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Gamete Developmental Biology (Zoology-Paper-III)

[B.Sc. Part-I]

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Preface

I am glad to present this book, especially designed to serve the needs of the students. The book has been written keeping in mind the general weakness in understanding the fundamental concepts of the topics. The book is self-explanatory and adopts the "Teach Yourself" style. It is based on question-answer pattern. The language of book is quite easy and understandable based on scientific approach.

Any further improvement in the contents of the book by making corrections, omission and inclusion is keen to be achieved based on suggestions from the readers for which the author shall be obliged.

I acknowledge special thanks to Mr. Rajeev Biyani, *Chairman* & Dr. Sanjay Biyani, *Director* (*Acad.*) Biyani Group of Colleges, who are the backbones and main concept provider and also have been constant source of motivation throughout this Endeavour. They played an active role in coordinating the various stages of this Endeavour and spearheaded the publishing work.

I look forward to receiving valuable suggestions from professors of various educational institutions, other faculty members and students for improvement of the quality of the book. The reader may feel free to send in their comments and suggestions to the under mentioned address.

Author

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B.Sc. Part-I (Zoology: Paper-III)

Z-103

Gamete & Developmental Biology

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Section A

Gamete Biology

Q.1 Define embryogenesis.

Ans. The science of embryology deals with the study of development of animals. In embryology the term "development" is used to denote the processes that are involved in the transformation of the fertilized egg into a new adult individual. This type of individual development is referred to as the ontogenetic development. In contrast, the gradual historical development of a species over a long period of time is known as **phylogenetic development**. Embryology may be defined as the study of the ontogenetic development of organism.

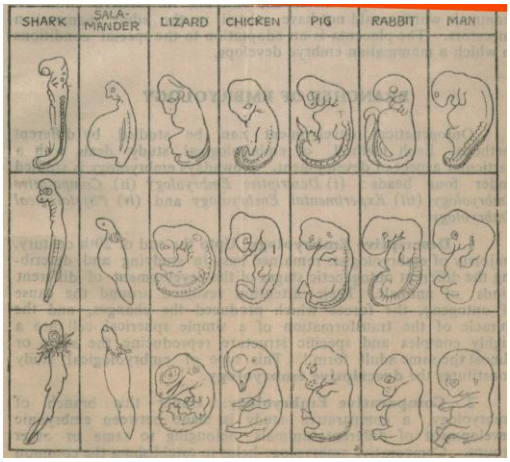
In sexual reproduction, new individuals are produced by sex cells. These cells undergo meiotic division and haploid cells are formed. In multicellular animals there are two types of sex; the female cells or ova and the male cells or spermatozoa. When the two gametes unite by the process of fertilization they form a single cell, the zygote. The zygote undergoes a series of transformations to develop into a new adult animal. The development of an animal from the egg by way of sexual reproduction is termed embryogenesis.

Q.2 What is recapitulation principle?

OR

Explain Biogenetic law?

Ans. Baer's law was formulated before the recognition of the theory of evolution. Later on, it was modified in the light of evolutionary theory by Muller (1864) and Haeckel (1868). Haeckel gave it, the name **"Biogenetic Law"**.



In 1891 Ernst Haeckel, the German morphologist, proposed a relationship between ontogeny and phylogeny. Haeckel proposed the principle of recapitulation according to which the successive stages of individual development (ontogeny) correspond with successive adult ancestors in the line of evolutionary descent (phylogeny). A developing mammal would first be a fish, then an amphibian and then a reptile before it becomes a mammal. Haeckel put it, **"Ontogeny recapitulates phylogeny"**.The repetition is clearly not a complete one, and the biogenetic law states that Ontogeny is a shortened and modified recapitulation of phylogeny.

Q.3 What is Baer's Law?

Ans: After an extensive study of the development of various animals, the German embryologist Kari von Baer arrived at two important conclusions, which are collectively known as Baer's Law. They are as follows:

(i) More general features, that are common to all the members of a group of animal appear in the embryo earlier than the more special features which distinguish the various members of the group.

(ii) Instead of passing through the adult stages of other animals during its ontogeny, developing animal moves away from them.

Thus, in the development of chordates, more general features like brain and spinal cord, notochord, segmented muscles, aortic arches develop earlier than the features distinguishing the various classes of vertebrates like limbs in quadrupeds, features in birds, hair in mammals etc. The characters distinguishing the families

Genera and species come last in the development of the individual. The early embryo thus has a structure common to all members of a large group of animal kingdom known as a phylum.

Q.4 What is differentiation? How many types of differentiations are there?

Ans. After growth the cells in each rudiment become differentiated i.e. they acquire a diversification of form and function. Differentiation refers to the events by which cells and other parts become different from one another and also different from what they were originally. Differentiation is of three types.

(a) Morphological differentiation: Accompanied with multiplication, individual cells and their groups become structurally different from other cells and groups of cells. For

example, from a common starting point in generalized ectoderm, epidermal and nerve cells acquire the distinguishing characteristics of size, shape and internal structure.

(b) Behavioral differentiation: Although all cells exhibit common basic properties like metabolism and irritability, special functional capabilities are ultimately laid upon these general properties. For example nerve cells take up the responsibility to transport electrical impulses muscles to contract, gland cells to secrete special secretions, and so on.

(c) Chemical differentiation: From the very beginning the vertebrate egg has a complex chemical composition that is often exhibited by a measure of pattern and spatial arrangement. The individual cells and areas of cells become biochemically different from one another as, the egg undergoes elevate and progressively becomes converted into blastula, gastrula and embryo.

Q.5 Discuss branches of embryology.

OR

Write short note on Ontogenetical development.

Ans. Ontogenetical development can be studied by different methods such as:

(i) Descriptive Embryology (ii) Comparative Embryology (iii) Experimental Embryology and (iv) Physiological Embryology.

1. Descriptive Embryology: Up to the end of 20^{th} century, majority of embryologists remained busy in studying and describing the different ontogenetic stages of development of different kinds of animals. Their attention revolved around the cause of ontogeny, the forces which produced the changes and the miracle of the transformation of a simple spherical cell into a highly complex and specific structure reproducing the same or almost the same adult form. This type of embryological study constitutes the descriptive embryology.

2. Comparative Embryology: A comparative study is made between embryo developments of different animals belonging to same or other groups. Comparative embryology helps in establishing the common trends among the developments of diverse groups of animals. It helps to understand the phylogenetic relationships among the vertebrates.

3. Experimental Embryology: This branch of embryology uses experiment as a method of investigation. During last days of 19^{th} century and early 20^{th} century, various embryologists; such as Weismann (1883), Roux (1888), H. Driesch (1891), Endres (1895), Spemann (1901-1903) and Schmidt (1933) etc., made experimental and analytical investigations on the developing eggs of sea urchin, newt and frog to understand developmental phenomena more clearly.

4. Physiological Embryology: The embryo in every stage of its development is a living entity and therefore, performs all the basic functions of living matter. For example, it carries out the processes of metabolism that may be studied by experimental methods. The physiological ways of approach to the developing embryo are studied in a special branch of embryology termed Chemical Embryology (J. Needham, 1931; Brachet, 1950). Lehmann (1945) called it Physiological Embryology. It also includes the physiology of such developmental phenomena as regeneration, metamorphosis and tumor growth in human adults.

Q.6 Write short note on physico-chemical nature and forms of yolk in animals.

Ans. The principal components of yolk are proteins, phospholipids and fats in differ combinations. Depending on the components which predominate, the yolk is distinguished as "protein yolk" or "fatty yolk". These two kinds of yolk are present side by side in the eggs of many animals. The avian yolk as a whole contains 48.7% water, 16.6% proteins, 32.6% phospholipids and fats and 1% carbohydrates. The fatty portion of avian yolk is mainly neutral fat (50% of the dry weight), the remaining being phosphatides and cholesterol. In animals yolk is found in three forms as given here under:

(a) Granular Yolk: Protein yolk of many invertebrates like echinoderms and of lower chordates (Amphioxus, Tunicates) consists of fine yolk granules which are fairly evenly distributed in the cytoplasm of the eggs.

(b) Yolk Platelets: In amphibian eggs, the yolk is found in the form of large granules called yolk platelets. The yolk platelets are oval and flattened in one plane. They contain two main proteinaceous substances: phosvitin and lipovitellin.

(C) Yolk Spheres: The yolk of birds, reptiles and bony fishes lies in a compact mass in the interior of the egg. The cytoplasm is restricted to a thin layer on the surface, with a thickened cap on the upper side. Most of the yolk is liquid, but about 23% is in the form of solid "yolk Spheres."

Q.7 What are the functions of Yolk?

Ans. (1) Yolk is the most usual form of food storage in the egg.

(2) It influences the differentiation of ooplasm and the patterns of cleavage.

(3) The size of the egg is determined by the amount of yolk present in it.

(4) Yolk exercises an important influence on the morphogenetic movements of blastomeres during gastrulation.

(5) The nature of development whether indirect with larval forms or direct with juvenile stages is governed by the amount of yolk present in the egg.

Q.8 What are the roles of follicle cells and nurse cells in Oogenesis?

Ans. There are two main types of nutritive cells, viz., follicle cells and nurse cells.

(a) Follicle Cells: Particularly in mammals and some other vertebrates, the oocytes are surrounded by special cells during growth and maturation phases which are called follicle cells. These are derived from the germinal epithelium of the ovary. Initially, the young oocyte is surrounded by a single layer of follicle cells but later the cells arranged in several rows. In a mammal the mature follicle cells of oocyte are called Graffian follicles. As the egg approaches maturity, an eccentric cavity called antrum appears in the mass of the follicle cells. This cavity is filled with a fluid known as liquor folliculi which is secreted presumably by the cells of the follicle.

The plasma membranes of oocyte and that of follicle cells show close connections at some points in the form of desmosomes.

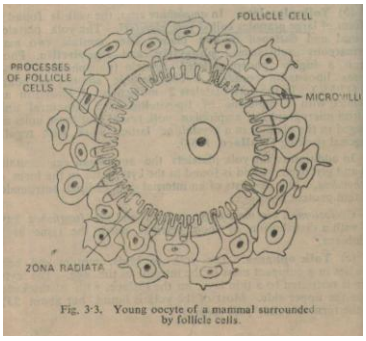


Fig. 3·3. Young oocyte of a mammal surrounded by follicle cells.

Fig

The surface of a young oocyte is drawn out into numerous finger-like microvilli which project into the space, between the oocyte and follicle cells. These microvilli interdigitate with cytoplasmic processes of the follicle cells. The presence of the microvilli greatly increases the surface area of the oocyte. This increase in area facilitates metabolic turnover between the oocyte and the surrounding cells. It is believed that the follicle cells actively help in the growth of the oocyte by secreting substances which are taken up by the oocyte.

(b) Nurse Cells: In some invertebrates like annelids, insects and molluscs the oocyte is surrounded, in addition to follicle cells, by special nurse cells. Derived from the egg cell, the nurse cells supplement the function of follicle cells in providing nutrition to the growing oocyte. In Drosophila an oogonial cell divides by four successive mitotic divisions into 16 cells. One of these cells becomes an oocyte whereas the other 15 become nurse cells which nourish the oocyte. Nutrients from the cytoplasm of the nurse cells pass into the oocyte through gaps developed in the cell membranes of two cell types. This type of relationship is different from that found in between oocyte and follicle cells because in this case no microvilli or cytoplasmic processes are developed at the interface between the oocyte and the nurse cell.

Q.9 What is fertilization? Mention the sites of fertilization.

Ans. Fertilization is the fusion of a male and female gamete; spermatozoa and ovum respectively. It results in the formation of zygote from which new offspring is formed. Fertilization fundamentally performs two functions:

(1) It activates the egg to start development.

(2) It injects a male haploid nucleus into the egg cytoplasm. The fusion of two haploid nuclei spermatozoa and ovum, restores the diploid state and introduces genetic variation in the new organism. The intermingling of the paternal and maternal hereditary characters in the offspring is known as amphimixis.

In majority of aquatic animals, the sperms and ova are shed into the surrounding water where fertilization takes place. It is called external fertilization. Examples: fishes, amphibians and echinoderms. In amniotes, the male introduces sperms into the female's tract where the fusion takes place. It is called internal fertilization. This mode of fertilization takes place in animals whose development is ovoviviparous (e.g. certain lizards and snakes, scorpion, some-fishes) or viviparous (e.g. some fishes like *Musculus*, marsupials and placental mammals including man). Internal fertilization is

the rule in those viviparous animals which lay eggs covered by hard shells (e.g. insects, most reptiles, birds and egg-laying mammals). Animals in which internal fertilization takes place posses specialized sex organs for transmitting and receiving the sperms. In such forms the fertilization may occur either in the lower part of the oviduct (e.g. Urodeles); in upper part of the oviduct (e.g. salamanders, reptiles, aves and most mammals); or in the ovarian follicles (e.g. viviparous fishes like *Gambusia affinis* and certain eutherian mammals such as *Ericulus*).

Q.10 How will you distinguish monospermy and polyspermy. Write significance of fertilization.

Ans. **(1) Monospermy:** Fertilization performed by penetration of one sperm only is called monospermic. This is the normal mode of fertilization in most classes of the animal kingdom e.g., coelenterates, annelids, echinoderms, bony fishes, frogs and mammals.

(2) Polyspermy: When more than one sperm establish contact and penetrate into the egg, the fertilization is called polyspermic. It may be of two types:

(i) Pathological and (ii) Physiological

(i) Pathological polyspermy: It takes place under abnormal conditions when the egg is somehow adversely affected or if there happens to be unusual high concentrations of spermatozoa around the egg. The development after such polyspermic fertilization is abnormal and the embryo is not capable, if living.

(ii) Physiological polyspermy: Several spermatozoa enter the large yolky egg of molluscs, selachians, reptiles and birds as a rule, but of these only one takes part in the development of embryo. Rest of the spermatozoa degenerate sooner or later.

Significance of Fertilization:

(1) Fertilization brings about reproduction, (a) by restoring the diploid number of chromosomes, and (b) by causing to develop a new kinetic division-centre.

(2) It brings about shuffling and recombination of the maternal and paternal genes, producing genetic variations.

(3) Fusion of different strains of protoplasm which occurs during fertilization brings about revitalization in certain animals like *Paramecium*.

(4) The entrance of sperm activates the secondary cocyte to complete its second maturation division; hence it is of physiological importance.

(5) Fertilization causes separation of vitelline membrane which allows the rotation of the egg inside during gastrulation

Q.11 What do you mean by artificial parthenogenesis?

Ans. In many animals it has been demonstrated that the ripe eggs can be insisted to start development by certain treatments, which is known as artificial parthenogenesis. It has been described to occur in annelid, mollusca, echinodermata, amphibian, aves and some mammals.

Stimuli for Artificial Parthenogenesis-Parthenogenetic development of eggs may be induced artificially by various means:

(1) The unfertilized sea urchin eggs can be made to develop successfully by:

(i) Treating the eggs with various substances- (a) hypertonic or hypotonic sea-water; (b) various salts, such as; the chlorides of K, Na, Ca, Mg etc; (c) weak organic acids: butyric acid, lactic acid, oleie acid and other fatty acids; (d) fat solvents-ether, toluene, alcohol, acetone and benzene; and (e) urea and sucrose.

(ii) Temperature shocks, i.e. by transferring the eggs for a short while to cold (0^0 to 10^0 C) or warm (32^0 C) water.

(iii) Electric Induction shocks.

(iv) Ultraviolet light, and

(v) Shaking the eggs in ordinary sea water.

O. Hertwig and R. Hertwig demonstrated that ripe sea urchin eggs may be induced to develop parthenogenetically by treatment with chloroform or strychnice (R. Hertwig, 1896).

(2) An unfertilized frog egg can be induced to develop successfully by pricking the egg with a fine glass needle. Better results are obtained if the needle is smeared with blood.

Q.12 What is significance of parthenogenesis?

Ans. (1) Means of reproduction: Parthenogenesis is a simple method of reproduction in absence of sexual reproduction.

(2) Rapid multiplication: Parthenogenesis produces large number of individuals within a short span of time.

(3) Elimination of disadvantageous characters: Parthenotes with unfavorable mutation is eliminated altogether from the population.

(4) Persistence of advantageous characters: Sometimes useful characters appear in the parthenotes by mutations. Once formed, these mutations are retained as there is no genetic segregation in animals, reproducing by parthenogenetically.

(5) Sex Determination: Sex is determined by chromosomes; therefore, parthenogenesis is very useful in determining the frequency of males and females in a population.

(6) Polyploidy: Parthenogenesis produces polyploidy.

