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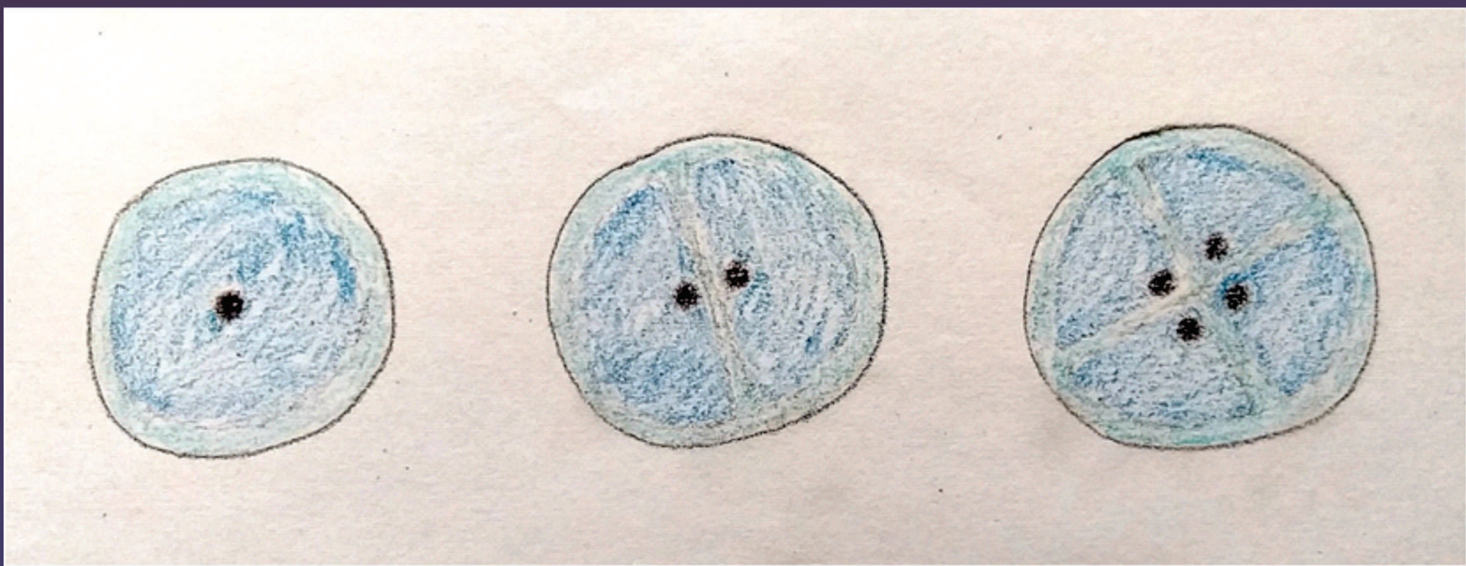
A HANDBOOK OF DEVELOPMENTAL BIOLOGY



JV'n Dr. Neeraj Dholia

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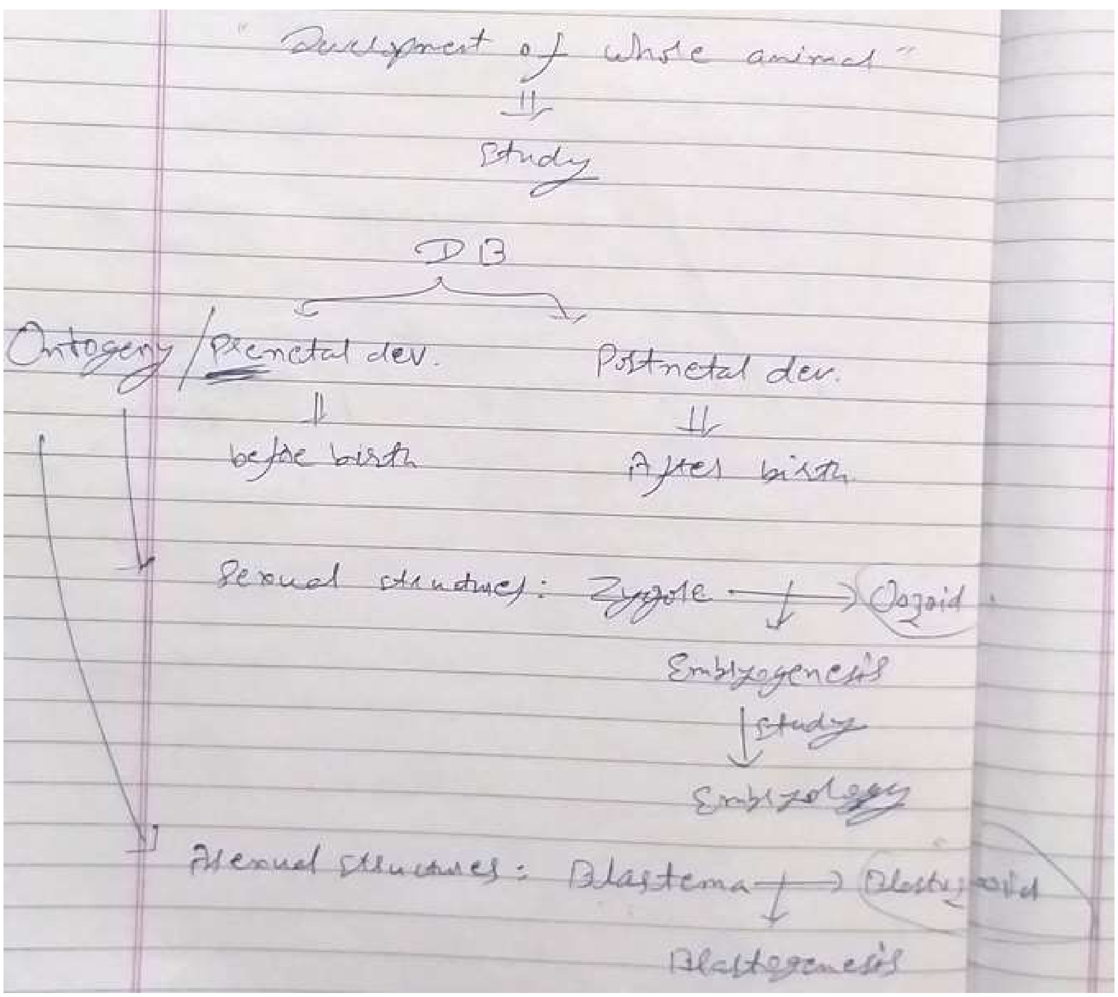
A Handbook of Developmental Biology

