ISSN: 0974-5823 Vol. 7 No. 1 January, 2022

International Journal of Mechanical Engineering

EMBRONIC AND FETAL DEVELOPMENT

Prof. Sathiyalatha Sarathi
Vice Principal & HOD OBG Nursing Dept, Sree Balaji College of Nursing, Chrompet, Chennai.

ABSTRACT:

The beginnings Human development is a continuous process that begins when an oocyte(ovam) from a female is fertilized by a sperm (spermatozoon) from a male. Cell division, cell migration, differentiation, growth and cell rearrangement transform the oocyte, a highly specialized Zygote, into a multicellular human being. Most changes occur during the embroyonic and fetal periods, finally the fetus to the birth of a new individual.

Key words: Embryo, fetal period, fertilization, cellular division, implantation, fetal development and placental development.

INTRODUCTION

The beginnings of human life occur when a female gamete unites with a male gamete. The birth of a newborn signals the completion of a successful process that begins with the conception and continues throughout a remarkable period of fetal growth and development. During this time many complex events take place. Fertilization of an ovum by a sperm create zygote, which must successfully implant into the hormonally prepared uterus for continued survival. The placenta plays an essential role in the ongoing transfer of oxygen and nutrients to the developing embryo and fetus. The umbilical cord that connect the developing fetus to the placenta is another key structure that facilitates the transfer of maternal oxygen and nutrients and the removal of waste products.

BASIC CONCEPTS OF INHERITANCE

The human genome project began in 1990 with an overarching goal to identify the exact DNA sequences and genes that occurs in humans. The information obtained from the human genome project has enabled scientists to read the complete genetic blueprint of a human being. It is anticipated that the project findings will lead to new methods of diagnosing, treating and perhaps even preventing a host of adverse human disease and disorder.

CHROMOSOMES, DNA and GENES

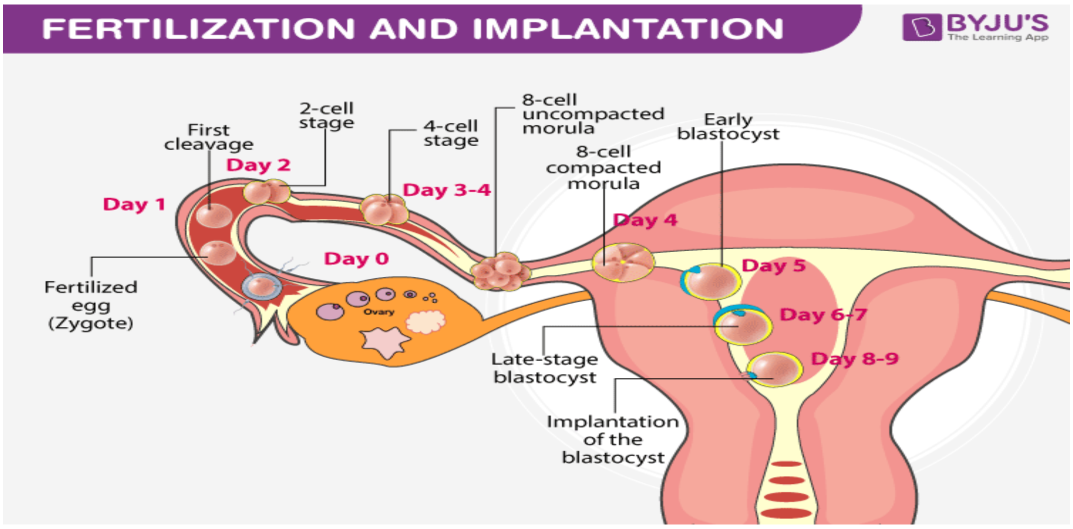
Before our present understanding of DNA, scientists notices that traits were passed down from preceding generations. In the 19th century greor mendel proposed that the strength of some characteristics explains the variations in patterns of inheritance.
The fundamental unit of heredity in humans is a linear sequence of working subunits of DNA called genes. DNA carries the instructions the allow cells to make proteins and transmit hereditary information from one cell to another. Most genes are located o chromosomes found in the nucleus of cells. Genes occupy a specific location along each chromosome, known as a locus. Genes come in pairs, with one copy inherited from each parent. Many genes come in a number of variants forms known as alleles. Different alleles produce different characteristics such as hair colour or blood type. One from the allele may be more greatly expressed than another from.
All normal somatic cells contain46 chromosomes that are arranged as 23 pairs of homologous or matched chromosomes. One chromosomes of each pair is inherited from each parent. Twenty-two of the pairs are autosomes and there a common to and there is no pair of the sex chromosomes that determines gender. The autosomes are involved in the transmission of all genetic traits and conditions other than those associated with the sex-linked chromosome. The large X chromosomes is the female chromosomes, the small male chromosome is the Y chromosome. If the gene pairs are identical, they are homozygous, if they are different, they are heterozygous. In the heterozygous state, if one allele is expressed over the other, this allele is considered dominant. Recessive traits can be expressed when the allele responsible for the trait is found on both chromosomes.

