membranes participate in the formation of human placenta?

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(ii) Name the hormone secreted by the placenta at the initial stage of pregnancy and state its function.

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(iii) Name two substance that pass from foetus to maternal blood trough the human placenta.

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(iv) Name a substance secreted by human placenta which stimulates uterine contractions in the birth process.

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2011/New

A. (i) What are structures involve in formation of human placenta?

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(ii) Name hormone produced by the placenta during the initial stage of pregnancy and state its functions.

Hormone	Function



(iii) Name hormones produced by the placenta during late stage of pregnancy.

.....

(iv) (a) Name the other important substance produced by the placenta in addition to hormones and state its functions.

Substance	Function

(b) Name the hormone that induce the production of substance stated in (iv) (a) above and state its site/sites of synthesis.

Hormone	Site of synthesis

(v) What is the hormone responsible for inhibiting the contraction of myometrium during pregnancy.

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B. (i) Name the hormones responsible for the development of milk glands their ducts.

Hormone	.....
	.....

(ii) (a) Name the hormone responsible for the production of breast milk and state its site of production

Hormone	Site of production

(b) Name the hormone that prevents the secretion of breast milk during pregnancy.

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(iii) What are the major components of breast milk other than water

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(iv) At what age should supplementary foods should be introduce to infants.

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(v) Until what age should breast feeding be continued to child?

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### MCQ

- Which of the following statements regarding capacitation of human sperms is incorrect?  
(1) During capacitation some glycoproteins of sperm membrane are altered.  
(2) Highly motile sperms release trypsin. (3) Acrosome reaction occurs only in capacitated sperms.  
(4) Capacitated sperms can bind to receptors in zona pellucida. (5) Capacitation starts in the epididymis. 2012/23
- Which one of the following statements regarding human fertilization is correct?  
(1) It usually occurs in the lower  $1/3$  of the fallopian tube. (2) It must occur within 24 hours of ovulation.  
(3) During this process polyspermy is prevented by the egg membrane. (4) At fertilization entire sperm enters the egg.  
(5) Under no circumstances it occurs outside the female reproductive system. 2014/26
- Which of the following statements is incorrect regarding human milk?  
(1) It is the best food that can be given to an infant. (2) It's synthesis is stimulated by oxytocin  
(3) It provides antibodies to the infant. (4) It has iron binding proteins. (5) It is virtually sterile. (2001)
- Select the correct statement regarding human lactation and milk.  
(1) oxytocin stimulates milk production. (2) Prolactin controls release of milk.  
(3) Release of milk starts immediately after birth. (4) Sodium content of milk is low. (5) Milk is rich in glucose. 2009/27
- Which one of the following statements on implantation of human embryo is correct?  
(1) It is the process of embedding of morula stage in the endometrium. (2) It usually starts on the third day of fertilization.  
(3) It is completed by the 15<sup>th</sup> day after fertilization. (4) It takes about two weeks to complete.  
(5) When it is completed, the embryo is known as the fetus. 2010/17
- Which of the following statements regarding parturition in women is incorrect?  
(1) It usually occurs 36 weeks after fertilization.  
(2) it results from a series of strong rhythmic contractions of the smooth muscles of myometrium  
(3) The signal for parturition comes from the fetus.  
(4) About a week before parturition progesterone triggers formation of oxytocin receptors in myometrium.  
(5) Uterine stretch receptor play an important role in oxytocin release at parturition. 2012/24
- Which of the following statements regarding human lactation is incorrect?  
(1) It is the production and release of milk from mammary glands. (2) Oxytocin is involved in the milk ejection reflex.  
(3) Progesterone suppresses milk production. (4) Baby's suckling is essential for maintenance of milk production.  
(5) Human placental lactogen enhances milk production. 2013/22
- Which of the following statements regarding human reproduction is correct?  
(1) Acrosome reaction of sperms is necessary for penetration of corona radiata.  
(2) Cortical reaction of ovum prevents polyspermy. (3) During ovulation a primary oocyte is ejected from Graafian follicle.  
(4) Fertilization should occur within 48 hours after ovulation. (5) Oogenesis starts after puberty. 2013/24
- Which one of the following statements is incorrect regarding contraception?  
(1) Lactation can provide a contraceptive effect.  
(2) Oral contraceptive pill obstructs the release of FSH and LH from the pituitary.  
(3) Depo -Provera prevents uterine implantation.  
(4) IUDs prevent ovulation.  
(5) Vasectomy is a permanent method of male contraception. 2014/24