(Volume I)

Index:

1. Historical review and types of embryology

- It is a branch of biology that studies the genetically regulated processes by which multicellular organisms grow and develop.
- It entails the investigation of molecular, cellular, genetic, and evolutionary mechanisms of development, differentiation, and growth in animals and plants.
- It also includes the biology of regeneration, asexual reproduction, metamorphosis, and stem cell growth and differentiation in adults.
- The study of development is now needed to comprehend every other aspect of biology. Developmental Biology



Developmental biology, also known as "embryology," has a long and illustrious but imperfect history. It is notable for the long list of prominent scientists and thinkers who have contributed to it, spanning antiquity to the present day.

In higher plants, seed formation occurs after fertilisation. The egg, the seed coat, and another component known as the endosperm make up the seed. Animal embryology is discussed here, despite the fact that plants are extremely necessary for animal survival.

The word "embryo" is described by the dictionary as a developing animal that has not yet hatched or given birth. During the first eight weeks after conception, human embryos are known as developing humans. The fact that this language is strictly arbitrary is one of the reasons that many embryologists struggle with it. Distinguishing a human embryo nearing the end of the eighth week from a developing human during the ninth week after conception will be difficult, if not impossible. As a result, there are no morphological variations between a pre-hatching and a post-hatching frog tadpole (hatching never happens synchronously in an egg mass—there are always those that hatch early and those that are dilatory).

Embryologists study the transformation of a zygote into a multicellular organism. Even in the case of humans, growth does not end at birth. Teeth begin to develop and sexually distinct sex glands grow long after birth. Many embryologists have referred to their field as developmental biology for years in order to avoid having to limit their research to earlier stages. Human embryology explores developmental aspects of life as a whole, not just the first eight weeks, and Embryology in the modern sense is the study of an animal's life history.

The ancient Greek philosophers were the first to research embryology, the science that deals with the creation and growth of the embryo and foetus. Embryology was once considered part of the area of "generation," which included studies of reproduction, growth and differentiation, part regeneration, and genetics. The process of creating new animals or plants is referred to as generation. New species could be created through sexual reproduction, asexual reproduction, or spontaneous generation, according to the ancients. Greek physicians and thinkers proposed using the growing chick egg as a tool of inquiry as early as the sixth century B.C.

Preformation and epigenesis are two historically important models of development mentioned by Aristotle (384–322 B.C.). According to preformationist ideas, an embryo or miniature entity preexists in either the mother's egg or the father's sperm and grows when stimulated properly. Some preformationists claimed that God created all of the embryos that would ever evolve at the Creation. Aristotle actually supported the epigenesis theory, which states that the embryo starts out as an undifferentiated mass and that new sections are inserted as it develops. The female parent, according to Aristotle, contributes only unorganised matter to the embryo. He claimed that the "shape," or soul, given by the male parent directed creation, and that the heart was the first part of the new organism to form.

Before the work of physiologist William Harvey (1578–1657), Aristotle's theory of epigenetic evolution dominated the science of embryology. A human two-cell embryo 24 hours after fertilisation. Richard G. Rawlins took the picture. Stock photo of a doctor. With permission, this image has been reproduced. classical ideas in a variety of ways Harvey was influenced by his teacher, Girolamo Fabrici (ca.1533–1619), in his studies of embryology as well as his experiments on blood circulation.

Because of the relevance of his embryological texts, On the Formed Fetus and On the Development of the Egg and the Chick, some historians believe Fabrici should be considered the founder of modern embryology. While Harvey's On the Generation of Animals did not appear until 1651, it was the culmination of years of study. Harvey started these investigations with the intention of providing experimental proof for Aristotle's theory of epigenesis, but his findings revealed that several aspects of Aristotle's theory of generation were incorrect.

When the form-building theory of the male worked on the material substance produced by the female, Aristotle claimed that the embryo ultimately developed by coagulation in the uterus immediately after mating. Harvey dissected the uterus and looked for the embryo using deer that had mated. He didn't see any signs of a developing embryo in the uterus until six or seven weeks after mating. Harvey also conducted systematic studies of the evolving chick egg in addition to his deer experiments. His findings persuaded him that generation was accomplished by epigenesis, or the incremental addition of sections. Despite this, several of Harvey's adherents opposed epigenesis in favour of preformation theories.

The new mechanical theory, as well as the microscope, which allowed them to see the embryo at earlier stages of development, influenced naturalists who favoured preformationist theories of generation. Some naturalists made shaky observations of early embryos, but two pioneers of microscopy, Marcello Malpighi (1628–1694) and Jan Swammerdam (1637–1680), presented evidence that seemed to confirm preformation. Naturalists proposed that embryos preexisted within each other like a nest of boxes based on Swammer dam's studies of insects and amphibians. Given such a theory, however, only one parent can be the source of the preformed individuals' series. Many species' eggs were well established at the time, but when the microscope showed the presence of "small animals" in male sperm, some naturalists believed that the preformed individuals must also be present in the sperm.

Albrecht von Haller (1708–1777), Charles Bonnet (1720–1793), Lazzaro Spallanzani (1729–1799), and René Antoine Ferchault de Reaumur (1683–1757) were all supporters of preformation at the time. Bonnet's observations of aphid parthenogenesis is viewed as clear evidence for ovist preformationism. As a result, some naturalists believed that the entire human race predated Eve's ovaries, while others claimed to have seen homunculi (tiny people) within spermatozoa. Both ovist and spermist preformationist views were opposed by other eighteenth-century naturalists.