CELLULAR DIVISION

Human cells can be categorized into either gamete or somatic cells. Gametes are haploid cells. They have only one member of

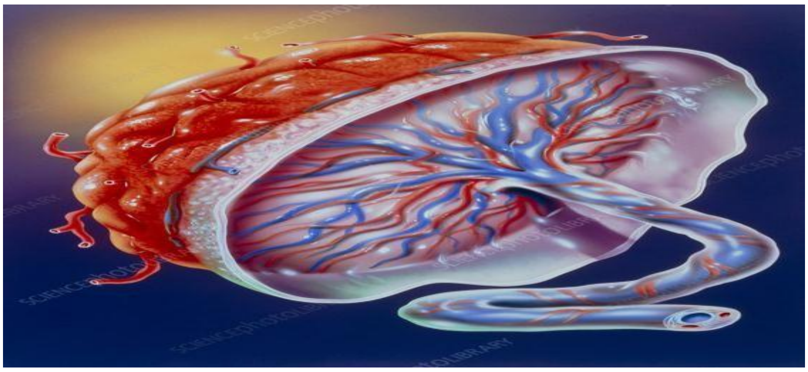
each chromosome pair and contain
23 chromosomes. Somatic cells are diploid, which mean that they contain chromosomes pairs. One members of each pair comes from the mother, and one member comes from the father. Cells reproduce through either meiosis or mitosis. Meiosis is a process of cell division that leads to the development of sperm and ova, each containing half the number of chromosomes as normal cells. Mitosis is the process of the formation of two identical cells that are exactly the same as the original cell and have the normal amount of chromosomes.
Meiosis occurs during gametogenesis, the process in which germ cells, or gametes, are produced. During cell division, the genetic component of the cells is reduced by one half. During meiosis, a sex cell containing 46 divides into two, and four cells, each containing 23 chromosomes.

THE PROCESS OF FERTILIZATION



Fertilization is a complex series of events. Transportation of gametes must occur to allow oocyte and the sperm to meet. Most often, this meeting takes place in the ampulla of the uterine tube.
After completion of the first meiotic division, the secondary oocyte is expelled from the ovary during ovulation. The oocyte then makes its way to the infundibulum at the end of the fallopian tube and passes into the ampulla of the tube. At the time of ejaculation about 200- 600 million sperm are deposited around the external; cervical os and in the fornix of the vagina. During ovulation, the amount of cervical mucus increases and it becomes less vicious and more favourable for sperm penetration. Propelled by the flagellar movement of their tails, sperm travel into the uterus and upward through the fallopian tubes. Muscular contractions of the tubal walls, believed to be enhanced by prostaglandins in the semen, facilitate the enhanced by prostaglandins in the semen, facilitate the sperm movement. The fallopian tubes are lined with cilia, hair like projections from the epithelial cells that serve a dual action, movement of the ovum toward the uterus and movement of the sperm from the uterus toward the ovary. Of the 200 to 600 million sperm deposited approximately 200 actually reach the fertilization site.
Sperm must undergo a process called capacitation whereby a glycoprotein coat and seminal proteins are removed from the surface of the sperms acrosome. The sperm become more active during this process of capacitation, which takes about 7 hours and usually occurs in the fallopian tube but may begin in the uterus. An acrosome reaction occurs when the capacitated sperm come into contact with the zona pellucida surrounding the secondary oocyte. During the acrosome reaction, enzymes from the sperms head are released. This helps to create a pathway through the zona pellucida allowing the sperm to reach the egg and fertilization to occur.
Once a sperm penetrate through the zona pellucida a reaction takes place to prevent fertilization by other sperm. The oocyte then undergoes its second meiotic division and forms a mature oocyte and secondary polar body. The nucleus of the mature oocyte becomes the female pronucleus. The sperm loses its tail within the cytoplasm of the oocyte, and then enlarges to become the male pronucleus. Fusion of pronucleus of the oocyte and sperm create a single zygote containing the diploid number of chromosomes. The zygote is genetically unique in that it contains half of its chromosomes from the mother and half from the father.