(7) Fertility: Parthenogenesis prevents sterility in the races.

(8) Prevention of Wastage of Energy: Sexual reproduction involves mating which requires energy, parthenogenesis does not involve mating. Hence, most of the energy can be stored and utilized for feeding and other activities.

Long Questions

Q.1 Explain following forms:

1. Gametogenesis

2. Fertilization

3. Cleavage

4. Gastrulation

5. Organogenesis
6. Growth
7. Metamorphosis

Ans.

1. Gametogenesis: The ripening of egg and the formation of spermatozoa is known as gametogenesis. During oogenesis and spermatogenesis the number of chromosomes in egg cell and sperm cell is reduced to half. In both sexes the first step in the formation of gametes is a rapid proliferation of cells by ordinary mitosis. The proliferating cells in the testes are known as the spermatogonia whereas in the ovaries they are called oogonia. After proliferation, the cells enter into a stage of growth and maturation. During maturation the spermatozoa takes on its distinctive form and structure; for the egg it is the period when it acquires its nutritive materials.

2. Fertilization: The term fertilization describes the actual union of ovum and spermatozoa. It also encompasses two other very important events: (a) the activation of the egg which causes it to begin division and (b) the union of the haploid nuclei of the two gametes restoring diploid chromosome number.

3. Cleavage: Upon activation, the egg cell enters the phase of cleavage or segmentation. This consists of a series of mitotic cell division by which the egg is segmented into smaller and smaller parts. During this period the size of the embryo does not change, the cleaved cells or blastomeres becoming smaller and smaller with each division. As result of cleavage, a hollow, usually spherical mass of cells known as blastula is formed.

4. Gastrulation: As the cells continue to multiple, the various regions of the blastula become folded and moved about in various ways so as to build up an embryo known as a gastrula. During this phase, the single primary germ layer splits into three the outermost one is called ectoderm, the innermost one endoderm, and the one in the middle mesoderm. The germinal layers are complex rudiments from which organs of the animal are derived. The movements by which these layers are brought into position collectively comprise gastrulation.

5. Organogenesis (Organ formation): The continuous masses of cells of the three germ layers split up into smaller groups of cells. Each of these groups give rise to a certain organ or part of animal. Every organ begins its development as a group of cells which is called the rudiment of the respective organ. The rudiments into which the germinal layers become subdivided are known as primary organ rudiments. These produce a whole system of organs, such as the nervous system, the alimentary canal etc. The complex primary organ rudiments later become subdivided into secondary organ rudiments which give rise to the parts.

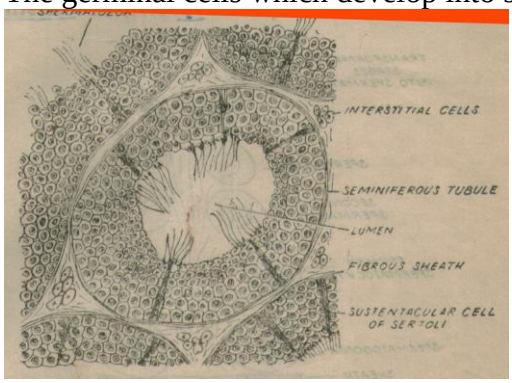
6. Growth: Growth may be defined as the developmental increase in mass. After the organ rudiments are formed they begin to grow and greatly increase in volume. Growth results from synthesis of new protoplasm, both the cytoplasmic and nucleic. Increase in mass, is usually accompanied by cell division. Cell Multiplication, is a distinguishing characteristic of growth. In this way the animal gradually achieves the size of its parents.

7. Metamorphosis: In some cases the animal hatching out from the egg, possesses special organs that are absent in the adult but which are necessary for the special living mode of the young animal. The young animal here is called a larva which may lead a different mode of life from the adult. The larva is transformed into an animal similar to the adult by undergoing a morphogenetic process called metamorphosis. During metamorphosis the larva

undergoes more or less drastic changes in its organization, depending on the degree of difference between the larva and the adult. New organs may develop during the course of metamorphosis which is regulated by hormones.

Q.2 Describe the formation of spermatid in detail.

Ans. Spermatogenesis begins in the germinal epithelial cells of the seminiferous tubules. The germinal cells which develop into spermatids are called primordial germ cells.



There are three phases in the conversion of primordial germ cells into spermatids. They are (A) Multiplication phase (B) Growth phase and (C) Maturation phase.

(A) Multiplication Phase: The primordial germ cells are larger in size and their chromatin-rich nucleus is distinct. They undergo repeated mitotic cell divisions to produce sperm-mother cells or spermatogonia (Gr. Sperma - sperm or seed; gone - offspring). These cells contain a diploid (2n) number of chromosomes and enter the next phase i.e. growth phase.

(B) Growth Phase: Spermatogonia increase in volume roughly by a factor of 2. The cells in this stage are called primary spermatocytes which are still diploid (2n) in nature.

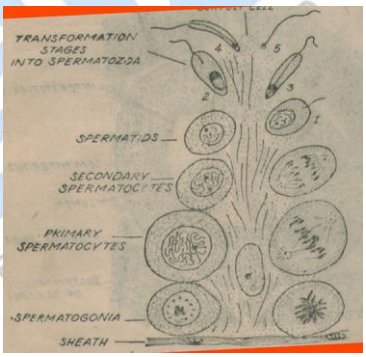
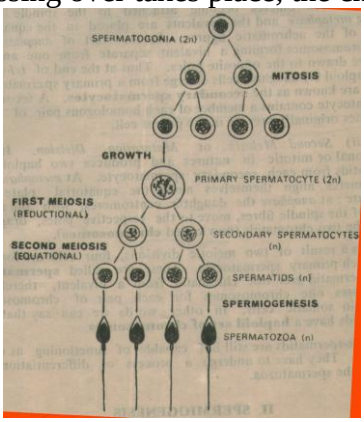


Fig. Spermatogenesis in male

(C) Maturation Phases: In this phase, a diploid primary spermatocyte produces four haploid spermatids. The reduction is accomplished by meiosis which consists of 2 consecutive cell division:

(i) First Meiotic or Maturation Division: It is reductional in nature and the number of chromosomes reduces from diploid to haploid, the nuclear DNA is duplicated in the beginning of division. In the first division homologous chromosomes pair up at prophase in a process called synapsis, each such pair being referred to as a

bivalent. Nevertheless, a bivalent consists really of four chromatids closely joined together in one complex unit while the chromatids are in close proximity, breakage occurs along the length of the chromatids and their parts join up in new combinations. This phenomenon is called crossing-over which enables an exchange of parts of the chromosomes to take place. At the site where the crossing over takes place, the chromosomes are joined by a chiasma.



The centromere becomes attached to the spindle fibers during metaphase and the bivalents are placed in the equatorial plate of the achromatic figures. At the start of anaphase, the two chromosomes forming a bivalent, separate from one another and are drawn to the opposite poles. Thus at the end of telophase two haploid (n) daughter cells emerge from a primary spermatocyte contains a member of each homologous pair of chromosomes originally present in the parent cell.

(ii) Second Meiosis or Second Maturation Division: It is equational or mitotic in nature and produces two haploid (n) spermatids from each secondary spermatocyte. At metaphases the centromeres align themselves along the equatorial plate and duplicate; at anaphase the daughter centromeres with the assistance of the spindle fibers, move to the respective poles, dragging along the two chromatids (now called chromosomes).

As a result of two meiotic divisions, four cells are formed from each primary spermatocyte. These are called spermatids. Each spermatid gets one chromatid from a bivalent, therefore, possesses one chromosome for each pair of chromosomes present in somatic cells. In other words we can say that the spermatids have a haploid set of chromosomes. The spermatids are still not capable of functioning as male gametes. They have to undergo a process of differentiation to become the spermatozoa.

Q.3 Describe the process of spermiogensis.

Ans. The transformation or differentiation of the spermatid into spermatozoa is called spermiogenesis. The haploid spermatid is a typical cell containing nucleus and cytoplasm with mitochondria, centrioles and Golgi bodies. Since the sperm is very active and mobile cell, therefore, to provide greater mobility to the sperm, the

superfluous material of the spermatid is discarded and a high degree of specialization is attained by the sperm cell during spemiogenesis. Following changes occur.

1. **Changes in the nucleolus**: (a) The nucleus gradually diminishes in size by losing water from the nuclear sap and the chromosomes become closely packed into a small volume. The weight is reduced to enhance the motility of the spermatozoa.

(b) Whole of the ribonucleic acid (RNA), especially in the nucleolus, is eliminated, leaving only the genetic material, the deoxyribonucleoproteins.

(c) The shape of the nucleus changes from the usual spherical to an elongated and narrow form which is an adaptation for the propulsion in any fluid medium.

2. **Acrosome formation**: The acrosome of the spermatozoa is derived from the Golgi bodies. In an early spermatid, the Golgi body is concentrated

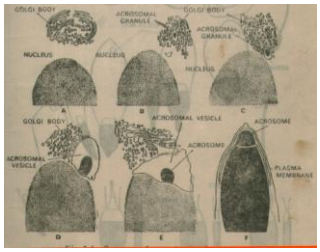


Fig.Sequence of stages in the formation of the acrosome and head cap from the Golgi body during spermiogenesis. (After Balinsky, 1970)

near the anterior end of the nucleus. It consists of a series of membranes arranged concentrically around a cluster of smaller vacuoles. One of the Vacuoles starts enlarging and a small dense body, the progressional granule (mucopolysaccharide) appears in it. The vacuole with its granule becomes closely applied to the tip of the nucleus. The pro-acrosomal granule increases further and becomes the acrosomal granule.

The latter forms the core of the acrosome. In the next stage the vacuole loses its liquid content and its wall spreads over the acrosomal granule and the front half of the nucleus, covering hem with a double membranous sheath called the cap of the spermatozoon, the remaining part of the Golgi body is gradually reduced and ultimately discarded from the spermatid as "Golgi rest", alongwith some cytoplasm. According to L.H. Colwin and A.L. Colwin (1961), the acrosomal granule contains a supply of enzymes which are used to dissolve the egg membranes during fertilization.

3. **Changes in the centrosome**: The centrosome of a spermatid after the second meiotic division consists of two centrioles. The centrioles are in the form of two cylindrical bodies, lying at right angle to each other. During early stages of sperm differentiation, the two centrioles move to a position just behind the sperm nucleus in the neck region. A depression is formed in the posterior surface of the nucleus and one of the two centrioles becomes placed in this depression with its axis at right angle to the main axis of the sperm. This is the proximal centriole of the spermatozoa. The other centriole called the distal centriole gets positioned behind the proximal centriole with its axis parallel to the longitudinal axis of the sperm. The distal centriole gives rise to the axial filaments of the flagellum of the spermatozoa for which it serves as a basal granule.

4. Changes in the mitochondria: In many animals, particularly mammals, the mitochondria of the spermatid join in continuous body which becomes twisted spirally, around the axial filaments. In other animals, the mitochondria fuse together to form one or more massive clumps called mitochondrial bodies.

5. Change in the cytoplasm: The abundant cytoplasm of the spermatid is reduced to a condensed layer known as manchette in sperm. The manchette is confined to the periphery of the middle piece. It is also present at the posterior part of the head of the spermatozoa.

6. Ring Centriole: In some species the posterior end of the middle piece is marked by dark ring called the "ring centriole". The ring centriole forms the boundary between the middle piece and the tail. The function of the ring centriole is still not known.

7. Axial filament: It starts from the distal centriole of the spermatid. The axial filament of the sperm has the same organization as the axial filaments of the flagella. It has a pair of longitudinal fibers in the centre and a ring of nine pairs of longitudinal fibers surrounding it. The spermatozoa totally devoid of stored food and protective envelopes, which characterize female gamete.

Q.4 Explain the Microscopie Structure of a mature spermatozoon.

Ans. A spermatozoon is a highly specialized type of cell. The greater part of its total volume is represented by nuclear material. The sperm is characterized by the presence of a propulsive system in the form of an axial filament powered by energy obtained from the mitochondria. Unlike female gametes,

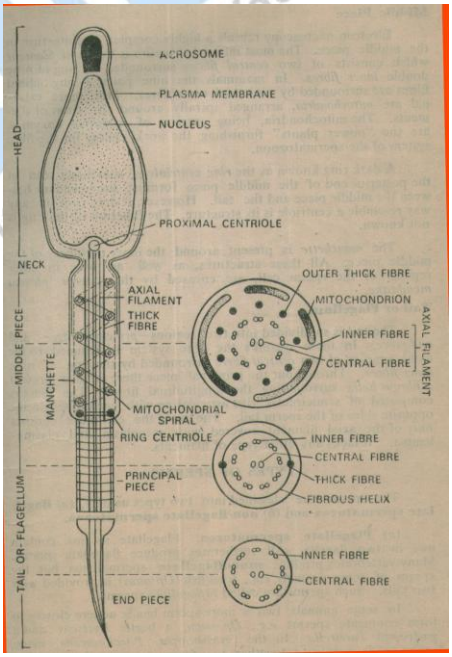


Fig. Diagrammatic structure of a mammalian spermatozoa

the sperm cell is totally devoid of stored food and protgective envelopes. Thus a spermatozoa may be looked upon as hardly more than a motile nucleus whose fate is to carry the paternal chromosomal elements to the ovum and to activate ovum.
A typical mammalian spermatozoa consists of the following main parts.
Head, middle piece, tail or flagethum.
Head:

The head is spoon-shaped in man and many other mammals. The anterior tip of the head is differentiated as acrosome which plays an important role in penetration of spermatozoa through the egg membrances and activation of the egg during fertilization. The nucleus occupies ;the majaor part of the head. It contains genes and is thus responsible for the transmission of the hereditary characters from male parent. A depression on posterior surface of the nucleus, contains two centrioles, lying at right angle to each other. During fertilization, the proximal centriole of the sperm gives rise to a spindle system inside the egg and is necessary for the initiation of the cell division in the fertilized egg. The distal centriole lies behind the proximal cenriole. Its axis coincides with the longitudinal axis of the sperm. The distal centriole gives rise to the axial filament of the flagellum of the spermatozoa for which it serves as a basal granule or astarting point. The cytoplasm forms a condensed layer known as the manchette around the posterior part of the nucleus.

Middle Piece

The most internal structure is the axial filament which consists of two central fibres surrounded by ring of nine double inner fibres. In mammals the nine pairs of longitudinal fibres are surrounded by nine thick outer fibres. Still more external are nutochondria, arranged spirally around the rings of filament.

A dark ring known as the ring centriole is sometimes seen at the posterior end of the middle piece forming the boundary between the middle piece and the tail. However, it does not resemble a centriole in its structure. The function of the ring is still not known. The manchette is present around the inner periphery of the middle piece. All these structures, as well as those in other regions of the sperm cell, are encashed by the sperm plasma membrane.

Tail or Flagellum:

The tail is lsubdivided into two regions : principal piece ;and end-piece. In these regions the fibre system is reduced: the axial comp;lex of ;two central fibres surrounded by ;the ring of nine inner fibres. There is a fibrous helix surrounding the longitudinal fibres throughout the principal piece. The helix is composed of semicircular ribs articulating with each other on the opposite sides of the sperm tail. The tip of the end-piece consists of the axial filaments only covered with cytoplasm and plasmalemma. It lacks any other type of filaments.

Types of Sperms

The sperms are classified into two types namely, (a) flagellate spermatozoa and (b) non-flagellate spermatozoa.(a) Flagellate spermatozoa: Flagellate sperms contain one or two flagella. All vertebrates produce flagellate sperms. Many vertebrates produce

monoflagellate spermatozoa but the sperm of some animal e.g. toad-fish (*Opsanus*) is provided with two tails. Such sperms are called biflagellate sperms.

In some animals two or more sperm heads adhere closely to form conjugate sperms e.g. *Opossum*, a beetle-*Dytistcs* and a gastropod- *Turritella*. In the grasshopper-*Poecilocercus* many spermheads aggregate together to form a sperm-boat. After ejaculation by the male, all conjugate sperms normally dissociate from each other in the female genital tract.