One of the most prominent was Casper Friedrich Wolff (1733–1794), who published "Theory of Generation," a seminal article in the history of embryology, in 1759. The organs of the body, according to Wolff, did not exist at the start of pregnancy and were created through a series of steps from some initially undifferentiated material. Wolff's theories were quite appealing to naturalists who were interested in the movement known as nature philosophy. Cell theory, Karl Ernst von Baer's (1792–1876) discovery of the mammalian ovum, and Wilhelm Roux (1850–1924) and Hans Driesch's (1867–1941) establishment of experimental embryology transformed philosophical claims about the existence of embryological development during the nineteenth century.

A century ago, scientists made careful observations of a variety of developing species. There was a cell theory at this stage, and good microscopes were affordable. The next step was to conduct a causal analysis. The dorsal ectoderm in all vertebrate embryos, for example, is known to roll up into a tube to form the central nervous system. What factors influence the nervous system's normal presentation and subsequent division into different parts of the brain and spinal cord? The underlying chordamesoderm cells of the gastrula is thought to signal the ectoderm to become neural. Induction was the name given to the signal. Induction also appeared to trigger the appearance of other embryonic organs. Chemical embryology sought to characterize the nature of inducing signals. Modern molecular embryology aims to investigate what governs differentiation of various tissues and cell types in a developing organism at the gene level.

Some embryologists are driven by practical considerations. With an understanding of embryology, the origins of developmental defects (congenital malformations) in humans become more understandable. During the first few months of development, when many vital organ systems are developing, the human embryo is highly vulnerable to drugs, viruses, and radiation.

BRANCHES OF EMBRYOLOGY-

1. **DESCRIPTIVE EMBRYOLOGY**

   The morphological classification of different embryonic stages in the ontogenetic growth of individuals of various organisms is concerned with this area of embryology. This includes embryologists' early work up to the 18th century.

2. **COMPARATIVE EMBRYOLOGY**

   It encompasses the comparative study of embryology in various animal species.

3. **EXPERIMENTAL EMBRYOLOGY**

   It includes all research aimed at gaining a better understanding of the various fundamental processes involved in animal development, such as fertilisation, cleavage, Gastrulation, Embryonic induction, determination, and differentiation.

4. **CHEMICAL EMBRYOLOGY**

   All studies that use various biochemical, biophysical, and physiological techniques to explain embryological events at the molecular level are included in this branch of embryology.

5. **TERATOLOGY**

It is the branch of embryology that deals with the study of birth defects or malformations. Tetratogens are the compounds that cause birth defects. Ectomalia (arms child with poor development), Phocomalia (arm less child)

2. Structure of Testis

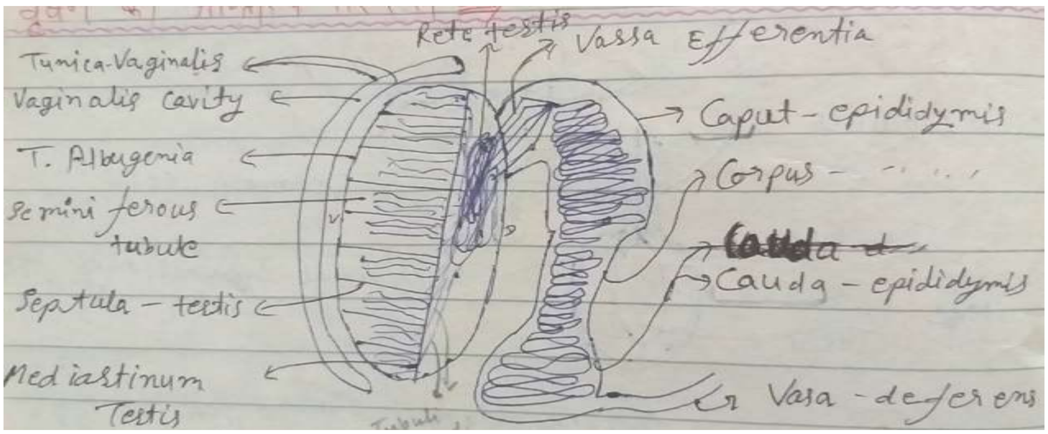


Diagram of Testis

Anatomy and function of testes

The testes' primary role is to produce and store sperm. They're also important for the development of testosterone and other androgens, which are male hormones.

Lobules are tissues that give testes their ovular form. Lobules are coiled tubes with thick connective tissues surrounding them.

Seminiferous tubules

The majority of each testis is made up of seminiferous tubules, which are coiled coils. Spermatogenesis, or the process of producing sperm, is carried out by the cells and tissues of the tubules.

The epithelium is a layer of tissue that lines the tubules. Sertoli cells make up this layer, which help in the development of sperm-producing hormones. Spermatogenic cells differentiate and become spermatozoa, or sperm cells, among the Sertoli cells.

Leydig cells are the tissues that surround the tubules. Male hormones such as testosterone and other androgens are formed by these cells.

Rete testis

Sperm cells migrate through the rete testis to the epididymis after being formed in the seminiferous tubules. The rete testis assists in the mixing of sperm cells in the Sertoli cell-secreted blood. When sperm cells migrate from the seminiferous tubules to the epididymis, the body absorbs this blood.

Sperm can't move until they reach the epididymis. Microvilli, which are millions of tiny projections in the rete testis, aid in the movement of sperm to the efferent tubules.

Efferent ducts

The efferent ducts connect the rete testis to the epididymis through a series of tubes. The epididymis is where sperm cells are processed until they are mature and ready to be expelled.

These ducts are lined with cilia, which are hair-like projections. Cilia, in conjunction with a layer of smooth muscle, aid in the movement of sperm into the epididymis.

The efferent ducts also absorb the bulk of the fluid that aids in sperm cell movement. As a result, the sperm concentration in the ejaculate fluid rises.

Tunica: Vasculosa, albuginea, and vaginalis

The testes are encased in several layers of tissue. The tunica vasculosa, tunica albuginea, and tunica vaginalis are the three.