## 1. Write short notes on Human placenta (AL 2001)

### Answer

- The embryonic trophoblast and the mother's endometrium intermingles and form the placenta.
  - The placenta is a disc shaped organ formed by two parts:
    - embryonic/fetal portion formed by chorionic villi of the chorion
    - and maternal portion formed by the endometrium.
  - The placenta contains both embryonic/fetal and maternal blood vessels.
  - However maternal and fetal blood vessels do not join
  - and the blood they carry do not normally mix.
  - The placenta mediates the exchange of material (nutrients, respiratory gases, metabolic wastes)
  - between the embryonic/fetal and the mother's circulatory systems.
  - The placenta supplies oxygen
  - and nutrients to the fetus from the maternal blood stream
  - and excrete waste products from the fetus to the maternal blood stream.
  - The placenta also helps to provide immune protection to the developing embryo/fetus.
  - The placenta produces hormones (eg. hCG, progesterone etc.) needed to sustain the pregnancy.
  - Umbilical cord is a flexible cord-like structure containing blood vessels
  - and attaches embryo/fetus to the placenta during gestation.
  - Oxygen poor blood from the embryo/fetus
  - travels to the placenta through the two arteries of the umbilical cord and passes through
  - fingerlike projections (chorionic villi) of the placenta where oxygen and nutrients are acquired.
  - Fetal blood (oxygen rich blood) leaves the placenta through
  - the umbilical vein leading back to the embryo/fetus.
2. (a) States what lactation and briefly describes the hormonal and nervous regulation of lactation.
- Lactation is the secretion and ejection of mother's milk from the mammary glands.
  - Lactation is subjected to nervous and hormonal regulation.
  - The main hormone in promoting milk synthesis and secretion is prolactin.
  - In response to suckling by the new born baby (which initiates nerve impulses from touch receptors in the nipples)
  - and decrease in estradiol
  - and progesterone levels in the mother's blood after birth,
  - the hypothalamus send impulses to the anterior pituitary
  - to secrete prolactin hormone which stimulates the mammary glands to produce milk.
  - Suckling also stimulates the secretion of oxytocin hormone
  - from the posterior pituitary gland
  - and triggers the release (ejection) of milk from the mammary glands.
  - This is a positive feedback mechanism as milk availability encourages continuous suckling,
  - so touch sensation on the nipple
  - and oxytocin release continue further ejecting milk from the mammary glands.

### (b) State composition of human milk and describe significance of breast feeding

- During the first few days after birth, the mammary glands secrete a fluid called 'colostrum' until appearance of true milk.
- lactose, fatty acids, amino acids, minerals, vitamins, and water
- ideal for baby's digestion, brain development and growth.
- Human milk includes proteins such as casein, lactalbumin and immunoglobulins.
- Colostrum and true milk provide nutrients for the baby and contain important antibodies that protect the infant.
- Several types of white blood cells are also present in the breast milk which help the baby to resist microbial infections.
- Compared to the true milk, colostrum contains less nutrients (less lactose and no fat) but they are adequate for the early nutritional needs.
- Breast feeding supports optimal infant growth, enhances intellectual development and fosters mother-infant relations by establishing early and prolonged contact between them.
- Compared to cow's milk, the fat, iron and the proteins in the breast milk are more readily metabolized. Lower sodium content of breast milk is more suited to the baby's needs.
- The baby is less likely to have allergic reactions to mothers milk than the milk from another source.





### Answer

#### 4. (a) States what is infertility.

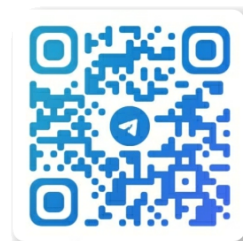
- Infertility is the inability to conceive off spring.

#### (b) States the major two types of modern reproductive technologies;

- Hormone therapy:
  - can increase sperm production in the infertile male or egg production in the infertile female.
- Surgery:
  - The ducts in the reproductive system that are formed improperly or have become blocked can be corrected surgically to resolve infertility.

#### (c) Describes assisted reproductive technologies.

- In vitro fertilization (IVF):
  - In vitro fertilization is a series of procedures used to treat infertility problems and assist with the conception of a child.
  - The process involves removal of oocyte(s) from a female ovary and obtaining sperm from a male and combining the oocyte and the sperm to achieve the fertilization under laboratory conditions.
  - The fertilized eggs are incubated until they reach at least 8 cells and then these embryos are transferred to the woman's uterus for implantation and to continue its development.
  - Conventional IVF needs between 50 and 100 thousands of sperm from the male per one oocyte in order to achieve the fertilization.
  - This is due to the fact that in IVF, acrosome reaction has to take place and thousands of sperm cells have to be involved.
- Intra-cytoplasmic sperm injection (ICSI):
  - This is also a type of in vitro fertilization method which is used to address male infertility.
  - If mature sperm are defective or low in number,
    - a whole sperm or
    - a spermatid nucleus
  - is injected directly into the cytoplasm of an oocyte that has been removed from the women's ovary.
  - For insemination, ICSI needs only one sperm per oocyte.
  - Unlike in conventional IVF, the sperm which will be inserted into a particular oocyte is already selected in ICSI.
  - The fertilized egg can then be returned to the woman's uterus for implantation.



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