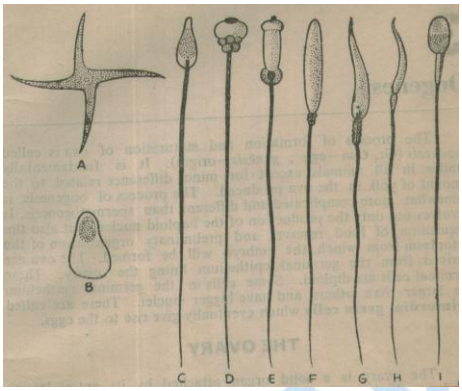


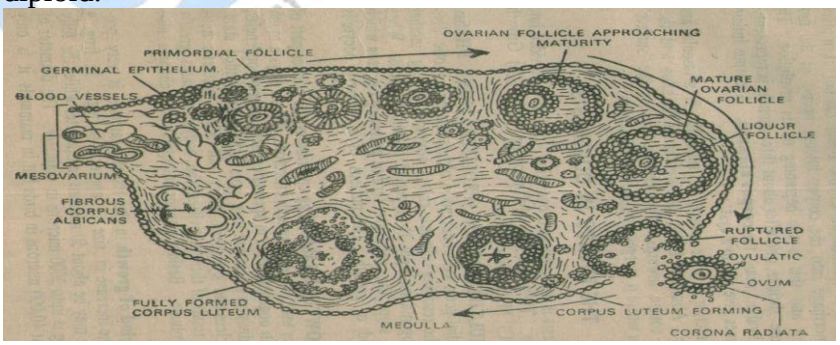
Fig. types of sperms in some animals. (A) *Procambarus* (Cray fish) (B) *Ascaris* (C) *Arbacea* (sea-urchin) (D) *Amphioxus* (H) Chick (bird) (I) Man

Q.5 Discuss the process of oogenesis in detail.

Ans. Formation of ovum form primordial germinal epithetical cells is known as oogenesis. The process is divided into there phases (A) Multiplication Phase (B) Growth Phase and (C) Maturation Phase

A. Multiplication (Proliferation) Phase:

The primordial germ cell undergo proliferation by mitotic divisions and the resulting cells are called oogonia or egg-mother cells. The oogonia multiply by repeated mitotic divisions. When the division stops, the cells are termed primary oocytes which enter a period of growth. The nucleus of a primary oocyte is diploid.



B. Growth Phase:

Egg contributes the greater part of the substances used in development, therefore, growth plays a much greater role in oogenesis than in spermatogenesis. During oogenesis, first meiotic division starts and then goes into a suspended state, while the nucleus and cytoplasm carry out major synthetic activities. As a result of these

activities, the oocyte increases greatly in size and volume. Besides, important qualitative changes also occur.

The period of growth in the female gametes is very prolonged and the increase in size is appreciably high. In frog, a young oocyte may be about 50 microns in diameter while the fuly developed egg is up to 2000 microns in diameter. The diameter of ovum is about 40,000 microns in birds but in mammals it is only 200 microns.

Period of oocytes may be divided into two stages (i) Previtellogensesis and (ii) Vitellogenesis (Raven,1961).

(i)Pre-vitellogenesis: During this period of growth, the nucleus and cytoplasm of primary oocyte increases tremendously in volume.

(a) **Growth of nuclear substances:** The nucleus of the oocyte becomes enlarged mainly because of the production of a large amount of nuclear sap. Due to this the nuclei of advanced oocytes appear to be bloated with fluid an are often referred to as germinal vesicles.

The chromosomes increase in length. In oocytes of animals having large eggs(notably in the amphibian oocyte), the chromosomes acquire a very characteristic appearance. Numerous paired threads or loops project transversely from the main chromosomal axes. The shaggy appearance given to the chromosomes by these loops has led to their being called lamp brush chromosomes.

The loops of lamp brush chromosomes represent loci of gene activity i.e., at these sections messenger RNA is synthesized which subsequently controls the synthesis of proteins in the cell. However, the amount of DNA in the chromosomes does not increase in proportion to the enlargement of the nucleus.

The nucleus in the germinal vesicle is concerned with the synthesis of ribosomal RNA. The nucleolus of a growing oocyte increase greatly in size. In many animals., for example in amphibians, instead of one large nucleolus, many smaller nucleoli are formed in the germinal vesicle. It is believed that RNA passes out of the nucleus into the cytoplasm during the growth of the oocyte.

(b) **Growth of cytoplasmic substances**: The amount of cytoplasm increase quantitatively during the growth of the oocyte. Besides, it also changes in quality by elaboration and regular distribution of various cell inclusions like motochondria, golgibodies, endoplasmic reticulum, cortical granules etc.

Mitochondria: The mitochondria are fewer in young oocytes but increase in numbers quite appreciably during the growth of oocytes. In some animals, e.g., amphibia, birds, they are aggregated in the form of large mitochondrial cluds (Romanoff, 1960; Wartenberg, 1962; Balinsky and Devis, 1963). Mitochondria are carriers of oxidative enzymes, therefore, the overall oxygen consumption increase during the growth of the ooyte.

Golgibodies: younger ooytes, golgi bodies are found around the centrosome. In mature oocytes the sometimes disappear completely (Odor,1960). This

Indicates that golgi bodies are transformed into some other structures like cortical granules.

Endoplasmic reticulum: The cytoplasm of the young oocytes contains numerous vesicles surrounded by a simple membrane. Ribosomes are often attached to the surface of the vesicles. These vesicles are often supposed to be equivalent to or to be a modification of the endoplasmic recticulum. Oocytes often have a different kind of membranous structure. It takes the form of stacks of double membranes. Usually do not have ribosomes attached to them but instead are performed by pores. These pores closely resemble the pores of the nuclear membrane.

Cortical Granules: In mature oocytes, formation of special structures known as the cortical granules takes place on the inner side of the plasma lemma. These are spherical bodies, surrounded by a simple membrane and containing acid mucopolysaccharides. The acid mucopolysaccharides of the cortical granules synthesize fertilization membrane during fertilization. The cortical granules are present in sea urchins, frogs, fishes, bivalve molluscks, some annelids, and some mammals (e.g., hamster, rabbit and man).

(ii) Vitellogenesis: Yolk appears in the oocytes in the second period of their growth called the vitellogenesis period. Yolk is the most usual form of food storage in the egg. In amphibians (Ward 1962; Baliksky and Devis, 1963) and fishes Yamamoto and Oota, 1967) the vitellogenesis or synthesis of different yolk components takes place inside modified mitochondria. In other vertebrates, the yolk is not synthesized in the oocytes at all but is produced in the liver of the body of the female, It is then transported in a soluble form via the blood stream and the follicle cells to the oocytes when it is finally deposited in the form of yolk platelets or yolk granules.

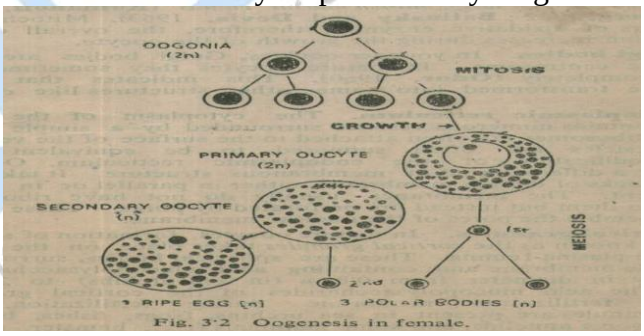


Fig. 3·2 Oogenesis in female.

C. Maturation Phase: The primary oocyte contains diploid number of chromosomes. After the oocyte complets its growth, it is ready for meiosis or reduction division during which the diploid chromosome number is reduced to haploid number. In this process, the primary oocyte is changed into haploid ovum or egg. This is called maturation. In spermatogenesis, the primary spermatocyte divides into four cells of equal size which eventually give rise to four sperms. In oogenesis only one ovum is produced out of the four unequal cells derived from the primary oocyte.

At the beginning of the maturation phase, the nuclear membrane breaks up and the contents of the nucleus get mixed up with the surrounding cytoplasm. The chromosomes which have become greatly contracted and concentrated toward the centre of the germinal vesicle, are carried to the periphery of the oocyte. An achromatic spindle is formed at the

periphery, which takes up a position, perpendicular to the surface of the oocyte. The bivalents come on the equatorial plate and subsequently separate into the two component chromosomes. Next, a bulge appears at the surface of the oocyte. The outer pole of the spindle with half of the chromosomes enters into this cytoplasmic bulge during anaphases first meiotic division. The bulge is then pinched off from the rest of the oocyte as a small cell, the first polar body. It receives only a very small quantity of cytoplasm, while the rest goes to the occyte which is now distinguished as the secondary oocyte. The secondary oocyte is of the same size as that of primary oocyte. Thus as a cones quence of the first meiotic division the primary oocyte divides into a large and a very small cell, each with a haploid number of chromosomes.

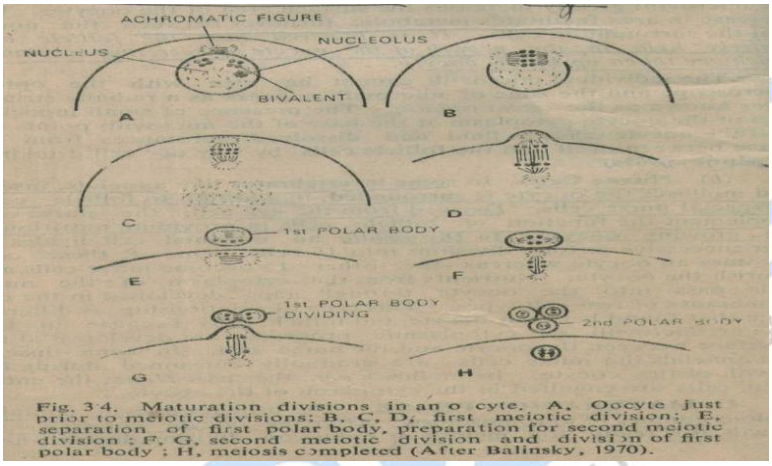


Fig. 3.4. Maturation divisions in an o cyte. A, Oocyte just prior to meiotic divisions; B, C, D, first meiotic division; E, separation of first polar body, preparation for second meiotic division ; F, G, second meiotic division and divisi on of first polar body ; H, meiosis completed (After Balinsky, 1970).

In the second meiotic division an achromatic spindle is again formed at the surface. When division takes place, half of the chromatids are given off, along with a small quantity of cytoplasm to form a secondary polar body. The larger cell, which receives the major part of the cytoplasm together with one half of the chromatids, represents the fully mature ovum. As the secondary oocyte is dividing, the first polar body divides into two cells. Therefore, in the maturation of egg, four cells are produced from one oocyte. One cell, the egg, as a functional gamete, the second and third cells are produced by the division of the first polar body, and the fourth cell is the second polar body. All the polar bodies disintegrate later because they have very little cytoplasm with no food reserves.

The unequal cytokinessis (cytoplasmic division) during oogenesis has the great significance for the egg. These unequal divisions allow one cell out of the 4 daughter cells to inherit most of the cytoplasm and reserve food material which is essential for the developing embryo.

Q.6 Discuss all the complete process of fertilization.

Or

Explain the mechanism of fertilization in details.

Ans. The process of fertilization in animals is completed through different 5 steps:

1. The meeting of gametes.
2. Barrier Penetration.
3. Sperm and egg fusion: the acrosome reaction.
4. Activation of the ovum.
5. Migration of pronuclei and amphimixis.

1. The Meeting of Gametes

Whether fertilization is external or internal, the first step is the encounter of spermatozoa and the ovum which is brought about by the swimming movements of the spermatozoa. The movements of the spermatozoa are entirely at random and they collide with the egg as a matter of pure chance. However, in all those vertebrates in which fertilization is internal, spermatozoa tend to be transported passively, from the site of deposition to the site of fertilization, by muscular contractions of the female genital tract.

(a) Agglutination: In most animals it has been observed that in the presence of ripe eggs, the spermatozoa adhesion of spermatozoa to each other result in their clumping or agglutination.

(b) Fertilizin-Antifertility reaction: Lillie (1919) was the first to show that the eggs produce a substance called fertilizin which combines with a substance termed antifertilizin present on the surface of spermatozoa. As a mater of fact, fertilizin is released in the surrounding water and, as a consequence of combining reaction with antifertilizin, most of the sperms agglutinate or clump together.

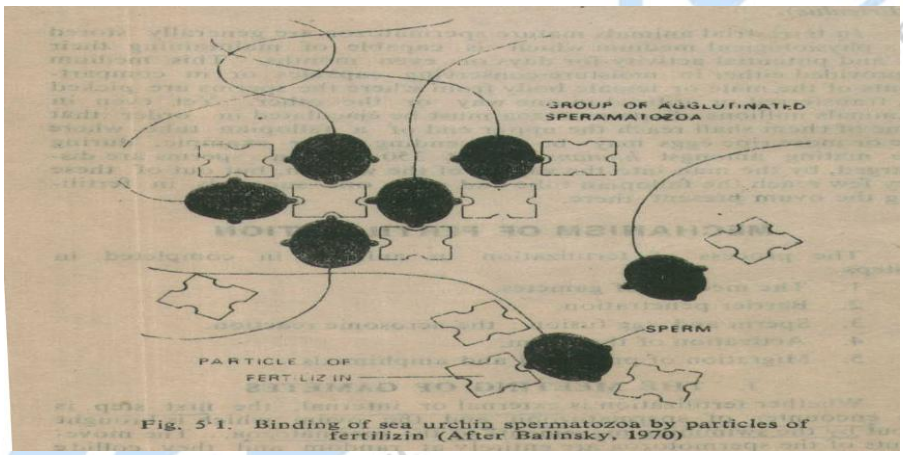


Fig. Binding of sea urchin spermatozoa by particles of fertilizing

Chemically, fertilizin is a glycoprotein which consists of a number of amino acids and one or more monosaccharides (glucose, fucose, fructose, or galactose). Depending upon their chemical composition, there are many types fertilizin in different animals.
The molecules of the fertilizins are quite large Molecule. The antifertilizins are acid proteins with a fairly smaller molecule.
The adhesion of the spermatozoa to the surface of the egg is brought about by linking of fertilizing molecules with antifertilizin molecules percent on the surface of the spermatozoon. This phenomen on established an initial bond which would later lead to the penetration of the sperm into the egg. This reaction is highly specific that is fertlizin of one species will not react with the antifertilizin of another species. This is analogous to a lock-and-key-effect, and serves as a barrier against cross breeding. It qualifies the spermatozoa to become fully capable of fertilizing an egg of the same species. Berill (1971) called it capacitation.

2. Barrier Penetration

The surface of the ripe egg is rarely naked (as in coelenterates). It is usually surrounded by egg membranes or follicle cells or both (as in mammals). The spermatozoa has to penetrate through these barriers before it can reach the interior of the egg. The mechanism of penetration is chemical. The egg envelopes are by substances of an enzymatic nature known under the general name of spermlysins released by the acrosome of the sperm.

In the case of eggs with very thick and resistant membranes e.g., fishes and insects, the sperm penetrates through a special canal, the micropyle which is left in the egg membrane.

In mammals, the egg when released from the ovary, is commonly encased in a layer of cells of ovarian origin, termed the corona radiate. These cells are held together by a cementing substance known as hyaluronic acid. The spermatozoa has to pass through this barrier on its way to the egg. In order to do so, its acrosome produces and enzyme hyaluronidase which dissolves the cement and disperses the cells. The enzyme thus enables the spermatozoa to penetrate the corona radiata.

3. Sperm and egg fusion: The acrosome reaction

As the spermatozoa comes in contact with the egg, the acrosome of the sperm undergoes radical changes as the spermatozoa makes contact with the egg envelope, the sperm plasma membranes and the acrosomal membrane rupture at the point of contact.

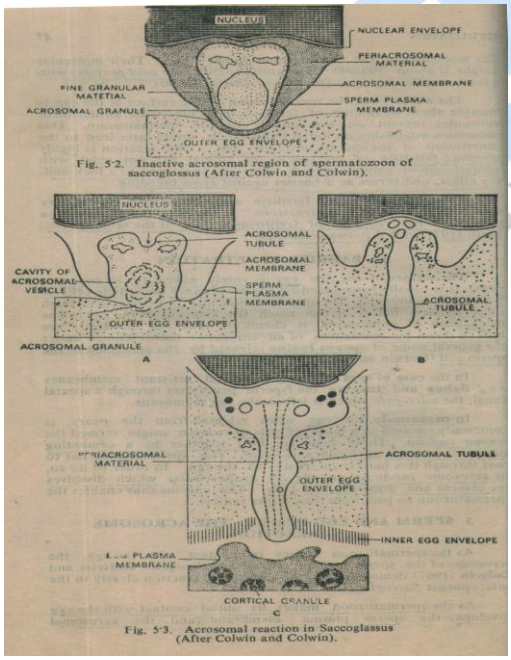


Fig. 5·2. Inactive acrosomal region of spermatozoon of saccoglossus (After Colwin and Colwin).

Fig. 5·3. Acrosomal reaction in Saccoglassus (After Colwin and Colwin).