The first thin layer of blood vessels is the tunica vasculosa. This layer protects each testicle's tubular interior from more layers of tissue surrounding the outer testicle.

The tunica albuginea is the following sheet. It's a thick, protective layer made up of tightly packed fibres that protects the testes even more.

The tunica vaginalis refers to the outermost layers of tissue. There are three layers to the tunica vaginalis:

• The visceral layer is the deepest layer of the body. This layer protects the seminiferous tubules by surrounding the tunica albuginea.

• Vaginal cavum This layer is an empty space between the visceral layer and the tunica vaginalis' outermost layer.

• The layer of the parietal lobe. This is the outermost layer of protection that covers almost the entire testicular structure.

3. Phases of spermatogenesis and structure of sperm

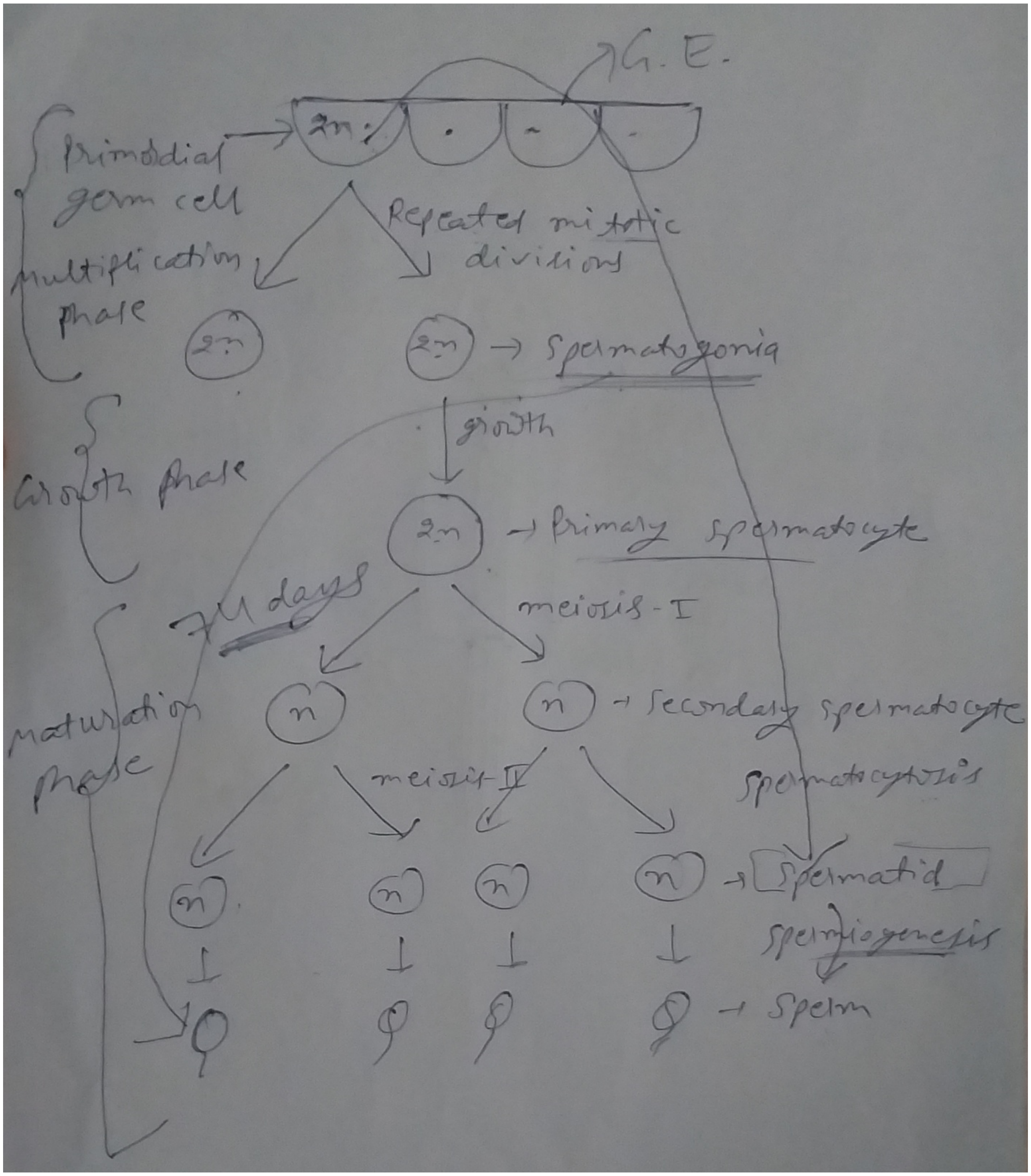


Diagram of spermatogenesis

The testes generate sperm cells on a continuous basis, although not all parts of the seminiferous tubules produce sperm cells at the same time. It can take up to 74 days for an immature germ cell to achieve full maturity, and there are periodic resting periods along the way.

The immature cells (called spermatogonia) are all derived from stem cells in the seminiferous tubules' outer wall. Nuclear content makes up almost all of the stem cells. (The chromosomes are contained in the nucleus of the cell.) The stem cells begin their journey by duplicating themselves in a process known as mitosis. Half of the fresh cells from this first harvest go on to become potential sperm cells, while the other half stay as stem cells, ensuring a steady supply of germ cells.

Primary sperm cells are spermatogonia that will grow into mature sperm cells. These migrate from the seminiferous tubule's periphery to a more central position, where they bind themselves to the Sertoli cells. The amount of cytoplasm (substances outside of the nucleus) and structures called organelles inside the cytoplasm increase as the primary sperm cells expand. The primary cells divide into a shape known as a secondary sperm cell after a resting period. There is a separation of the nuclear material during cell division.

There are 46 chromosomes in the nucleus of primary sperm cells, but just 23 chromosomes in the nucleus of secondary sperm cells, as in the egg. The characteristics of both individuals blend when the egg and sperm merge and their chromosomes fuse, and the new organism begins to evolve. Before it can fertilise an egg, the secondary sperm cell must mature, which involves changes in the sperm cell's shape and form. The nuclear material condenses and takes on an oval form, and this area transforms into the sperm's head.