THE PROCESS OF IMPLANTATION AND PLACENTAL DEVELOPMENT



The uterus secretes a mixture of lipids, mucopolysaccharides, and glycogen that nourishes the blastocyst to adhere to the endometrial surface of the uterus to obtain nutrients. Implantation begins as the trophoblast cells invade the endometrium. By the tenth day after fertilization, nidation has occurred and the blastocyst is buried beneath the endometrial surface.

The placenta develops from the trophoblast cells at the site of implantation. This important organ is essential for the transfer of nutrients and oxygen to the fetus and the removal of waste products from the fetus, and any alteration in its function can adversely affect growth and development. As the trophoblast cells invade the endometrium spaces termed lacunae develop. The lacunae fill with fluid from maternal capillaries and endometrial glands. This fluid nourishes the embroyoblast by the process of diffusion. The lacunae later become the intervillous space of the placenta. At about the same time, the trophoblast cells from primary chorionic villi, small non-vascular processes that absorb nutritive materials for growth. Blood vessels begin to develop in the chorionic villi around the third week and a primitive fetoplacental circulation is established.

The trophoblast cells continue to invade the endometrium until 25 to 35 days after fertilization, when they reach the maternal spiral arterioles. Spurts of maternal blood from hollows around the villi, creating intervillous spaces containing reservoirs of blood that supply the developing embryo and fetus with oxygen and nutrients. The placenta has become well established by 8 to 10 weeks after conception. By 4 moths, the placenta has reached maximum thickness although circumferential growth progresses as the fetus continues to grow. The placenta is responsible for providing oxygenation, nutrition, waste elimination, and hormones necessary to maintain the pregnancy.

The placenta is a metabolic organ with its own substrate need. Metabolic activities of the placenta include glycolysis, gluconeogenesis, oxidation, protein synthesis, amino acid interconversion, triglyceride synthesis, and lengthening or shortening of fatty acid chains. The placenta uptakes glucose, synthesizes oestrogens and progesterone from cholesterol and uses fatty acids for oxidation and membrane formation. Placental transport of gases, nutrients, wastes and other substances occurs in a bidirectional movement from maternal to fetal circulation, and from fetal to maternal circulation. Transport across the placenta increases with gestation due to the decreased distance between the fetal and maternal blood, increased blood flow, and increased needs of the developing fetus.

There are several mechanisms by which substances are transported across the placenta. These include simple diffusion, facilitated diffusion, active diffusion, pinocytosis and endocytosis, bulk flow, accidental capillary breaks, and independent movement. Pinocytosis is the process by which cells absorb or ingest nutrients and fluid, endocytosis is a method of ingestion of a foreign substance by a cell wall.

Placental endocrine activity plays a crucial role in maintaining the pregnancy. He four main hormones produced by the placenta are human chronic gonadotropin, human placental lactogen, progesterone and oestrogens. Human chorionic gonadotropin maintains corpus luteum during early pregnancy until the placenta has sufficiently developed to produce adequate amounts of progesterone. Human placental lactogen regulates glucose availability for the fetus and promotes fetal growth by altering maternal protein, carbohydrate, and fat metabolism. Progesterone helps to suppress maternal immunological response to fetal antigens, thereby preventing maternal rejection of the fetus. Progesterone has a number of additional functions. Oestrogen production increases significantly during pregnancy. This essential hormone enhances myometrial activity, promotes myometrial vasodilatation, and increases maternal respiratory centre sensitivity to carbon dioxide.

The placenta also plays an important role in protecting the fetus from pathogens and in preventing maternal rejection of the pregnancy. Although the placenta, most bacteria are too large to pass through the placenta, most viruses and some bacteria are able to cross the placenta. Maternal antibodies transit the placenta primarily by pinocytosis. Other cross by the process of diffusion.

DEVELOPMENT OF THE EMBRYO AND FETUS THE YOLK SAC

Early in the pregnancy, the embryo is a flattened disc that is situated between the amnion and the yolk sac. The yolk sac is a structure that develop in the embryo's inner cell mass around day 8 or 9 after conception.it is essential for the transfer of nutrients to the embryo during the second and third weeks of gestation when development of the uteroplacental circulation is underway. Haematopoiesis occurs in the wall of the yolk ac beginning in the third week. This function gradually declines after the eighth gestational week when the fetal liver begins to take over this process. As the pregnancy progresses the yolk sac atrophies and is incorporated into the umbilical cord.