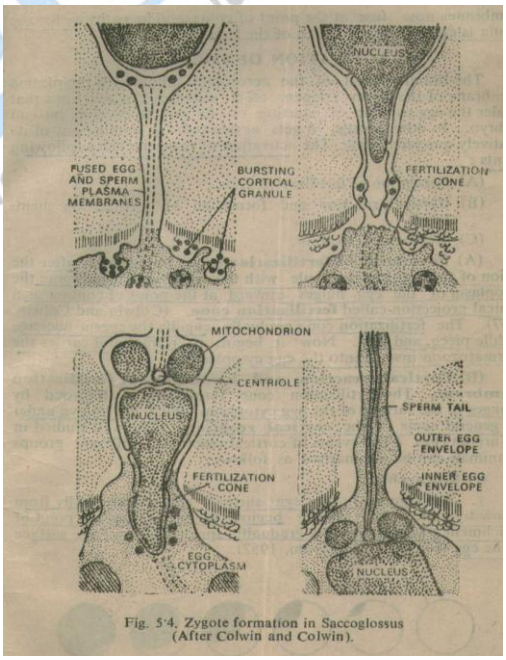


Fig. 5·4. Zygote formation in Saccoglossus (After Colwin and Colwin).

The acrosomal membrane then joins with the plasma membrane the margin of rupture so that the acrosomal granule is exposed to the surface of the egg envelope. Now the peripheral part of the acrosome collapses and its lysins (enzyme) are extruded. The central part of the acrosome elongates and becomes transformed into a long thin tube known as the acrosomal tubule. The acrosomal tubule traverses the egg envelopes (jelly and vitelline membrane) and finally touches the egg plasma membrane. These

two membranes now fuse as the point of contact. The pathway for the tubule is cleared by the action of the lysins.

4. Activation of the ovum

The initial contact of the acrosomal tubule with the plasma membrane of the ovum triggers off a sequence of reactions that render the egg capable of starting on its way to develop into an embryo. In other words, it gets activated by coming out of its relatively quiescent state. The activation of ovum includes following events.

(a) Formation of fertilization cone
(b) Cortical reaction and formation of fertilization membrane.
(c) Metabolic activation.

(a) Formation of Fertilization cone: Immediately after the fusion of the acrosomal tubule with the egg plasma membrane, the cytoplasm of the egg bulges upward at the point of contact as a conical projection called fertilization cone. The fertilization cone gradually engulfs the sperm. Now it begins to retract carries the spermatozoa in ward the egg cytoplasm.

(b) Cortical reaction and formation of fertilization membrane: The fertilization cone formation is followed by changes in the surface of the egg cytoplasm which are known under the general name for the cortical reaction. The events of cortical reaction is different in different groups of animals.

1. The colour of the egg surface changes gradually from yellow to white sea-urchin. The cortex of the unfertilized egg is bounded by two membranes. The outer one, called the vitelline membrane whereas the inner one being the plasma membrane. A layer of cortical granules is found beneath the plasma membrane. The outer, vitelline membrane becomes lifted off from the plasma membrane. It undergoes an expansion, an expansion, and gives rise to the outer layer of the fertilization membrane. The space between it and the surface of the egg is called perivitelline space. The cortical granules swell and explode.

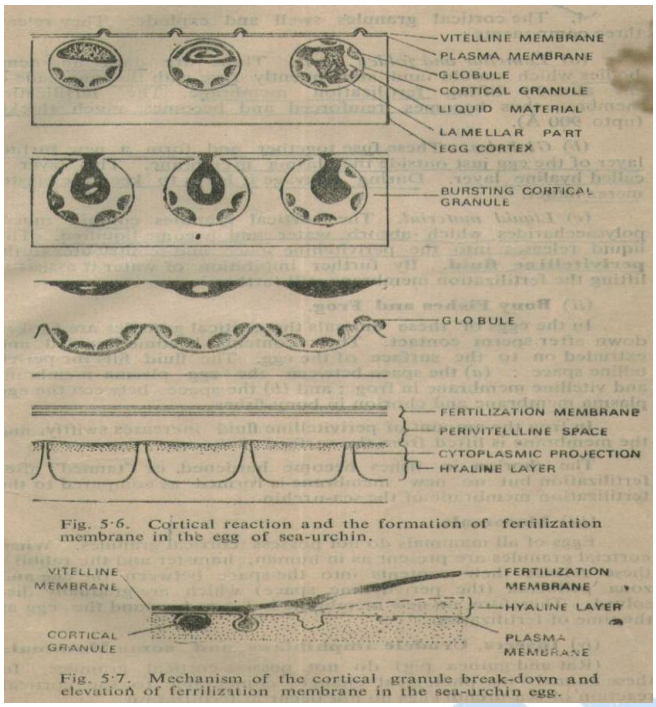


Fig. Mechanism of the cortical granule break –down and elevation of fertilization membrane in the sea-urchin egg.

Eggs of all mammals do not process cortical granules. When cortical granules are present as in human, hamster and the rabbit; theses, release their contents into the space between the egg and zona pellucida (the peri space) which are gradually dissolved. Therefore, no new membrane is formed around the egg at the time of fertilization.

(C) Metabolic Activation: The visible structural changes during fertilization are accompanied by alteration in he physiological properties of the egg substance. These include (i) changes in permeability of egg plasma membrane, (ii) ionic changes, (iii) respiration changes, (iv) change in the rate of protein synthesis, and (v) initiation of mitosis.

5. Migration of pronunclei and Amphimls (Union of Haploid Nucle):

In the case of most vertebrate eggs, oogenesis comes to a standstill after the first meiotic division and is resumed only following sperm penetration. Entrance of spermatozoa serves to act as a stimulus which causes the second maturation division. As the head and middle piece of the sperm advance into the egg, these parts rotate through an angle of 180^0 so that the mitochondria and proximal centriole of the associated middle piece assume the leading position. The nucleus itself starts swalling by absorbing fluid from the surrounding cytoplasm and becomes vesicular. It is now called male pronucleus.

As the male pronucleus and centroile move inward, they may be accompanied by some cortical and subcortical cytoplasm. If the latter is heavily pigmented, as in symphysion eggs, the path of the male pronucleus may be marked by pigment granules trailing along its path. This path is referred to as penetration path.

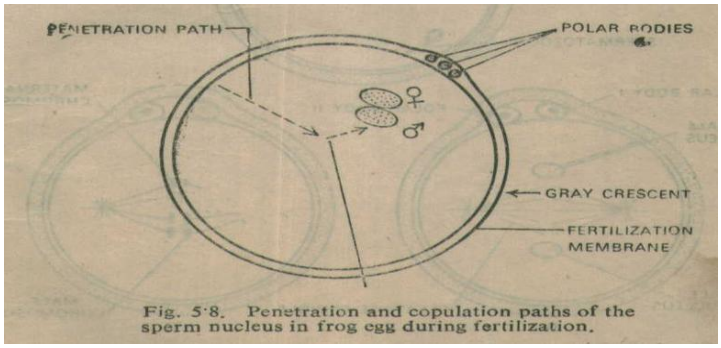


Fig. 5·8. Penetration and copulation paths of the sperm nucleus in frog egg during fertilization.

Fig. Sequence of evens in fertilization (semi diagrammatic) (A) First polar body formed and second in process of forming upon entrance of sperm. (B) Second polar body formed and pronuclei approaching each other. (C) Maternal and paternal chromosomes arranged on spindle in preparation for first cleavage

The centriole brought in by the permatoza subdivides into two and an achromatic spindle is established in the centre of the active cytoplasm.

With the production of the second polar body the egg nucleus or female pronucleus is ready for union with the male pronucleus provided by the sperm head. It also migrates towards the site of union. Both pronucleri assume the general form of an interphase nucleus.
The male pronucleus which has been advancing along the penetration path, now moves directly toward the female pronucleus. This in many cases involves a slight change in the course of sperm. In such cases, the latter portion of its course is called the copulation path as distinguished from the first portion of entrance path.
Amphimixis: The fusion of male and female pronuclei is called amphimixis. The site of amphimixis lies in the centre of active cytoplasm at the animal pole in macro and telolecithal eggs, while in microlecithal eggs it lies near the centre of the egg.
In a few animal types, the two pronuclei actually fuse together. In mammals and other vertebrates the male and female pronuclei do not fuse as such.

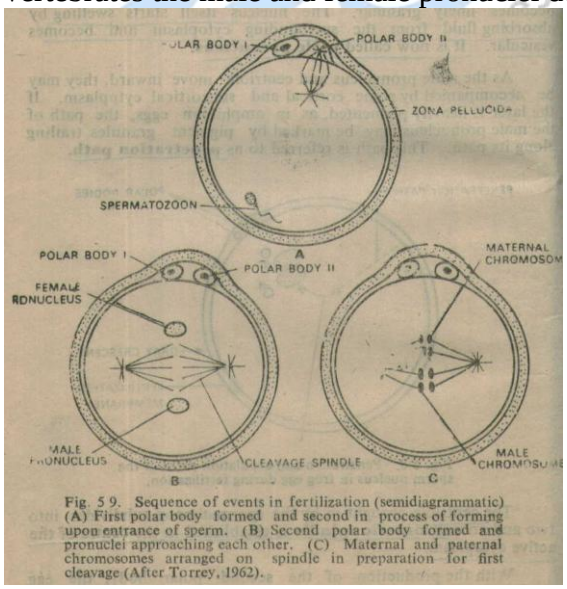


Fig. 5 9. Sequence of events in fertilization (semidiagrammatic) (A) First polar body formed and second in process of forming upon entrance of sperm. (B) Second polar body formed and pronuclei approaching each other. (C) Maternal and paternal chromosomes arranged on spindle in preparation for first cleavage (After Torrey, 1962).

Instead, each pronucleus loses its membrane and its chromation resolves into the paploid set of chromosomes. The two sets of chromosomes then arrange themselves across the division spindle. This arrangement heralds the readiness for the first cleavage division.

Section B

Developmental Biology

Q.1 What are the planes of cleavage?

Ans. The cleavage is initiated by the appearance of a constriction of groove called cleavage furrow. The cleavage furrows may divide the egg from different angles of planes. There are four important planes of cleavage.

1. meridional plane: When cleavage furrow bisects both the poles of the egg, passing through the animal-vegetal axis, the plane of cleavage is called maridional plane. Examples are, I and II cleavage furrows in frog; I cleavage furrow in chick.

2. Vertical plane: A furrow which passes from the animal pole to the vegetal pole, but it does not pass through the median axis of the egg. Instead, it is oriented towards one side of the axis. Example: III cleavage furrows in *Amia calva*, *Lepidosteus osseus* and chick.

3. Equatorial plane: This plane of cleavage bisects the egg at right angles to the median axis and half way between the animal and vegetal poles. Example: I cleavage plane of eggs of higher mammals.

4. Transverse, Latitudinal or horizontal plane: The transverse plane resembles the equatorial plane, but it passes either above (towards the animal pole) or below (towards the vegetal pole)
the equator the egg. Examples: III cleavage plane of Amphioxus and frog.

Q.2 What are the characteristics of cleavage?

Ans. (1) All divisions are mitotic and occur consecutively.

(2) The cell size reduces continuously as the cleavage proceeds.

(3) The general shape of the embryo does not change, except for the formation of a cavity among the cleaving cells. This is called the blastocoel.

(4) Cytoplasmic substances transform into nuclear substance, but qualitative changes in the chemical composition of the egg are very few.

(5) A great increase in the synthesis of DNA takes place because it is needed for duplication of chromosomes.

(6) The ratio of nucleus to cytoplasm is very low at the beginning of cleavage, but at the end it is brought to the level found in ordinary somatic cells.

(7) During cleavage, oxygen consumption is greatly increased.

(8) The constituent parts of ooplasm remain unaltered during cleavage.

Q.3 What effect does yolk take on cleavage?

Ans. Yolk is a mechanically inert material, which when present in large quantities, may interfere physically with the subdivisions of an egg during cleavage. It retards the progress of the furrow to divide the cytoplasm following nuclear division. During cleavage, the chromosomes and the achromatic spindle are generally shifted into the more protoplasmic portions and away from the yolky areas of the egg. Consequently, the protoplasmic portions divide into smaller cells than the yolky areas. Besides, they divide more frequently.

The cleaves mitosis. Mitosis is characterized by the movements of cell components viz., the chromosomes, achromatic figure, mitochondria etc. The activity of these components along the equator of the maternal cell leads to the ultimate separation of the daughter cell. The yolk granules or platelets are passively distributed between the daughter blastomers during these movements. When yolk become abundant, it tends to retard and the process of cleavage slows down. The yolk in the uncleaved egg is generally more concentrated toward the vegetal pole of the egg than the animal pole. Therefore, the cleavage is most retarded at the vegetal pole of the egg and here the blastomeres are larger in size.

Frog's egg is a good example to explain the effect of yolk on cleavage. The first cleavage furrow is meridional but it does not appear simultaneously all stround the circumference of the egg. At first it is seen only at the animal pole of the egg where the amount of yolk is less. It then gradually prolongs along the meridian of the egg. Passing through the yolk-laden cytoplasm or deutoplasm, it eventually reaches the vegetal pole. This divides the egg into two blastomeres. The same process is repeated during the second meridional cleavage which takes place at right angles to the first. During the third cleavage, when the plane of division is latitudinal, the cleavage furrow appears simultaneously all over the circumference of the egg because it meets with an equal resistance from yolk at all sites. There is a greater accumulation of yolk at the vegetal pole of telolecithal egg. This interferes with the cell division at this pole and as a result the cleavage here become inhibited.

The pattern of cleavage is determined considerably by the amount of yolk in the egg. Isolecithal and telolecithal eggs undergo complete or holoblastic cleavage. In this type, the cell membranes formed during cleavage cut completely through the egg. Including the yolk. In centrolecithal and discoidal eggs, the cleavage is incomplete or meroblastic. Such eggs contain so much yolk that only a small amount of cytoplasm with nucleus undergoes segmentation.

Q.4 Writes short notes on determinate and indeterminate cleavage.

Ans. Eggs of molluscs, annelids, flatworms, nematodes, ctenophores, and ascidians undergo determinate cleavage in which definite bastomeres give rise to specific part of the embryo. A special type of bilateral cleavage in Ascaris is an example of determinate cleavage. The first division produces two unequal cells: a slightly larger cell AB and a smaller cell P. In the second division, the two cells divide in mutually perpendicular planes with the result that the blastomers in the four-cell stage are arranged in the form of a letter T. The transverse shaft of the T is made up of blastomers A and B which are descendants of the cell AB. The vertical shaft is made

up of the derivatives of blastomere P_1. These cells are designated as EMST and P_2 . EMST is abbreviation for Endoderm, Mesoderm and Stomodaeum which indicated the destiny of this cell. The P2 cell soon shifts towards the B cell and the blastomeres are arranged in a rhomboid figure.

The indeterminate or regulative cleavage occurs in the eggs of echinoderm, balanoglossids, coelenterates, and amphibians. In this type, the cleavage pattern bears no definite relation to the embryo. If a first cleavage blastomers from the embryo of a sea urchin, an amphibian or a mammal is isolated, it can change its usual destiny and could develop into a perfect, though small, embryo. Likewise, when two fertilized eggs are made to stick together, they produce a single giant embryo.

Q.5 Write short note on blastula formed holoblastically.

Ans. The development of blastula is called blastulation. The types of blastulae greatly varies among different animals depending upon various factors such as the egg size, the amount and distribution of yolk, and the rate and pattern of cleavage. The various types of blastulae can be classified into four types: (i) stereoblastula, (ii) Coeloblastula, (iii) periblastula, and (iv) discoblastula.

(1) Holoblastically Formed Blastulae: In holoblastic embryos, the blastula is either solid (stereoblastula) or hollow coeloblastula).

(i) Steroblastula. This type of blastula is composed of densely-packed but larger sized and relatively small number of cells. Blastocoelic space in the centre is very small or virtually absent. The blastomeres in a stereoblastula may reach from the surface to the centre; or separate blastomeres may occupy the interior. Examples; Insects, some worms (e.g., Nereis) and some mollusks (e.g., Crepidula).

(ii) oeloblastula. This type of blastula consist of one or several layers of cells arranged around a large blastocoel. It is of two types:

(a) Adequal. The cells of the blastoderm of about the same size throughout. The blastocoel is centrally placed, e.g., echinoderms.

(b) Inequal: The wall of the vegetal half is thicker than that of the animal half. The blastocoel is reduced in volume and distinctly eccentric, i.e., displaced towards the animal pole, e.g., Amphioxus, amphibians.

Q.6 What is gastrulation and what are its features?