The acrosome, a cap that covers the top of the head and helps sperm entry into the egg, is partly hidden by the head. The tailpiece is attached to the opposite end of the head. The tail is derived from the cytoplasm of the secondary sperm cell. It consists of a long, slender bundle of filaments that propel the sperm via their undulating movement in mature sperm. When sperm matures, it is transferred via the long seminiferous tubules and deposited in the testes' epididymis until it is ready to leave the male body.

While all sperm cells have a head, body, and tail, they do not all have the same appearance. They can vary in shape and size as a result of different irregularities, and other variations can be found on any part of the cell (head, body, tail).

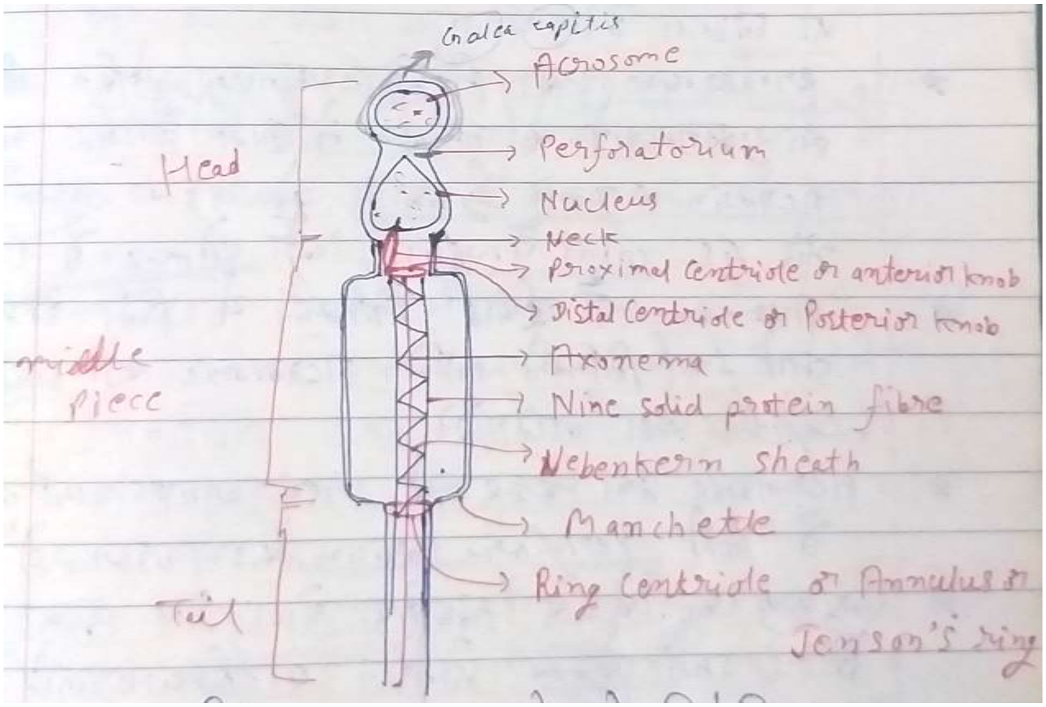


Diagram of sperm

While all sperm cells have a head, body, and tail, they do not all have the same appearance. They can vary in shape and size as a result of different irregularities, and other variations can be found on any part of the cell (head, body, tail).

The following are the features of a good sperm:

A smooth oval head - A naturally developed sperm's head has a smooth surface and is shaped like an egg. The sperm head has a diameter of 2.5 to 3.5 um and a length of 4.0 to 5.5 um (um=micrometers). This yields a length-to-width ratio of 1.50 to 1.70. Their acrosome is well-developed, covering 40 to 70% of the oval-shaped head. The body has a slender middle segment that is around the same length as the head. A 45-micrometer-long tail segment with a thinner profile. A sperm cell is made up of three parts: a head, a body (middle section), and a tail. Each of these components contains a variety of molecules and smaller structures that allow the sperm to function properly as a whole.

The Sperm Head is a fictional character.

A typical sperm head is smooth and oval in shape, as previously mentioned. Because of its wide base and tapering apex, the head segment resembles an egg. The nucleus (genetic material with 23 chromosomes) needed to create a new organism is found in the cell's head, which is the most important part of the cell. Aside from the heart, the head is made up of many components, including:Acrosome and Acrosomal Cap

The acrosomal area is made up of both the acrosome and the acrosomal cap. The acrosome is a product of the Golgi complex that develops during spermiogenesis and contains a variety of contents, including the acrosin enzyme in the acrosomal matrix. Acrosomes also contain polysaccharides including mannose, hexosmine, and galactose, in addition to enzymes. The acrosome is situated between the plasma membrane and the nuclear membrane on the inside of the cell. The acrosome has an inner and outer membrane (acrosomal membrane), with the outer membrane forming a boundary with the plasma membrane and the inner acrosomal membrane forming a boundary with the nuclear membrane.

The acrosome is involved in fertilisation in a variety of ways. The acrosome, for example, is involved in the identification of the oocyte (egg) to be fertilised with a number of its related molecules. The sperm cell is stimulated to swim towards the eggs when it comes into contact with the diffusible molecules from the egg jelly. Chemotaxis is the identification of the egg based on molecule composition. The cell swims towards the egg (area of high molecule concentration) and makes physical contact after detecting a high concentration of the molecule. As a consequence of physical touch, an acrosome reaction occurs.

*Chemotaxis is the ability of sperm to move towards eggs using chemical signals. As a result, this is a critical step in ensuring that the sperm fertilises a conspecific egg (within the same species).
*Near the acrosome, primary ligands (proteins) identify the target gamete.