ORIGIN AND FUNCTION OF THE UMBILICAL CORD

During the time of placental development, the umbilical cord is also being formed. The body stalk connects the embryo to the yolk sac that contains blood vessels contract to form two arteries and one vein as the body stalk elongates and develop into the umbilical cord. Maternal blood flow through the uterine arteries and into the intervillous spaces of the placenta. The blood return through the uterine veins and in to the maternal circulation. Wharton's jelly is a specialized connective tissue that surrounds the two arteries and one vein in the umbilical cord. Most umbilical cord have a central insertion site into the placenta and at term are approximately 21 inches (55cm) long with a diameter that ranges from
0.38 to 0.77 inch(1-2cm)

THE FETAL CIRCULATORY SYSTEM

The embryo receives nutrition from maternal blood by diffusion through the extra embryonic coelom and the yolk sac by the end of the second week and embryonic blood vessels beginning of the third week and embryonic blood vessels begin to develop about two days later. The primordial heart tube joins with blood vessels in the embryo, connecting the body stalk, chorion and yolk sac to form a primitive cardiovascular system. The heart begins to beat and blood begins to circulate by the end of the third week. Oxygen and nutrients from maternal blood diffuse through the walls in the villi and enter the embryo's blood. Carbon dioxide and waste products diffuse from blood in the embryo's capillaries through the wall of the chorionic villi and into the maternal blood. The umbilical cord is formed from the connecting stalk during the forth week.

FORMATION OF THE PRIMARY GERM LAYERS

Implantation of the blastocyst occurs at approximately 7 to 8 days after conception. At the time, the cell of the embryonic disc are separated from the amnion by a fluid filled space. The syncytiotrophoblast continue to erode the endometrium and implantation is completed by the ninth day. The extra embryonic mesoderm forms a discrete layer beneath the cytotrophoblast. By the 16th day, all three germ layers are present.

WEEK 4

At the beginning of the fourth week, the flat trilaminar embryonic disc folds into a C-shaped, cylindrical embryo. Development continues as the three germ layers differentiate into various organs and tissues. By 28 postovulatory days, four limb buds and a closed otic vesicle are present. During the third and fourth weeks, development of nervous system is well underway. A thickened portion of the ectoderm develops into the neural plate. The top portion will differentiate into the neural tube which form the central nervous system. Later the eye and inner ear develop as rejections of the original neural tube. During the early period of development the embryo's nervous system is particularly vulnerable to environment insults.

WEEK

By the end of the eighth week, there is a clear distinction between the upper and lower limbs, the external genitals are well developed although not always well enough to distinguish the gender, and the embryo has a human appearance. The main organ systems have also begun to develop by the end of 8 weeks, accepts for the cardiovascular system. During the last 12 weeks of pregnancy there is a substantial increase in fetal size: the weights triples and the body length doubles.

WEEK 9 TO 12

The fetal head is half the length of crown-rum length at the beginning of the ninth week. The face is recognizably human at 10 weeks. Body growth increases, and as a result, the crown- rumps length more than doubles by the twelfth week. Ossification centres appears in the skeleton. The intestines leave the umbilical cord and enter the abdomen. The external genitalia differentiate and are distinguishable by week 12. At 9 weeks, the liver severs as the major site for red blood cell production. However by 12 weeks the spleen begins to take over this process. Urine production commences between 9 and 12 weeks.

WEEKS 13 TO 16

There is very rapid growth during this period. Although coordinated movements of the limbs occur by the fourteenth week, they are too small to be felt by the mother. Ossification of the skeleton take place the bones become clearly visible on ultrasound examination. The 12 to 14 weeks, the ovaries are differentiated and the primordial ovarian follicles are present by 16 weeks.

WEEKS 17 TO 20

Growth continues but slow during this period. Maternal awareness of fetal movements is frequently reporting during this time. The skin is now covered with a thick, cheese- like material called vernix caseosa that protects the fetal skin from exposure to the amniotic fluid. By 20 weeks, hair appears on the eye brows and head. Fine drowsy hair is usually present by 20 weeks and covers all parts of body excepts the palms, soles, or areas where other types of hair are usually found. Subcutaneous deposits of brown fat, used by the newborn for heat production, help to make the skin less transparent in appearance.

WEEKS 26 TO 29

A fetus may survive if born during this time because the lungs can breathe air, and the central nervous system can regulate body temperature and direct rhythmic breathing. The eyelids are open, the toenails are evident, and subcutaneous fat is present under the skin. Erythropoiesis occurs in the spleen but ends at 28 weeks when the bone marrow takes over that function.

WEEKS 30 TO 34

At 30 weeks, the pupillary light reflex is present. This week the baby is clocking in at 5¼ pounds and could be as long as 18 inches. Hold a 5-pound bag of flour in baby arms and imagine it's your soon-to-be-born baby — cradle it and you'll only get strange looks in the baking aisle. Then stack three such bags one on top of the other and get ready for some more strange looks, maybe from the same clerks who saw you grinning and holding that 1-pound bag of sugar a few weeks ago. That's how long your baby is at 34 weeks pregnant.