Ans. The events which transform a blastula into a gastrula are collectively called gastrulation. According to MeEwen (1923) gastrulation fefers to the formation of the primordial gastric or gut cavity, the process also involves the development of two of the three primoridial germ layers, referred to as the ectoderm (epiblast) and endoderm (hypoblast). The third layer called mesoderm (mesoblast) is derived from one of the other or both of the two layers; the endoderm is the inner layer; and the mesoderm is the middle layer.

Lankester (1875) and Hubrecht(1906) were of the opinion that the gastrulation is a process during which the single layered blastula is converted into a two-layered (e.g., Amphioxus) or three- layered (e.g., most vertebrates) embryonic stage called gastrula. During gastrulation, the cells are reorganized and rearranged. This arrangement of cells is brought about by very complex but co-ordinated movements and shifting of

positions of large masses of cells. According to Balinsky (1970) "The process of gastrulation involves involves displacement of parts of the early embryo. As a result the endodermal and mesodermal organ rudiments are removed from the surface of the embryo, where the presumptive material for these rudiments is to be bound in the blastula stage. These are then brought into the interior of the embryo, where the respective organs are found in the differentiated animal. Concomitantly, the single layer of cells, called blastoderm, gives rise to three germinal layers- the ectocderm, the endoderm and the mesoderm".

The Prominent Features of Gastrulation

1.Arearrangement of the cells of the embryo takes place by means of formative or morphogenetic movements.
2. The pace of cellular division is slowed down.
3. Growth, if any, is trifling.
4. The rate of oxidation is intensified and the type of metabolism changes.
5. The nuclei become more active in governing the activities of the embryonic cells.
6. The influence of the paternal chromosomes becomes clear during gastrulation.
7. New kinds of proteins, that were formerly not present in the egg begin to be synthesized.

Q.7 Define primary secondary, tertiary and quaternary organizers.

Ans. Primary Organizer: When Spemann transplanted portions of gastrulas other than the cells of he dorsall lip of the blastopore, no induction was seen. Only grafts taken from the dorsal lip of the blastopore and the adjoining parts of the marginal zone were found to be able to induce. It is the ability of the dorsal lip of the blastopore (future notochord and axial mesoderm) to cause, when transplanted, the fabrication of a total embryo that Spemann celled it organizer. Spemann gave the active region the name of organizer, meaning this was the part which organizes the process of development. He imagined the organizer as initiating the process of morphogenesis and differentiation by inducing the formation of the neural tube. The latter then might induce the development of still other embryonic structures like eye, ear, etc. The interaction of the grafted dorsal lip of the blastopore (chrdo-mesoderm) and the overlying ectoderm is the first stage of interacting system in the induction process. The dorsal lip of the blastopore, therefore, is called the primary organizer. The organizer of the gastrula is that region of the egg that coincides with the gray crescent before the beginning of cleavage.

Secondary, Tertiary and Quaternary Organizers.

As gastrulation proceeds, the various organ systems of the embryo are laid down under the influence of the primary organizer and they themselves then acquire the power of including later formed structures to develop. These, in turn, develop organizing properties and so on. It is thus possible to recognize a series of secondary, tertiary and quaternary organizers, which are arranged in a sort of hierarchy at whose summit is the primary organizer. It follows, therefore, that one embryonic tissue layer

interacts with an adjacent it to develop in a particular way. This developed tissue then interacts with another tissue in turn and induces it to develop. In other words, progressive development takes place by sequential induction. One tissue provides the stimulus for the development of the next.

Q.8 What is nature of induction?

Or

Introduce the nature of induction.

Ans. Soon after Spemann's discovery, it was found that the inducing properties of the organizer (dorsal lip of the blastopore) were retained even if the cells were killed by various means by boiling, by treating with alcohol or petrol ether, by freezing or by dessication. When implanted into a living embryo, it was found that a killed organizer can still induce (Bautzmann, Spermann and Mangold 1932). It indicated that the vital activity of the organizer is not essential for induction. Probably, the roof of the archenteron produces its effect by liberating some chemical substance which is the immediate causes of induction. It is acceptable that such a substance could be liberated even from dead tissues. Waddington, Needham and Coworkers concluded that this natural inducing substance is a steroid. Arey (1966) called it an evocator.

Abnormal inductors and induction by substances of known chemical substance. It has been found that not only the chordo-mesoderm but also a wide variety of tissues like liver, kidney, muscles, gut and skin etc. are able to produce induction. Induction can also be performed by tissues of various animals belonging to different phyla of the animals kingdom. For example, the tissues of Hydra, insects, fishes, reptiles, birds and mammals were found to be effective as inductors of newt. Neural inductions may result from such an unlikely agents as methylene blue or a mechanical irritant such as sillicious earth. Some worker have presented evidence that ribonucleoprotein, i.e., a complex of RNA and protein may have inductive properties. Besides, a number of weak organic acids are good inductors. These include muscle adenylic acid (AMP), thymonucleic acid (DNA), dithydroxystearic acid, linolenic acid and stearic acid.

Long Answer

Q.1 Describe patterns of cleavage in detail.

Ans. During segmentation, the cleavage furrows are not formed at random .

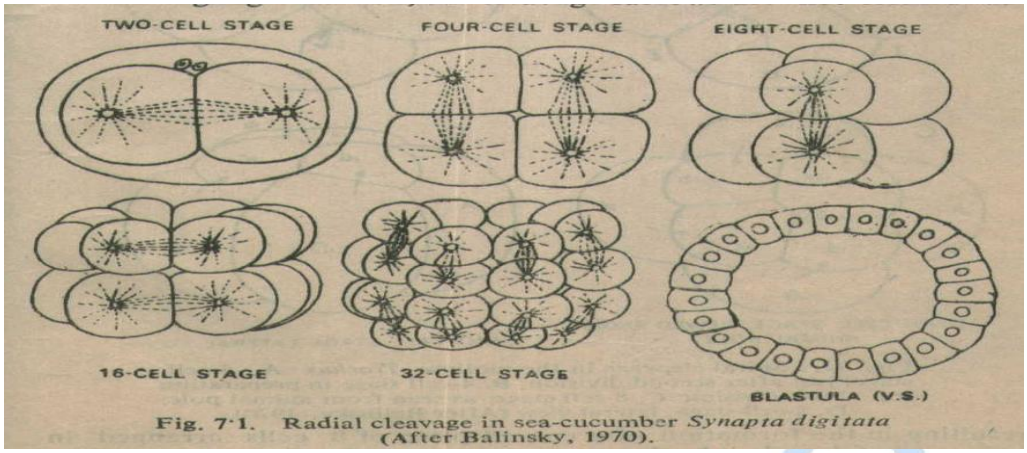


Fig. 7·1. Radial cleavage in sea-cucumber *Synapta digitata* (After Balinsky, 1970).

but are oriented in a particular with reference to the main (animal-vegetal) axis of the egg. The orientation successive cleavage furrows with respect to each other and to the main axis of the egg is, however, unlike in different species. As such, various patterns of cleavage are found among animals. Based upon symmetry, four patterns of cleavage have been recognized. They are radial, biradial, spiral and bilateral.

1. **Radial Cleavage** – In this cleavage pattern, divisions take place in such a manner that all the blasters are placed in a radically symmetrical fashions around the polar axis. When such an egg is viewed from the poles, the blasters seem to be arranged in a radically symmetrical form. Example: Sponge, coelenterates, sea urchin, sea **cucumber, Amphioxus.**
2. **Biradial Cleavage**- This pattern of cleavage is found in ctenophores like Beroe. Four blastomeres arise by the usual two meridional cleavages. The third

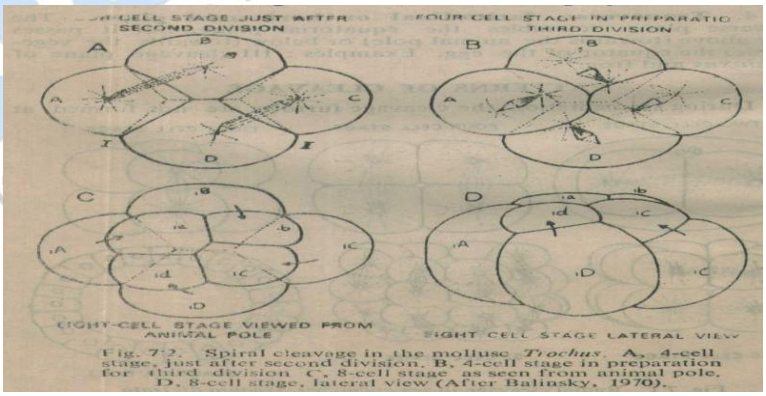


Fig. 7·2. Spiral cleavage in the mollusc *Trochus*. A, 4-cell stage, just after second division. B, 4-cell stage in preparation for third division. C, 8-cell stage as seen from animal pole. D, 8-cell stage, lateral view (After Balinsky, 1970).

Cleavage plane is vertical resulting in the formation of a curved plate of 8 cells arranged in two rows of a curved plate of 8 cells arranged in two rows of 4 each. In these rows, the central cells are larger than the end ones.

3. **Spiral Cleavage** – The spiral cleavage is diagonala to the polar-axis. In this type, the spindles for the third cleavage, instead of being erect, are oriented diagonally so that the rsuolting upper tier of cells is displayed sidewise. The ;upper 4 cells are placed over the junctions between the four lower cells. The upper smaller cells are called lmicro-, and lower larger cells are known as micrometers. The spiral cleavage results due to

oblique positions of the mitotic spindles. This type of cleavage is called the spiral type because the four spindles during the third cleavage are arranged in a sort of spiral.

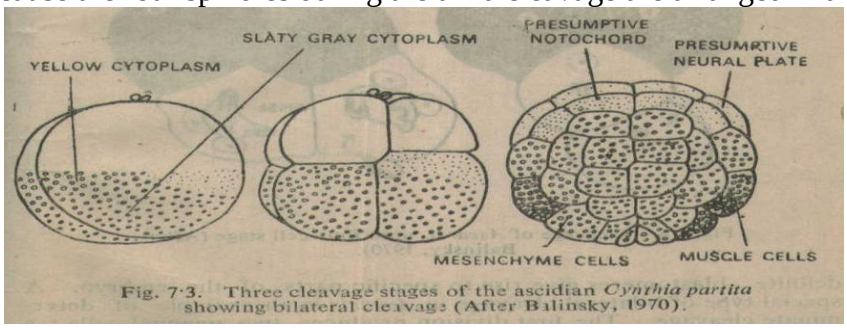


Fig. 7·3. Three cleavage stages of the ascidian *Cynthia partita* showing bilateral cleavage (After Balinsky, 1970).

The turn of the spiral as seen from the animal pole may be in a clockwise direction (dextral) or in a counterclockwise direction (sinistral). Moreover, the spindles are alternatively titled obliquely to the dextral and sinistsral directions, so that successive generations of blarometres are oriented in a twisted fashion.The pattern of cleavage characterizes the egg of annelids, mollusks, nemerteans and some of the planarians.

4. **Bilateral Cleavage** – In this pattern cleavage, the blasters are so arranged that the right and left sides becomes distinct. This cleavage pattern is dependent upon differences in the size of the blasters. In this case, two of the first four blastomeres may be larger than the other two, thus establishing a plane of bilateral symmetry in the developing embryo. Subsequent cleavages may make the bilateral arrangement of the blasters still more obvious. Examples are nematodes, cephalopod molasses, some echinoderms and tunicates.

Q.2 Describe the types of cleavage.

Ans. The major types of cleavage have been distinguished on the basis of the among and distribution of yolok in the egg. They are (I) holoblastic, and (ii) meroblastic cleavage.

(1) **Total Or Holoblastic Cleavage** – In order or complete cleavage, the entire egg divides by each cleavage furrow, it is of two types :

(i) **Equal Holoblastic Cleavage** – When the daughter blastomeres are approximately of the same size, the total cleavage is called equal holoblastic cleavage. It occurs in microlecithal and isolecithal eggs, e.g. sponges, echinoderms, lower chordates-tunicates, Amphioxus, mqarsupial and eutherian mammals.

(ii) **Unequal holoblastle cleavage** – If the daughter blastomeres are unequal in size, the complete division of the egg is referred to as unequal holoblastic cleavage. This is the case with the mesolecithal and teolecithal eggs of cyclostones, elasmobranch fishes, Dipnoi, amphibian and cephalopod mollusks. In these eggs the third cleafvage gives rise to four small and four large blastomeres. The smaller blastomers are called micrometers and the larger ones macro-or megamers.

(2) **Partial or Meroblastic Cleavage** –In Partial, incomplete or meroblastic cleavage, the division ;furrows divide only a small amount of active cytoplasm on the periphery ;remains undivided. This cleavagetakes place in macro-or polylecithal eggs, and may be of the following two types:

Superficial meroblastic cleavage of an insect,
Hydrophilus a beetle (After Balinsky, 1970)

(i) Superficial Cleavage – This type of incomplete cleavage is found in centralecithal eggs, e.g. insects and many other arthropods. At the beginning of cleavage the nucleus (sknkaryon) located in the centre of the yolk divide repeatedly. Then the daughter nuclei start moving away from the center of the egg.

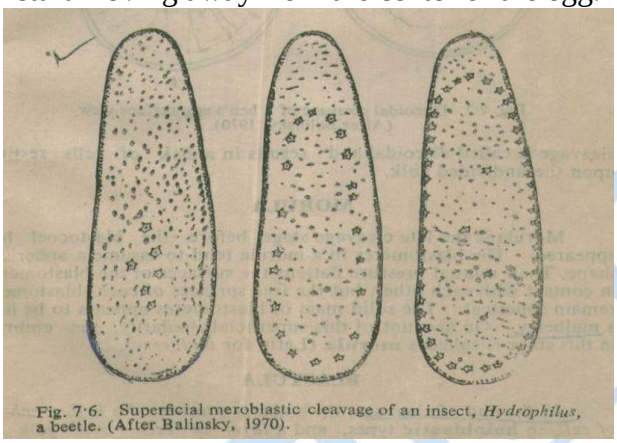


Fig. 7·6. Superficial meroblastic cleavage of an insect, *Hydrophilus*, a beetle. (After Balinsky, 1970).

Then the daughter nuclei start moving away from the center of the egg. Each nucleus ;remains surrounded by a small portion of the original central cytoplasm. When the nuclei reach the surface of the egg, the cytoplasm surrounding them fuses with the superficial layer of cytoplasm surrounding them fuses with the superficial layer of cytoplasm. Later furrows going inward from the surface subdivide the cytoplasm. In this way, a layer of superficial or peripheral cells surrounds ;an undivided central yolk mass.

(ii) Discoidal Cleavage – In the large; yolky macrolecithal eggs of elasmobranches, bony fishes, birds, reptiles and egg-laying mammals, the cleavage remains restricted to a disc-shaped area of active cytoplasm, the blastodisc, at the animal pole. The remaining yolk-filled part of the egg shows no division.

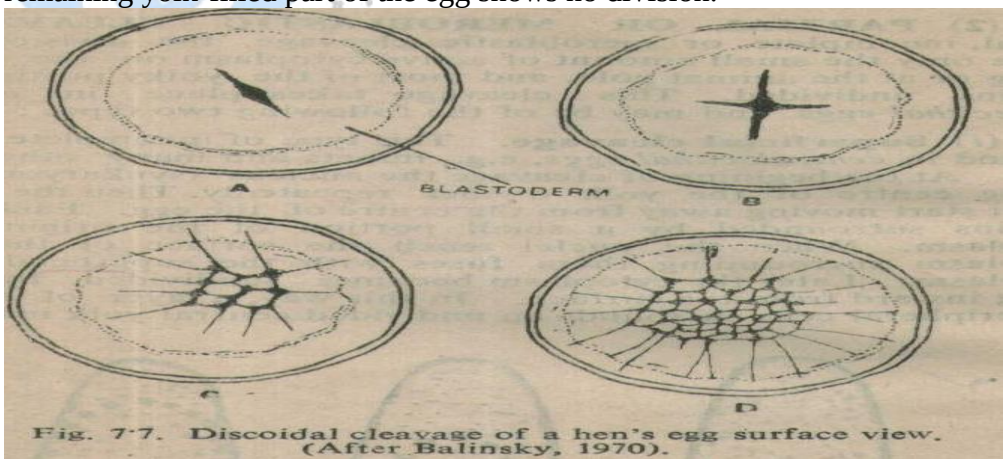


Fig. 7·7. Discoidal cleavage of a hen's egg surface view. (After Balinsky, 1970).

such incomplete cleavage is called discoidal and results in a disk of cells resting upon the undivided yolk.