Acrosome Reaction

The acrosome reaction is a critical event that happens when sperm come into contact with the oocyte membrane at various locations. In certain species, sperm interaction with the zona pellucida on the oocyte's plasma membrane triggers the acrosome reaction. This is a calcium-dependent event that causes exocytosis (the release of cell molecules from the cell) of the outer acrosome membrane, releasing the acrosome's contents (enzymes). This causes acrosome enzymes (such as acrosin) to be released, allowing sperm to enter the egg. One of the secondary ligands, acrosin/proacrosin, is involved in the lysis of the thick membrane that surrounds the ovum (zona pellucida).

In essence, the enzyme (Acrosin) is retained in the acrosome as zymogen, which is an inactive form of the enzyme. Since the pH within the acrosome is lower, the enzyme remains inactive. The enzyme is converted to acrosin, an active form capable of acting on the membrane, when it comes into contact with the glycoproteins of the ovum membrane (zona pellucida). As a result, the sperm cell will penetrate and enter the egg, allowing fertilisation to occur.
* Lysosomal enzymes are another name for acrosome enzymes.

The nucleus is located in the sperm head, which is a part of the egg. The nucleus is made up of 23 chromosomes and occupies 65 percent of the head. When a sperm cell enters an embryo, its chromosomes join with the female gamete to form 46 chromosomes - the total number of 46 chromosomes determines the new organism's characteristics (fetus etc).

* The sperm head accounts for around 10% of the cell's total volume.

Midpiece

Between the head and the tail is the midpiece, which is the central part of the sperm cell. The midpiece, like the head, accounts for about 10% of the total sperm length. The midpiece, unlike the sperm head, which contains genetic material, contains tightly packed mitochondria that provide the energy needed for swimming. In addition to supplying the energy needed for swimming, mitochondria are thought to play a role in apoptosis, or programmed cell death.

Centriole

The centriole is a portion of the sperm cell that is situated between the head and the midpiece of the sperm cell. The centriole is involved in the formation of sperm aster and zygote aster in a complex known as the centriole-centrosome complex. These are needed for pronuclear movement and union with the female genome. Furthermore, the centriole is involved in the development of mitotic apparatus, and is responsible for separating chromosomes during cell division, as well as serving as a template for all subsequent centrioles.

Tail

The sperm tail is a thin, elongated structure that accounts for around 80% of the sperm's total length. Although the tail appears to be one continuous structure, it is actually made up of many components, including:

The portion that links the flagellum to the sperm head is known as the connecting element.

Midpiece - The midpiece is often referred to as a part of the tail in some novels. It includes mitochondria, which provided the necessary energy for movement.

The most important part (axial filament).

End piece

* The flagella's main and end parts work together to create the waveform that enables movement.

Motility

One of the most important characteristics of a fully formed sperm cell is motility. Two forms of physiological motility have been described in mammals.

These include:

Enabled motility is the form of motility that is seen in the early stages of motility (in the epididymis as well as freshly ejaculated sperm). The flagella of the sperm beats softly from one side to the other as the cell travels along what appears to be a straight path in this form of motility.

Hyperactivated motility (hyperactivation) - The second form of physiological motility is hyperactivated motility. This form of motility occurs in the female reproductive tract, as opposed to activated motility (site of fertilization). Hyperactivated motility is also more chaotic, with a symmetrical, lower-amplitude waveform on the flagellum. More energy is used for movement in hyperactivated motility due to the irregular pattern of motion.

* Hyperactivated motility prevents sperm cells from being stuck and propels them across the female reproductive tract, as well as increasing sperm penetration into the egg (oocyte).

* Motility is only possible if the flagellum is completely formed and working, as well as if the cell has a supply of energy.

* Sperm cells have been discovered to swim at a speed of 3mm per minute.

Axoneme and Molecular Mechanism of Motility.

The axoneme is the tail's central strand (flagellum). It is one of the flagellum's main structures and is known as the motility motor. The axoneme stretches from the connecting piece of the tail to the end piece and is made up of microtubule doublets (containing inner and outer axonemal dynein) and a central pair (9+2 structure). The microtubules (nine microtubule doublets) in the flagellum (tail) are linked together by nexin connections. They are also linked to the central pair by radial spokes. These projections (radial spokes) also help in the alignment of microtubules around the central pair.

Dynein in the microtubules allows the microtubule to slip in relation to neighbouring microtubules during motion, facilitating motility. Axonemal travels towards the flagellum base with the energy supplied by mitochondria (ATP energy), causing the microtubule to slip down.

Since the microtubules are linked to the connecting piece behind the head, there is some resistance to movement, which allows the flagellum to bend. The flagellum bends into a whip-like shape as a result of this action.

4. Phases of Oogenesis and Structure of Ovary

Ogenesis is the mechanism by which the primary egg cell (or ovum) develops into a mature ovum in the female reproductive system. The egg's production begins before the female who carries it is even born; cells that will become mature ova have been multiplying for 8 to 20 weeks after the foetus has begun to grow, and by the time the female is born, all of the egg cells that the ovaries will release during the active reproductive years of the female have already been present in the ovaries. The primary ova, or cells that make up the ova, number about 400,000. The primary ova are dormant until just before ovulation, when the ovary releases an egg. Few of the egg cells take up to 40 years to mature, while others degenerate and never mature.

Until the time comes for the egg cell to be released from the ovary, it remains a primary ovum. The egg then divides into two cells. The nucleus divides into two cells, with half of the chromosomes going to one cell and the other to the other. The secondary ovum is normally bigger than the polar body, and one of these two new cells is known as the secondary ovum. The secondary ovum develops in the ovary until it reaches maturity, at which point it breaks free and enters the fallopian tubes. The secondary egg cell, once in the fallopian tubes, is ideal for fertilisation by male sperm cells.

Following their migration into the gonadal ridge, primordial germ cells proliferate, are enveloped by coelomic epithelial cells, and form germinal cords that remain connected to the coelom epithelium. A cortical zone (cortex ovarii) and a medulla can now be separated, with the exception that the germinal cords never reach the medullary zone in females. The following processes take place in the genital primordium:

Primary germ cells emerge in the cortical zone through mitosis of oogonia clones, bound together in cellular bridges, which occurs in rapid succession from the 15th week to the 7th month. The cell bridges are needed for the subsequent meiosis to begin synchronously.