WEEKS 35 TO 40

At 35 weeks the fetus has a strong hand grasp reflex and orientation to light. At 38 weeks, the average fetus weighs 3000 to 3800 grams, and is 17.3 to 19.2 inches long. By **week 40**, **baby** is around 7 and 1/4 pounds. She's come a long way these last 3 months, and she can't wait to meet you. **Baby**. **baby's** lungs are almost fully developed. It's still building fat deposits beneath its skin to keep warm after it leaves your womb.

EMBRYONIC AND FETAL GROWTH AND DEVELOPMENT

Weeks	Weight	Length	characteristics
2 weeks	-	2mm	Blastocyst implanted in uterus
4 weeks	0.4g	4mm 3cm 8cm	Embryo is curved, tail prominent. Upper limb buds and optic pits present. Heart prominence evident.
8 weeks	2g 19g	13.5cm	Head rounded with human characteristics. Unable to determine sex. Intestines still present in umbilical cord
12 weeks	100g	18.5cm 23cm	Resembles human being with disproportionately large head. Eyes fused. Skin pink and delicate. Upper limbs almost reached final length. Intestines in the stomach. Sex distinguishable externally.
16 weeks	300g		Scalp hair appears. External ears present. Lower limbs well developed. Arm to leg ratio proportionate. Fetus active.
20 weeks	600g		Head and body hair present. Vernix covers skin. Quickening felt by the women.
24 weeks			Skin reddish and wrinkled. Subcutaneous fat present. Some respiratory like movements fingernails present. Lean body.
28 weeks	1100g	27cm	Eyes open with eyelashes present. Much hair present. Skin slightly wrinkled, more fat now present.
32 weeks	1800g	31cm 34cm	Skin smooth. Increase in weight gain more than length. Toenails present. Tests descending
36 weeks	2200g	40cm	Skin pale, body plump. Body lanugo almost gone. Able to flex arm grasp. Umbilicus in center of body. Testes in inguinal canal, scrotum small with few rugae. Some sole creases present.
40 weeks	3200+g		Skin smooth and pink. Lanugo on upper back and shoulders. Ear lobes formed and firm. Chest prominent and breasts often protrude slightly. Testes with well defined rugae. Labia majora well developed. Creases cover soles of feet.

Conclusion

Fetal development is a process of conceiving a baby and developing the baby in the womb of the mother. The process starts with mating of the male and female species, and transfer of sperm from male into the female in the vagina through cervix. Although many sperm are deposited at the cervix, and are able to reach the egg in the fallopian tube, only one is finally able to penetrate and fertilize. This leads to the formation of the zygote.

Reference

❖ A.V Raman, Maternity nursing, published by Wolters Kluwer health,19th edition, page no93-95

❖ Annamma jocob,A comprehensive textbook of midwifery and gynaecological nursing ,published by jaypee brothers publications,4th edition,2017,page no 368-376

❖ Dutta DC,Text book of obstetrics, new central book agency,2011,page No: 260 - 273

❖ Lowdermilk , Maternity and women’s health health care, Publidhed by ELSELVER,11th edition,2012,page no-72-75,340-365, 720- 721.

❖ Susan L ward and shelton, Maternal -child nursing care, F.A davis company,library of congress cataloging -in-publication data, page no 165-186

❖ Baranwal, Amrita, Neelma Kunwar, And Devi Sarita. "Control And Prevention Of Female Infertility Through Natural Herbs, Medicines And Yoga: A Review." International Journal of General Medicine and Pharmacy (IJGMP) 5 (2016): 1-6.

❖ Jussila, Lotta, et al. "Lymphatic endothelium and Kaposi's sarcoma spindle cells detected by antibodies against the vascular endothelial growth factor receptor-3." Cancer research 58.8 (1998): 1599-1604.

❖ Nath, Nikhil Chandra, Et Al. "Efficacy Of Different Feeder Free Culture Conditions For Derivation Of Goat Embryonic Cell Clones." International Journal of Agricultural Science and Research (IJASR) 5.5 (2015): 225-235.

❖ Anirudha, Rishi, Chandra Subhash, and Sneha Sonam. "In-vitro regeneration of pearl millet from mature embryo derived callus." International Journal of Agricultural Science and Research (IJASR) 2.4 (2012): 37-40.

❖ Chali, Thamer Jaber, And Nadhamkadham Mahdi. "The Role Of Some Cytokines In Ectopic Pregnancy In Iraq-Thiqar." International Journal of Medicine and Pharmaceutical Sciences (IJMPS) 8.4, Aug 2018, 27-40