Morula –

Morula is the late cleavage stage before the blastocoel has appeared. The balstomeres in a morula tend to assume a spherical shape. Their mutual pressure flatters the surfaces of the blastomeres in contact with eqach other, but the free surfaces of each black were remain spherical. The solid mass of blastomeres appears to be like a mulberry. On account of this superficial similarity, the embryo in this stage is called a monula (Latin for mulberry).

Blastula – At the end of cleavage, the embrayo consists of a hollow sphere of cells I n holoblastic type, and a layer of cells over yolk in meroblastic types. This developmental stage is called a blastula. The layer of cells is known as the blastoderm and the cavity is the blastocoel. At first, the blastocoel may be represented, just by narrow crevices between the blastmeres, but it gradually increases as the cleavage goes on. The blastocoel may be identified in the 8-cell stages as the space enclosed b y the two quarters of blastomers.

Q.3 Describe processes involved in gastrulating.

Or

What do you mean by morphogenetic movement?

Ans. Gastrulating is essentially a process of movement of parts of the embryo. As a result of these movements new structural elements e.g., the archenteron, the neural tube and the notochord, are created in place of the simple layer of cells found in the blastula. The cell movement during gastrulating created new shapes, new forms in the embryo. They have been, therefore, designated as the morphogenetic movements.

Morphogenesis (Greek morphed, shape; genesis, production) literally means the origin and development of new form. The gastrulating movements are irreversible in nature i.e., each part remains in the position into which it has been brought by the preceding movement.

In the majority of animals, the regions of the blastula which will give rise to the germ layers are already determined on its surface, as revealed by studies of organ-forming zones. Therefore, gastrulating must involve an exteriorization of the endoderm and mesoderm-forming zones. Exteriorization of the endoderm forming regions occurs first, by either or both of two general processes:

(i) epiboly and (ii) emboly.

1. EPIBOLY

The term amphiboly is deriving from Greek meaning 'throwing on' or "extending upon". This morphogenetic movement involves overgrowth of the ectoderm forming regions around the endoderm forming regions. Amphiboly is characterized by a rapid proliferation of cells in the animal half and concomitant spreading of this enlarging sheep of cells over the vegetal half. It merely involves the gradual growth of the blastopral lip over the yolk, or the yolk filled vegetal cells. The movement takes place not due to any actual process of stretching, but on account of active cell division in the overgrowing layers. This activity is most intense in the

region of the blastoporal lip. The epibolic movement is enhanced by surface-tension changes which produce a crawling of the cellular rim over the yolk.

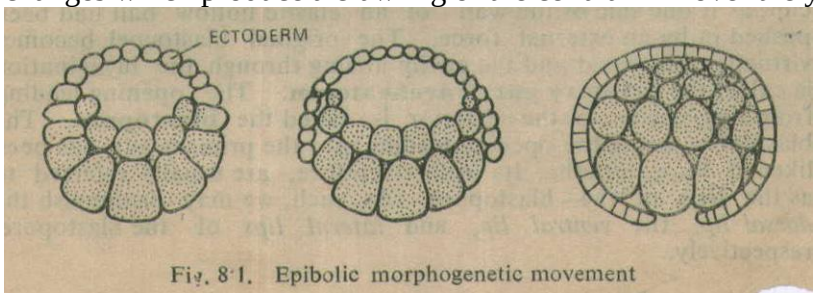


Fig. 8·1. Epibolic morphogenetic movement

Amphiboly of ectodermic blastomers (epidermal and neural areas) has been observed most typically in the development of eggs possessing a bund any yolk. In the rounded blastulae of amphibians, the prospective ectodermic cells spread over the inwardly moving presumptive notochord, mesoderm and endodermal blastomeres. In flattened blastulae of tallest fishes, reptiles and birds, episodic movement take place in the form of anteroom-posterior extension, associated with migration and expansion of the ectodermic blastomeres on the peripheral region.

2. EMBOLY

The term emboli are also derived from Greek meaning 'throw in' or 'thrust in'. This morphogenetic movement involves in growth of the endoderm forming-regions under the ectoderm-forming region. Stating simply, it is the movement of chorda-mesodermal and endodermis blastomers from the external surface of the blastula to the interior of the embryo.

The inward formative movement of prospective chordamesodermal and endodermis blastomers in different groups of vertebrates may occur by following methods.

(i) Invagination- The simplest method of gastrulating is by imagination. The movements of "in folding" or "inward bending" of the endoderm and mesoderm are known as invigilation. In this process, the vegetal half of the blastula is pushed in or invigilated until it almost touches the animal half opposite to it. Thus, a simple spherical body becomes converted into a double walled cup, as if one side of the wall of an elastic hollow ball had been pushed by an external force. The original blastocoels become virtually obliterated and the cavity arising through the invigilation is called the primary gut or archenteron. The opening leading from this cavity to the exterior is called the blast or pore. The blast or pore, being the opening leading into the primary gut, has been likened to the month. It s rims, there fore, are usually referred to as the lips of the blast or pore. As such, we many distinguish the dorsal lip, the ventral lip, and lateral lips of the blast or pore, respectively.

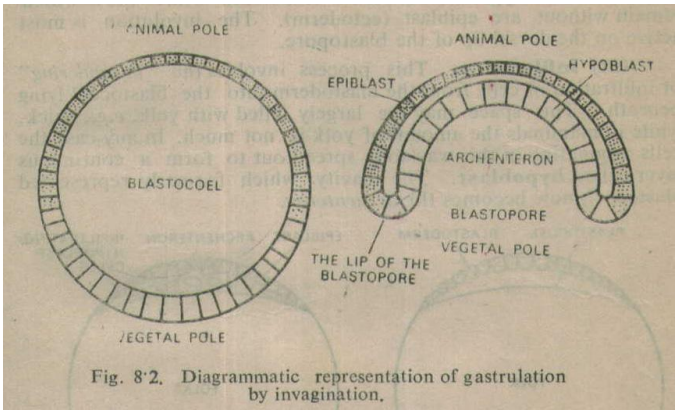


Fig. 8·2. Diagrammatic representation of gastrulation by invagination.

The archenteron is lined by the original vegetal cells which give rise to endoderm and mesoderm, the part of the gastrula that remains on the surface becomes ectoderm;

(ii) Involution or inflection- The term involution means a "tuning in" or "rolling under" or chorda-mesodermal cells along the blastoporal lip. It is very common among the vertebrates and is after accompanied with invagination.
The blastocoels is greatly reduced in eggs that gastrulated by involution. At some point on the edge of the blastoderm the dividing cells begin to be turned over the blastoporal rim, i.e., involutes in the blastocoels.

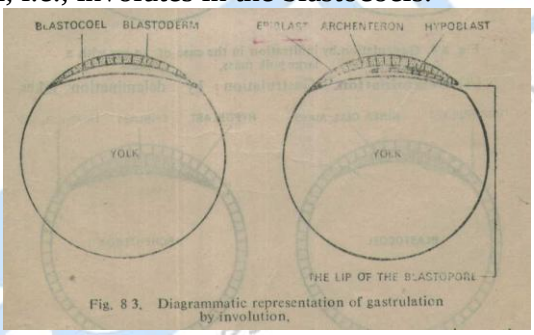


Fig. 8 3. Diagrammatic representation of gastrulation by involution.

As a result, the cells located on the external margin of the blastoporal lip, rollover the lip and are brought to the inside edge of the lip just beneath the ectodermic blastomers. These inturned cells then constitute the hypoblast (chord-mesoderm) while those which remain without are epiblast (ectoderm). The involution is most active on the dorsal lip of the blast o pore.

(iii) Infiltration- This process involves the "in wandering" or infiltration of cells from the blastoderm into the blastocoels lying beneath. This space may be largely filled with yolk, e.g., chick, while in mammals the amount of yolk is not much. In any case the cells originating in this way soon spread out to form a continuous layer called hypoblast. The cavity which formerly represented blastocoels now becomes the archenteron.

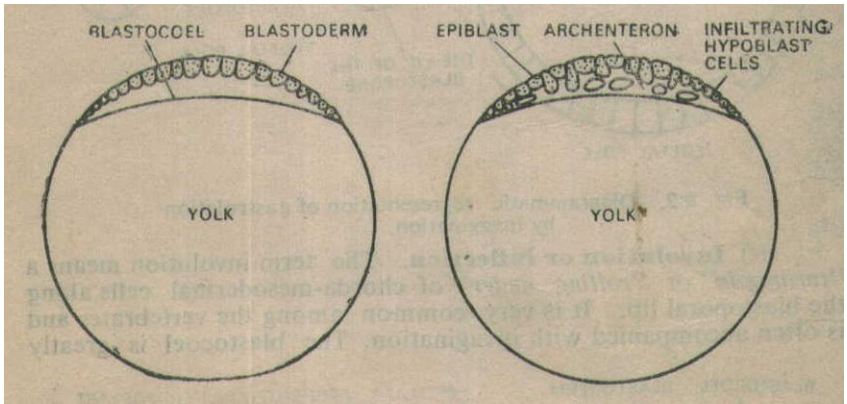


Fig. 8·4. Gastrulation by infiltration in the case of an egg with a large yolk mass.

(iv) Delamination- Gastrultion by delaimination takes place most typically in mammals and to some extent in amphibians and brids. The process consists simply in the separation or "splitting off" the cells from a pre-existing layer. These cells then untie together to form the hypoblast.

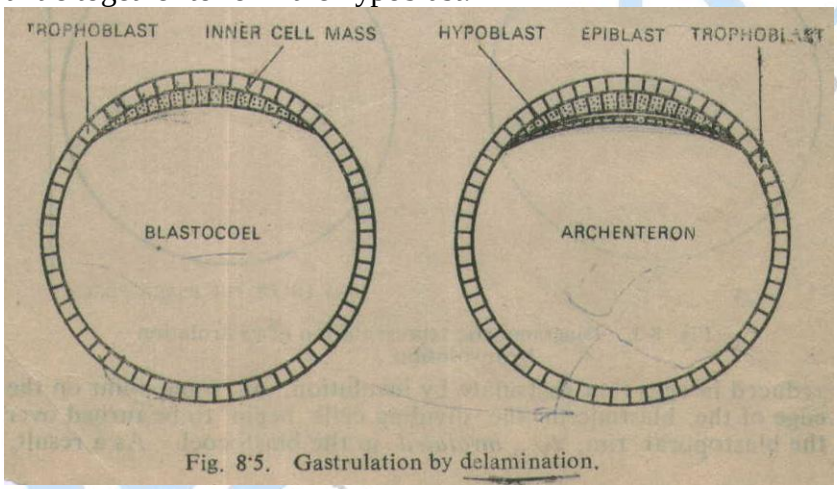


Fig. 8·5. Gastrulation by delamination.

(v) Concrescence- There is a gradual drawing together of the blast o pore lips during epiboly with the result that the blast o pore is continuously diminished in size. However, in the course of this procedure, there is no thickening of the lips as their circumference decreases. This fact may be explained by assuming that much of the material which blastoporal lips contain is required to form the germ layers. It was thought, therefore, that during the course of gastrulat ion two sides ofteh blastoporal ring "flow" together at a certain point upon the margin of the blastoderm. This movement is, therefore, designated as confluence or concrescence. According to this theory, it was believed that each side the blastoporal ring forms a lateral half of the axial structure of the embryo. This theory was specifically to telolecithal eggs with large quantity of yolk.

(a) Surface view of the blastoderm at the beginning of the gastrulation.

(B) Surface view of the same near the completion of gastrula ion. Most of the marginal material indicated by alphabets moves toward the median line and the dorsal

blastoporal lip of the future embryo some of the marginal material represented by alphabets A & B "turns in over the dorsal blastoporal lip. The material, thus involutes, becomes "invisible" as shown by tese alphabets in dots.

(vi) Convergence – This refers to the movement of groups of cells from each entire posterior half of the blastoderm toward the median line forming the axial structures of the embryo.

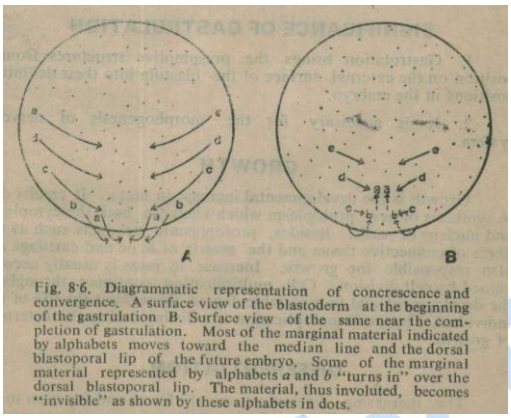


Fig. 8·6. Diagrammatic representation of concrescence and convergence. A surface view of the blastoderm at the beginning of the gastrulation B. Surface view of the same near the completion of gastrulation. Most of the marginal material indicated by alphabets moves toward the median line and the dorsal blastoporal lip of the future embryo. Some of the marginal material represented by alphabets *a* and *b* "turns in" over the dorsal blastoporal lip. The material, thus involuted, becomes "invisible" as shown by these alphabets in dots.

(vii) Ingression- It is the "Inward migration" of mesendoderm-forming cells from the external layer of the blastula or blast disc into the blastocoels. Gastrula ion by invigilation was described by Pastels (1945) in reptiles, birds and eutherian mammals

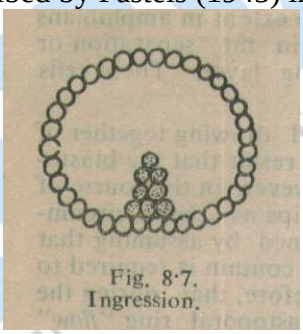


Fig. 8·7. Ingression.

(viii) Extension or elongation- It refers to the extension of cellular masses in the antero-posterior axis during gastrulation. The elongation of the presumptive neural plate, and of the notochord, mesoderm and endodermic materials after they gather up beneath the neural plate, are examples of extension. Extension or elongation is a prominent procedure during gastrulation of all chordates.

(ix) Constriction- This term is used with reference to the convergence of cells areas which results in the gradual closure of blast o pore. It occurs in frog's egg of gastrulation and is due to a narrowing of the marginal zone and a pull of the dorsal lip.

SIGNIFICANCE OF GASTRULATION

1. Gastrulation brings the presumptive structures from a position on the external surface of the blastula into their definitive positions in the embryo.
2. It is necessary for the morphogenesis of nervous system.

Q.4 Describe development of; chick according to the hours of incubation.

Ans. Summary of the condition at the end of the first day of incubation (4 Somite stage)

Gastrulation is over by the end of the first day of incubation. The developments completed by this period are summarized below :

1) The dark peripheral area opaca and central translucent cleaqr area pellucide are distinctly ;visible.
2) A Primitive streak with a primitive groove bound by primitive folds runs in the middle of the posterior half of the area pellucida.
3) At the anterior end of the primitive streak is present a thickening, the Hensen's node or primitive knot having a small depression in center which is called the Hensen's pit.

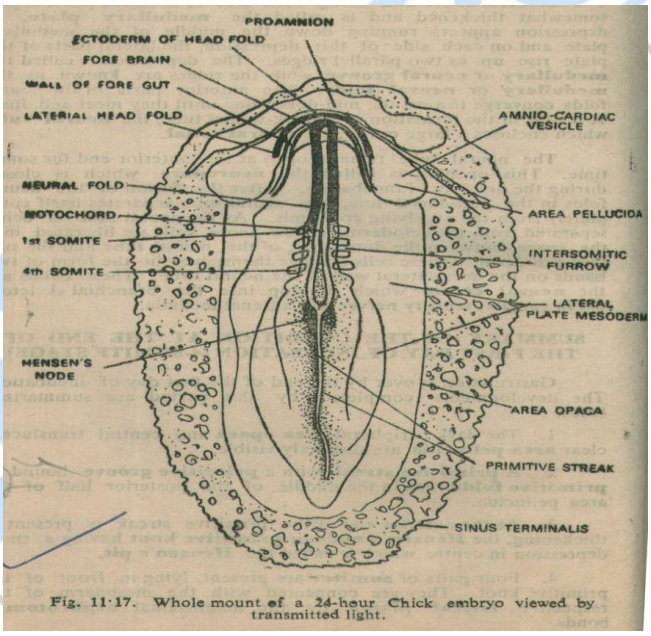


Fig. 11·17. Whole mount of a 24-hour Chick embryo viewed by transmitted light.

4) Four pairs of somites are present, ly ing in front of the primitive knot. They are connectd with the mesoderm of the respective lateral plates by the longitudinal nephroto mal bonds.
5) The neural folds have appeared in the region in front of the primitive knot. They had fused for a short space at their anterior ends forming the neural tube. The first part of the neural tube represents prospective forebrain.
6) In the anterior most part of the embryo, the ectoderm has given rise to the head ;fold.
7) The endoderm underlying the ectoderm is also transformed into a pocket like structure, the forgut.