The designation of the germ cells varies with the start of meiosis (earliest onset in the prophase in the 12th week). They're now referred to as primary oocytes.

In prophase I, the primary oocytes are arrested in the diplotene stage (the prophase of the first meiotic division). All of the foetal oocytes in the female ovary have reached this stage shortly before birth. The dictyotene is the next meiotic resting phase, which lasts until puberty, when a pair of primary oocytes complete the first meiosis each month (and every month after that until menopause). However, only a few oocytes (secondary oocytes plus one polar body) make it to the second meiosis and ovulation. Every month, the remaining oocytes mature and become atretic.

In the worst case, primary oocytes that remain in the ovaries will remain in the dictyotene stage until menopause, never maturing during a menstrual cycle.

The oogonia are restructured as they turn into primary oocytes, so that at the end of prophase I (the dictyotene), each one is enveloped by a single layer of flat, follicular epithelial cells (descendents of the coelomic epithelium). (primordial follicle = oocyte + follicular epithelium) Thus, from birth, two distinct structures must be differentiated that, at least conceptually, do not grow in lockstep: On the one side, the main oocyte, which is the female germ cell at birth and can only grow further during (and after) puberty (hormonal cycle is necessary).

Structure of ovary

The ovary is divided into two compartments: cortical (ovarian cortex) and medullary (ovarian medullary) (ovarian medulla).

The ovarian medulla's loose connective tissue contains both blood and lymph vessels. Oocytes are located within the different follicle stages in the cortical compartment.

The primordial follicles are influenced by sex hormones to develop and restructure. Primary follicles, secondary follicles, and tertiary follicles all arise from primordial follicles. Only a small percentage of primordial follicles make it to the tertiary follicle stage; the vast majority die in the various stages of maturation. Large follicles leave scars in the cortical compartment, while tiny ones vanish completely.

The tertiary follicles are the largest, with a special spurt of growth just before ovulation allowing them to reach a diameter of 2.5 mm. Graafian follicles are the name given to these follicles.

5. Formation of egg and Vitellogenesis

The development of the oocyte in the ovarian follicle outpaces that of the nurse cell complex during vitellogenesis. Endocytosis of yolk proteins, which can come from two places: the fat body (vitellogenins) and the follicular epithelial cells that surround the oocyte–nurse cell complex, boosts oocyte growth.

The follicular epithelium separates the oocyte from the hemolymph, so it is not directly exposed to it. Large channels form between epithelial cells, allowing hemolymphderived proteins to move through the follicular epithelium toward the oocyte surface and into the oocyte.

The phase of yolk formation is known as vitellogenesis. It begins when the fat body induces the release of juvenile hormones and the development of vitellogenin protein in insects. Except for mammals, it can be found in all animal types. In terms of chemistry, yolk is a lipoprotein made up of proteins, phospholipids, neutral fats, and a small amount of glycogen. The yolk is synthesised in soluble form in the female parent's liver. It is transported to the follicle cells that cover the maturing ovum by circulation and deposited in the ooplasm as yolk platelets and granules. The mitochondria and Golgi complex are thought to be involved in the conversion of soluble yolk to insoluble yolk.

FORMATION

An egg takes between 24 to 26 hours for a hen to lay. The hen begins the process all over again about 30 minutes after the egg is laid. The ovary, which produces the yolk, and the oviduct, which completes the egg, make up a hen's reproductive system. The ovary is situated halfway between the neck and the tail on the hen's back. Between the ovary and the tail, the oviduct, a tube-like organ about 26 inches long, is loosely connected to the backbone. While most female animals have two ovaries, the hen only uses one, the left. The right ovary and oviduct are both inactive.

OVARY

A fully developed ovary containing thousands of tiny ova, or future yolks, is present when a female chick is born. When a pullet (a hen less than a year old) reaches sexual maturity, the ova begin to mature one by one. Each yolk is contained inside its own follicle or sac. The follicle has a well-developed blood vessel system that carries nutrients to the developing yolk. Ovulation typically happens about 15 minutes after the last egg is laid. The follicle ruptures during ovulation, releasing the yolk into the oviduct. When two yolks are released at the same time, the result is a double-yolked egg. The stigma line, which is devoid of blood vessels, is where the follicle ruptures.

OVIDUCT

The ovulated yolk is captured by the infundibulum, also known as the funnel. Fertilization would take place in the infundibulum if it happened. The yolk passes to the magnum after about 15 minutes, and the hen deposits albumen (white) around the yolk after about 3 hours. The yolk rotates as the albumen (white) is formed, twisting the albumenous fibres to form the chalazae. The two shell membranes are then formed in about 1 1/4 hour, and some water and minerals are added to the isthmus.

The egg has grown to its full size and shape and is ready to be transferred to the uterus (shell gland), where it will develop its shell, shell colour, and bloom in 19 to 21 hours. The uterus inverts via the vagina, the cloaca (the intersection of the digestive, urinary, and reproductive systems), and the vent to expel the egg outside the hen's body after a short pause in the vagina. The act of laying an egg is known as oviposition. The egg travels through the oviduct small end first during formation. The egg rotates just before laying to be laid wide end first. A tiny egg is laid by a young hen. When she grows older, her size increases.

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A tiny egg is laid by a young hen. When she grows older, her size increases.Vitellogenins Precursors of the major egg yolk proteins
comprised of up to five different domains, each of which
corresponds to one of the stored yolk proteins (see also
yolk proteins). Vitellogenins are large (>350 kDa),
homodimeric phospholipoglycoproteins. Common
abbreviations for vitellogenin are Vg, VG, and Vtg.
Vitellogenins are a form of vitellogenin. There are up to five distinct domains in the precursors of the major egg yolk proteins, each of which corresponds to one of the stored yolk proteins (see also yolk proteins). Vitellogenins are homodimeric phospholipoglycoproteins that are massive (>350 kDa). Vg, VG, and Vtg are popular abbreviations for vitellogenin.