8) Beneath the fore-gut, the walls of the amino-cardiac portions of the coelom meet each other at the end of 24 hours. These represent the rudiment of the pericardial cavity.
9) Proamnion is a small and comparatively more translucent region of the area pellucida lying in the anterior region. It lacks mesoderm.
10) Blood Vessels and corpuscles have started to appear to the inner part of the area opaca, transforming it into the area vasculosa. The latter is beginning to be bounded by a blood vessel, the sinus terminalis.

II, 48 Hours Chick Embryo (25 Pairs of Somites)

1. Flexures – The embryo at this stage is like an inverted T. this shape is due to two bending or flexures in the h ead ;region of the embryo. One of the bending called flexure lies at the level of the mesencephalon. By this flexure the anterior regtion of the brain is directed backwards. The second flexure, called cervicala flexure is seen at the level of rhombencephalon. On account of these bending, a transverse section of the embryo at the anterior and exhibits two neural tubes, two notochords and two foreguts.
2. Torsion – Former to this stage, theembryo lies with its ventral surface in contact with the yolk. But now the mbryo is partially turned with the result that the anterior of the body is twisted to the right side. This process of twisting of the entire embryo along the antero-posterior axis is referred to as torsion. This is quite apparent in somites 10 and 11.
3. Nervous system –The neural folds have met along the mid-dorsal line and the neuropore is closed. The brain is differentiated into three distinct divisionsl, namely, prosencephalon, mesencephalon the rhombencephalon.
4. Eye – The optic vesicle invaginates to form optic-cup. The ectoderm facing the optic vesicle thickens to form a lens.
5. Ear – There are two auditory vesicles, one each side of the hind brain. In this stage, the mouth of the auditory vesicle is seen to be reduced to a small aperture.

6. Heart – The heart is tubular in shape. It has two auricles, a distinct ventricle and truncus arteriosus. Two aortic arches are present. Vitelline arteries lie between somites eighteen and twenty.
7. Alimentary Canal – The foregut is well formed and shows three divisions viz, the premolar gut, pharynx and the esophagus.
   The phrynx develops three pairs of lateral outpocketings called visceral pouches. These are separated from each other by solid bars known as bronchial arches. The pharynx is closed membrane.
   The hind gut begins to appear.
8. Excretory System – The pronephric tubules and ducts develop but they are solid in nature and hence non-functional. The mesonephric tubules begin to appear.

9. Foetal Membranes – The somatopieure grows over the head as folds to form the amnion and chorine. The seroamnictic connection becomes thin.
10. Tail bud – It begins to develop posterior to the hindgut.

1. Flexures- In addition to the cranial and cervical flexures which were formed in the 48 hours embryo, two more new flexures appear. These are : (a) dorsal flexure in the lumbar region and (b) caudal flexure in the tail region. Caudal flexure causes tail to be at an angle of 90^0 to the body.

   As a results of flexure, the embryo acquires a typical shape of the mirror image of a question mark (?).
2. Torsion – The process of torsion continues throughout the development of the embryo as a result of which the entire embryo lies on its left side on the yolk.
3. Nervous system – The regions of the braie are well demarcated. LThe cerebral hemispheres bulge outwards, the wall of the mesencephalon thickens to form crura cerebra and the corpora quadrigermina develop in the roof of the mesencepasion.

   The posterior end of the brain passes into the spinal cord.
4. Sense of Organs – Two olfactory pits lie near the tip of the head. The eyes exhibit well developed optic cup and lens. Due to flexure, they lie well posterior to the ears. The auditory vesicle is pear-shaped ;with a narrow ductus endolymphaticus.
5. Heart – The heart is S-shaped the vascular area develops extensively and almost covers the yolk.
6. Alimentary Canal – The mouth forms by rupturing of the oral plate. Four pairs of visceral pouches are formed in the pharynx. An invagination in the floor of the pharynx develops into thyroid gland. Midgut is still incomplete. The hind gut terminates in a tail gut. The latter begins to degenerate in the hours to follows.
7. Excretory System – Pronephric tubules start degenerating. Mesonephric duct increases in length and acquires connection with cloaca.
8. Foetal Membranes – Amnion and chorion are well developed. Allantoid develops as outgrowth from the hindgut of the embryo. Yolk sac encloses about half of the yolk.
9. Limb buds – The anterior and posterior limb buds are quite prominent and begin to exhibit nipple-shaped spices.

Q.5 Describe development and function of following

1. Yolk Sac
2. Amnion
3. Chorion
4. Allantois

Ans.

1. Yolk Sac

Development: In reptiles and birds the someatopleure and splanchnopleure develop from the periphery of the blasto disc which is differentiated as the area opaca. These gradually

spread peripherally over the yolk mass. Soon afterwards, the embryo begins to be undercut by a series of folds which appear all around the body of the embryo. The folds involve all three germ layers, i.e., the ectoderm, the mesoderm and the endoderm. Directed downward and inward, these are known as the body folds.

The extra embryonic splanchnopleure (splanchnic mesoderm+ Endoderm) continues to spread over the yolk mass and as a yolk sac eventually encloses the mass of yolk in a large measure. The yolk sac, however, never surrounds the yolk fully. A small passage is left on the ventral side for the embryo to absorb the remains of albumen at a later stage.

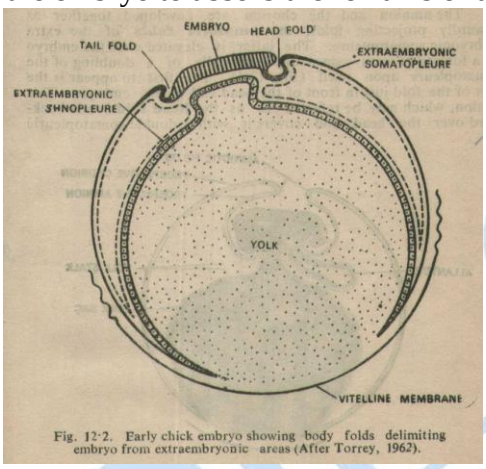


Fig. 12·2. Early chick embryo showing body folds delimiting embryo from extraembryonic areas (After Torrey, 1962).

Coincidently with the formation of the yolk sac, the intra embryonic splanchnopleure is subjected to folds resembling with the more superficial body folds. The intra-embryonic folds give rise to a walled digestive tract, or gut, in the body of the embryo. The middle of the embryonic gut remains open to the yolk beneath. At this level the yolk sac is connected to the digestive tract by a constricted yolk stalk.

The wall of the yolk sac is thrown into folds on its innor surface that pentrate the yols mass. These folds are known as the side yolk sac septa. A system of blood vessels is developed in the walls of the yolk sac, entering the heart by means of a pair of viteline veins.

Functions

The function of yolk sac is to digest the yolk and to transfer the products of digestion to the embryo. Digestion is brought about through the mediation of appropriate enzymes secreted by the endodermic cell lying in contact with the yolk, particularly at the yolk sac septa. Although the yolk sac is connected to the digestive tract by the yolk stalk, the yolky food is not transported to the embryo by this route. Instead, the products of yolk digestion are picked up and carried to the embryo by the Vitelline veins running in the mesoderm of the sac.

2. AMNION AND 3. CHORION DEVELOPMENT

The amnion and the chorion are developed together as upwardly projecting folds, the amniotic folds of the extra embryonic somatopleure. The latter is elevated over the embryo by a folding process consisting essentially of a doubling of the somatopleure upon itself. The first to appear is the part of the fold just in front of the head end of

the embryo. This section, which may be referred to as the head fold bends backward over the head and covers it with a double somatopleuric hood. Now the lateral ends of the fold are prolonged backward along both sides of the embryo. The lateral folds come near each other over the body of the embryo and fuse from the front end backward, so that more and more of the embryo becomes covered by the folds. Eventually, a tail fold also develops behind the embryo. All these folds finally converge so as to encase the embryo in two sheets of somatopleure. The inner somatopleuric sheet becomes the amnion, the outer, and the chorion. The point where the head and tail folds meet is called the sera-amniotic connection. It lies somewhat behind the middle of the embryos body.

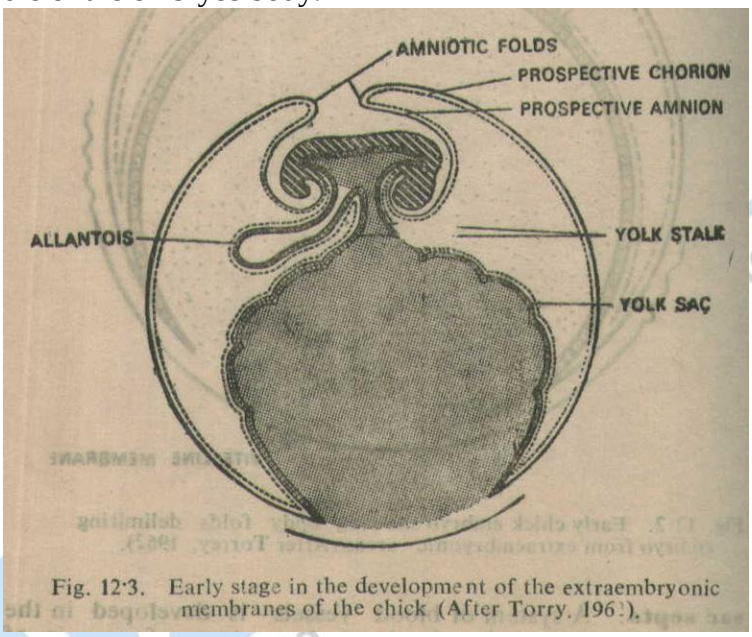


Fig. 12·3. Early stage in the development of the extraembryonic membranes of the chick (After Torry, 196).

The amnion consists of a layer of extraembryonic ectoderm on the inside and a layer of extra embryonic somatic mesoderm on the outside. The chorion is made up of a layer of extra embryonic ectoderm on the outside and a layer of extra embryonic somatic mesoderm on the inside. The latter is however, continuous with the ectoderm and splanchnic mesoderm covering the yolk sac. The cavity between the amnion and embryo is termed the amniotic cavity. In between the amnion and the chorine cavity or extra embryonic coelom, which is continuous with the coelom, which is continuous with the coelomic cavity in the embryo proper.

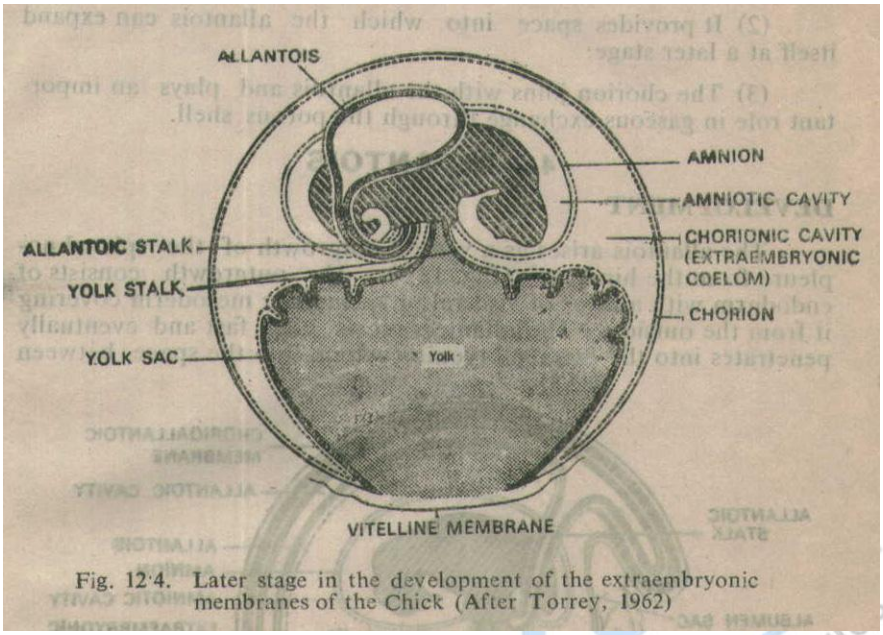


Fig. 12·4. Later stage in the development of the extraembryonic membranes of the Chick (After Torrey, 1962)

Function of Anmion

1. The primary function of the amnion is to protect he embryo from desiccation. The embryo gets a special advantage by the development of a fluid-filled amniotic cavity. It becomes immersed in a container filled with fluid and thus can carry out its development in a fluid mecum, although the egg is placed on "dry land".
2. Muscle fibers differentiate within the mesoderm of the amnion. The amnion with its muscle fibers and contained fluid serves as an efficient shock absorber. It protects the embryo from mechanical shock resulting from the possible violent agitations of the whole egg caused by incubating hen sitting on it.
3. The amnion separates the embryo from the shell of the egg. Thus it protects it from adhesion to the shell or from friction against it.

Function of Chorion

1. The fluid of the chronic cavity, which is also called the extra-embryonic coelom, provides further protection to the embryo.
2. It provides space into which the allantoises can expand itself at a later stage.
3. The chorion joins with the allantois and plays an important role I gaseous exchange through the porous shell.

4. ALLANTOIS

Development

The allantois arises as a ventral outgrowth of the splanchnopleure from the hindgut. (Fig.) the outgrowth consists of endoderm with a layer of visceral or splanchnic mesoderm covering it from the outside. The allantois grows very fast and eventually penetrates into the extra-embryonic coelom, into the extra-embryonic coelom, into the space between the yolk sac, the amnion and the chorine. The proximal part of the

allantois forms a narrow neck or the allantoic stalk with which it remains connected with the hindgut of the embryo.

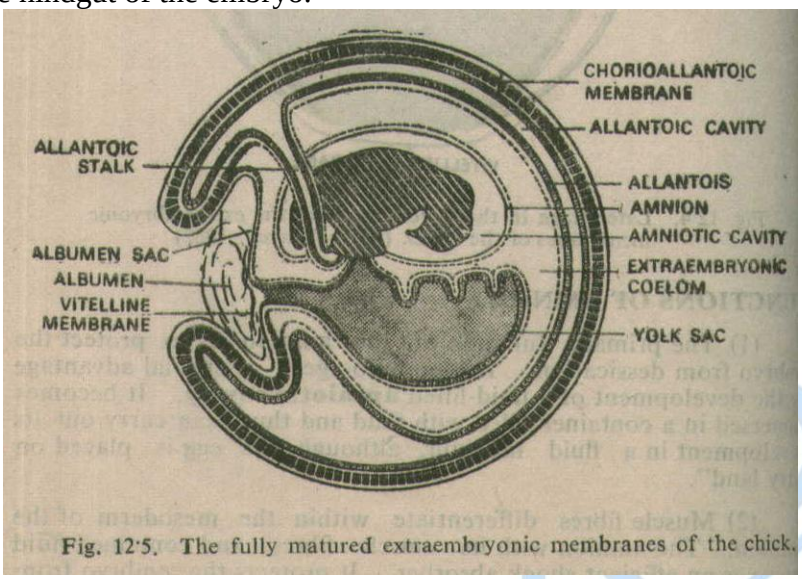


Fig. 12·5. The fully matured extraembryonic membranes of the chick.

The distal part of the allantois expands and penetrates between the anminon and the yolk sac on one side and the chorion on the other side. By the middle of the incubation period, the allantois spreads all around the egg underneath the chorine.

The mesoderm on the external surface of the external surface of the allantoises fuses with that of the chorion forming a conjoined chorioallantoic membrane. Actually, it consists of three layers:

(i) Ectoderm on the outside.

(ii) Mesoderm (splanchnic layer of allantois +somatic layer of chorion) in the middle.

(iii) Endoderm on the inside.

(iv) The chorioallantoic membrane gets pressed against the porous shell. It becomes highly vascular by developing allantois circulation.

Functions

(i) The cavity of the allantois serves as a urinary bladder. It stores the protein breakdown products in the form of water-insoluble crystals of urinc acid inside the egg up to the time of incubation, the allantois increases to enormous proportions.

(ii) The vascular "choriaoallantoic membrane lies in a close proximity to the inner surface of the porous shell. It acts as an extra-embryonic lung by supplying the embryo with oxygen. Gaseous exchange takes place between the blood circulating in the chorioallantoic membrane and the external air through the porous shell. A network of blood vessels develops in this membrane and this network is in communication with the embryo proper by means of blood vessels running along the allantois stalk. The allantois circulation is continued till the chick breaks the egg shell and begins to breathe the air.