6. Gametogenesis in plants: Plant Morphology/Embryology

Gametogenesis is a biological process that results in the formation of haploid male and female gametes. Plants and animals are both affected by this. There are two stages of growth in higher plants: sporogenesis and gametogenesis. The formation of spores is known as sporogenesis, while the formation of gametes is known as gametogenesis. In angiosperms, there are two stages of gametogenesis that lead to the formation of male gametes: microsporogenesis and microgametogenesis, respectively.

The stamen, filament, and anthers make up the plant's androecium. The anthers contain the pollen grains that hold the male gametes. Anatomically, the anther is divided into lobes, which are then divided into chambers known as microsporangia.

These microsporangia contain pollen. Pollen sac is another name for microsporangia. The pollen sac is said to grow from the archesporial cell, which is a parent cell. This archesporial cell is divided into two layers: outer and inner. The sporogenous tissue or cell that forms the pollen mother cell is formed by the inner layer.

The tapetum layer, which provided nourishment to the pollen or microspore mother cell present in the sporogenous tissue, surrounds the sporogenous tissue. The mother cell of the microspore is diploid and divides meiotically to produce haploid microspores or pollen. The process of microsporogenesis is defined in this way.

The pollen grain is a haploid cell that consists of two layers: an outer exine layer derived from the tapetum and an inner intine layer. The exine is found in the pollen grain, with the exception of a small area where the pollen tube emerges after pollination. The germ pore is the name for this small section.

The small generative nucleus and the larger vegetative nucleus split the pollen grain into two halves. Two male nuclei are formed by the generative cell, while the pollen tube is produced by the vegetative cell. This explains how microgametogenesis works.

Angiosperms, like male gametes, go through two stages of gametogenesis to form female gametes:

• Megasporogenesis

• Megagametogenesis

Since female gametes are larger than male gametes, the term ‘mega-‘ is used instead of ‘micro-‘ in females.

The ovules are found in several lobes within the ovary. A megaspore mother cell develops from a cell in the ovule. The mother cell of a megaspore is diploid. Meiosis occurs in this megaspore mother cell, resulting in the development of four haploid megaspores. Three of the four megaspores degenerate, leaving each ovule with only one megaspore. Megasporogenesis is the name given to this process.

This megaspore nucleus is now beginning to split mitotically, resulting in the formation of eight nuclei. Six of the eight nuclei migrate to opposite poles (3 each), leaving two nuclei at the end. Polar nuclei are the nuclei that remain at the middle. The secondary nucleus is formed when these polar nuclei fuse. An embryo sac develops from the megaspore. Megagametogenesis is the name given to this entire process.

7. Pre-fertilization changes

Prefertilisation is the process that occurs prior to fertilisation, i.e. the process that occurs prior to the fusion of gametes. Before fertilisation, there are two things that happen: Male and female gametes are formed during gametogenesis. Gamete transfer is the process of combining male and female gametes.

Gametogenesis

Gametogenesis is a term used to describe the process of gamete formation. Within the anther, male gametes are produced. Microsporogenesis and microgametogenesis are two of the phases. Megasporogenesis and megagametogenesis are the two stages involved in the formation of female gametes within the ovules. The systems and procedures are described below.

Structures

Let's take a closer look at the structures involved in the gametogenesis process.

The epidermis, endothecium, middle layers, and tapetum cover the microsporangium (pollen sac). This is where pollen grains are shaped. There are four pollen sacs on the plant. A collection of compactly organised homogenous tissues called sporogenous tissues makes up the core of each sac.

Ovules- These are the sites where female gametes are created. These are found at the bottom of a vase-like structure known as a carpel, which has a style neck and a stigma opening at the end.

Pollen Grains– It is of a variety of sizes. The inner wall, called the endospore, is made of cellulose, while the outer wall, called the exospore, is made of sporopollenin.

The anther is a two-lobed structure. The sterile part's strip is attached to the two lobes.

Stamen is made up of a filament, which is a stalk. The filament's proximal end is attached to the thalamus, which is a flower petal.

Formation of Male Gametes

Microsporogenesis

Microsporogenesis is the first step in the formation of microspores or pollen grains in the microsporangium, the pollen sac of the anther. Meiosis produces four haploid microspores from the diploid pollen mother cell. A pollen grain emerges from each microspore.

Microgametogensis

Microgametogensis is a form of microgamete infection. Microgametogenesis is the formation of a male gametophyte from a pollen grain. Mitosis occurs in pollen grains, resulting in the formation of two types of cells: small generative cells and large vegetative cells. This is where pollination takes place. Two male gametes are produced by the generative cells, while pollen tubes are produced by the vegetative cells.

Formation of Female Gametes

Megasporogenesis

The megasporangium is where the megaspore grows. Megasporogenesis is the term for this process. The nucellus, a structure within the ovule, is where the process takes place.

Meiosis occurs in the diploid megasporocyte within the ovule, resulting in the formation of four haploid megaspores.

The megagametophyte emerges from just one megaspore, while the other three disintegrate.

Megagametogenesis is a term that refers to the process of The functional megaspore produces female gametes. Megagametogenesis is the term for this process. The megaspore goes through three rounds of mitosis and produces an embryo sac with eight nuclei. Initially, each micropyle and chalaza end has four nuclei. One of them from each pole fuses at the middle during fertilisation to form a diploid nucleus.

Later, the three cells at the chalaza end of the chalaza disintegrate. One of the three cells at the micropyle grows into an egg cell. The pollen tube is driven by chemicals secreted by the remaining two.

Transfer of Gametes

Pollination is needed for seed formation. Pollen grains from the anther are transferred to the stigma during this process. Pollen grains germinate on the stigma and travel through the pollen tube to enter the ovule. After that, the male gametes are released near the egg.

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Contact Us:

University Campus Address:

Jayoti Vidyapeeth Women's University

Vadaant Gyan Valley, Village-Jharna, Mahala Jobner Link Road,

Jaipur Ajmer Express Way, NH-8, Jaipur- 303122, Rajasthan (INDIA)

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