(iii) Together with the chorion, the allantois also surrounds the albumen to form the albumen sac and thus assists in the absorption of nutritionally rich albumen.

Q.6 Describe the types of placentae in mammal.

Ans A Mammalian placenta typically is a structure produced by the apposition or fusion of the extra embryonic membranes with the endometrium of uterus for the purpose of physiological exchange. It, therefore, follows that the placenta from the point of view of its origin, consists of to parts a foetal placenta, furnished by the extra embryonic membranes and a maternal placenta, furnished by the uterine endometrium. Usually, the trophoblast cells of mammalian embryo remain specialized for interaction with the uterus.

Now it would be obvious that while on the material side a single component, the endometrium is involved; on the foetal side chorium yolk sac and allantois. The first of these, the amnion, may be ruled out immediately, as it is making no direct contribution to the placenta. This laves the other three, of which the chorion, because of its most extermal position, its membrane making immediate contact with the endometrium. But, we have seen in chick embryo that the chorion plays its role by way of a vascular supply, which it acquires from the allantois. In mammals, there are two possible sources of chorionic vascularizaiton- the vitelline circulation provided by the yolk sac and allantoic circulation provided by the allantois. Thus, it can be said that in mammals, there exist two essentially different main types of placenta, the chorio-vitelline placenta and the chorio-allantoic placentas.

A. Chorio-vitellineplacenta

In some mammals notably some marsupials (Didelphys Macropus) the allantois remains relatively small and never makes contact with the chorion, whereas the yolk sac becomes very large nad tets fused broadly with the chorion. In these forms the chorion gains its blood supply from the network of vitelline blood vessels of yolk sac such a placenta is called yolk sac placenta or chorio vitelline placenta. In such a foetal placenta the chorion never advances beyond a smooth membrane in close apposition with the vascular uterine lining the endometrium.

B. Choio-Allantoicplacenta

In some marsupial (e.g. Caramels, Dasyures), and all Lutherans the yolk sac remains rudimentary and the allantoids becomes well developed and vascularized to fuse with chorion and to furnish the latter the blood supply.

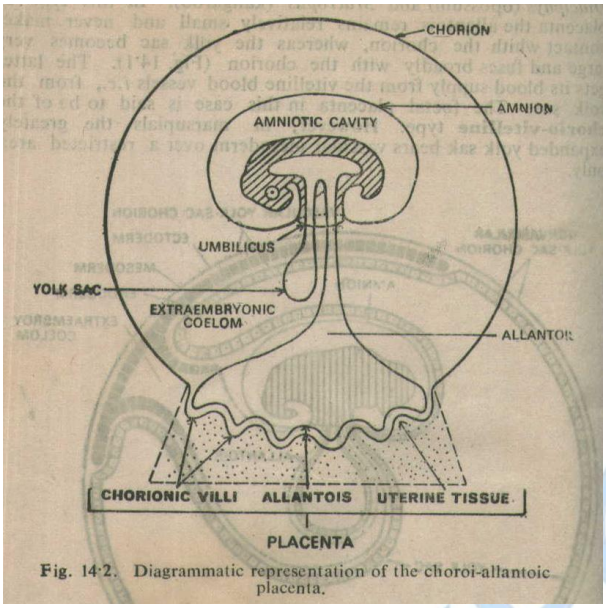


Fig. 14·2. Diagrammatic representation of the choroi-allantoic placenta.

Such a foetal placenta is called chorioallantoic placenta. In this kind of placenta, the chorion is not smooth but bears root-like vascular processes, the villi, which grows out from the chorion into the adjacent maternal tissue. The chorioallantoic placenta originates in the following fashion.

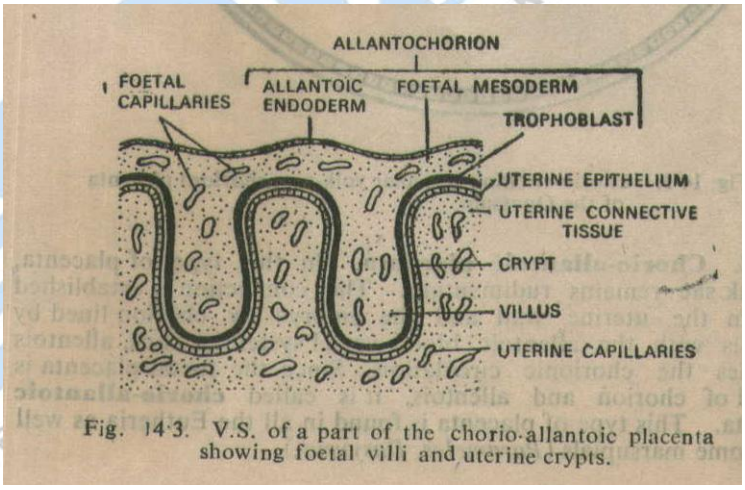


Fig. 14·3. V.S. of a part of the chorio-allantoic placenta showing foetal villi and uterine crypts.

Development of Chorio-allantoicplacenta

When a mammalian embryo enters the uterus, the zona pellucid, which previously surrounded it, becomes dissolved and the embryo (blastocyst) is bathed by the uterine fluid. The fluid contains organic substances produced by the tubular glands of the uterine wall and voided into the lumen of the uterus. The early embryo may absord some of these substances through its epithelium covering so long as a closer connection with the uterine, wall has not been established. For its further development however, the embryo is completely dependent of substances supplied to it from the tissues and the maternal tissues is essential. Nevertheless, it is found that

the closeness of this connection between foetal and maternal tissues differs greatly within euphoria mammals. On the degree of intimacy of foetal and maternal tissues following three types of placenta may be recognized;

1. Non- decideuous placenta or semi placenta – In most mammals, the implantation is superficial, i.e. the blast cyst lies in the cavity of the uterus in contact with the uterine wall. The ocontact may be made more intimate by the surface of the blastocyst by forming finger-like outgrowth which penetrate into depression ins the wall of the uterus. Such outgrowths are initially formed by the trophoblast (i.e. the epithelial layer covering the blast ocyst), but later on the connective tissue and blood vessels invade the outgrowths. These outgrowths are called chorionic villi, the blood vessels of Chorionic Villi are the branches of Allantoic bllod vessels in case of chorioallantoic placenta. (In chorio-vitelien placenta, viteline blood vessels give their branches to chorionic Villi).

At the time of birth, when parturition (the separation of the foetus and its membranes from the mother's body) occurs, the chorionic Villi are simply drawn out from the depressions in the wall of the uterus, and thus maternal and foetal tissue are separated without further damage to the uterine wall and no bleeding occurs. This type of placenta is called non-deciduate or non- placenta deciduous placenta and is found in pigs, cattle and some other mammals. Further, the chorionic villi of a non-deciduate placenta, because lie in apposition with the endometrium, but do not fuse with it, so such a placenta is also called semiplacenta.

2. Deciduous placenta or placenta Vera- In other mammals, however, the degree of intimacy between maternal and foetal tissues becomes further increased. The wall of the uterus becomes eroded to various degrees through the action of the trophoblast and the embryonic tissues penetrate into the uterine wall establishing a more intimate contact and facilitating the passage of substances from the mother to the foetus and from the foetus to the mother. Here because eth chorionic villi fuses with the eroded uterine mucosa, such placenta is called placenta Vera (true placenta). At the end of pregnancy the uterine walls is no longer intact and when the fuetus with its membranes including the chorion is removed, more or less extensive hemorrhage from the uterine wall ensues (i.e. at birth, when placenta is discharged, the uterine lining also tears away with some bleeding. Such a type of placenta found in higher eutherian mammals is called deciduate or deciduous placenta.

The maternal tissues which are expelled at birth in the case of deciduate placenta are called deciduae. These are three regions: (i) The part which lies between the chorionic vesicle and the muscles of the uterus wall is the deciduas basalis (ii) The part which surrounds the Chorionic sac and separates it from the cavity of the uterus is the deciduas capasularies. (iii) The part which forms the inner lining of the rest of the uterus is decidua parietalis.

The hemorrhage at parturition is normally stopped by the same mechanism as serves for the expulsion of the newborn, the contraction of the muscular wall of the uterus constricts the blood vessels and thus, slows down the flow of blood, until clotting of the blood stops the hemorrhage altogether.

3. Contra-deciduate placenta- In paameles and Talpa (male), some what modified type of deciduate placenta occurs, which is called contra-de-ciduate placenta. In such case, not only there is a loss of maternal tissue but also of the foetal portion of the placenta, both of which absorbed in situ by maternal leucocytes.

Q. 7 Classify the placental according to distribution of villi on chorion and histology.

Ans. In different mammals the pattern of distribution of villi varies from species to species and accordingly following kinds of placenta have been recognized.

1. Diffuse placenta- In some mammals (e.g. ungulates, pig, cow, mare, horse; lemur, etc.) the chorionic villi remain scattered all over the surface of the chorion and their placenta are correspondingly expensive. Such placenta are called diffuse placenta.

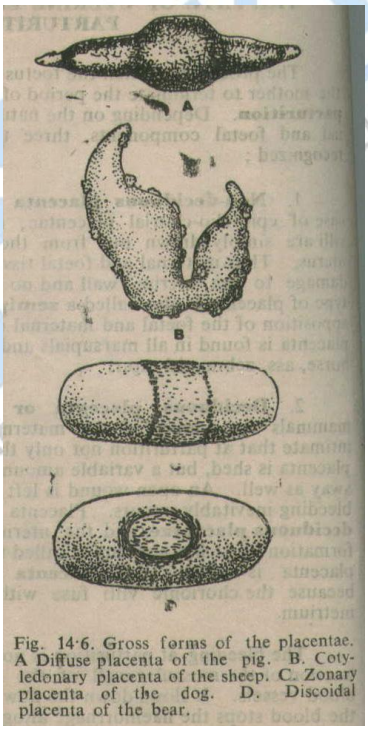


Fig. 14·6. Gross forms of the placentae. A Diffuse placenta of the pig. B. Cotyledonary placenta of the sheep. C. Zonary placenta of the dog. D. Discoidal placenta of the bear.

2. Cotyledonary placenta- In a cotyledon placenta, the villi are found in groups or patches, while the rest of the chorion surface remains smooth. The rosettes or patches of villi are called cotyledons, and the placenta of this types is found in ruminant (cud-chewing) ungulates such as, cattle, sheep and deer.
3. Zonary placenta- In a zonary placenta, the villi are developed in the form of a belt or girdle- like band around the middle of their blast cyst or chronic sac, which is

more or less elliptical in shape. Such a placenta occurs in carnivores (e.g., cat's dogs, etc.). Raccoon has incomplete zonary placenta.

4. discoidal placenta – In insectivores, bats, rodents (mouse, rat, rabbit, etc.), man and anthropoid apes, the chorion is at first of all covered with willi, but the villi continue developing only one side, the side turned away from the mumen of the uterus, while on the other parts of the chorion the villi are reduced. The functional placenta, therefore, has the shape of a disc and because this placenta has a single disc-shaped villous area is called mono-discoial placenta.

In the monkeys, the placenta consists of two disc-shaped villous areas and such a placenta is called bidiscoidal placenta.

CLASSIFICTION OF PLACENTAE ACCORDNG TO THE HISTORY

On histological basis, following types of mammalian placenta have been recognized:

1. Epithelio-chorial placenta- The epithelio-chorial type placenta in most primitive type placenta and it is found in marsupials, ungulates (pig, horse, saw, cattle, etc.) and lemurs. In such a case, no fewer than six tissues or membranes lie between the fetus and maternal blood streams, therefore, the molecules of nutrients and oxygen, for instance, in going from the mother to foetus would pass through in this order – (1) The endothelium of the maternal blood veseel; (Endometrial connective tissue (fetal mesenchyme); and (6) the endothelium of foetal blood vessel. Because, the immediate contact of the two halves of the placenta is called epithelio-chorial placenta. The villi of an epitheliochorial placenta pushes in the wall of uterus and later lies in the pocket-like depressions of the uterine wall.
2. Syndesmo-chorial placenta- In the ruminant ungulates (cattle, sheep), the foetal and maternal components are fused so intimately as to result in a destruction of the uterine epithelium, thus, bringing the chorion into contact with the connective tissue of the uterine mucosa. Only five barriers, therefore, lie between the two, (viz., foetal and uterine blood streams). This type of placenta is called syndesmo-chorial placenta.

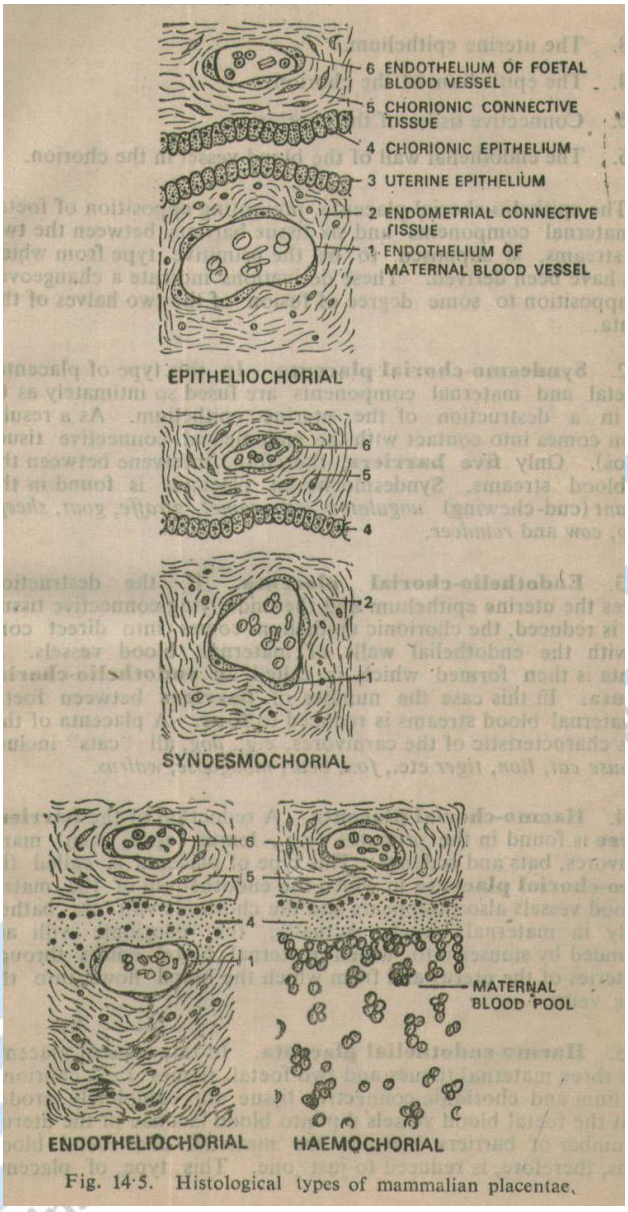


Fig. 14·5. Histological types of mammalian placentae.

3. Endothelio-chorial placenta- In carnivores (dogs, cats, bears, etc.), the uterine mucosa is reduced and the chorionic epithelium comes in contact with the endothelial wall of the maternal (uterine) blood vessels. In such a case, therefore, there lie only four barriers between the foetal and maternal blood streams. This types of placenta is called endothelio-chorial placenta.

4. Haemo-chorial placenta – in the haemo-chorial placenta of primates, insectivores (moles, shrews), and chiropterans (bats), a reduction of the barriers to three occurs. In such case, the endothelial walls of maternal (uterine) blood vessel also disappear and the chorionic epithelium is batched directly in maternal blood. Actually, the chorionic villies are surrounded by spaces (sinuses) devoid of endothelial lining, into which

maternal blood enters through the arteries of the uterus and from which the blood flows into the uterine vein.

5. Haemo-endothelial placenta-In haemo-endothelial placenta of higher rodents (rat, guinea pig, and rabbit), the number of barriers between the maternal and foetal blood streams is reduced to just two. In them, the chorionic villies lose their epithelial and mesenchymal layers to such a degree that, in most places, the essentially bare endothelial lining of their blood vessels alone separates the foetal blood from the maternal sinuses.

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Section C

New Dimensions in Developmental Biology

Q.1 Write short notes on anti-ageing therapies

Ans. ANTI-AGEING THERAPIES:- Particular efforts are being made to learn more about possible life prolongation and more attention is being given to life extension science. Premature ageing diseases (Progeria, Werner syndrome, Senescent accelerated mice), animals genetically modified by insertion or inactivation of genes (transgenic animals) and in vitro cell cultures allow identification of several mechanisms involved in life extension. Increased capacity to resist oxidative stress is particularly important.

The in balance in the dietary supply of sugars, proteins, and lipids may initiate major health problems including obesity, coronary heart disease, cancer, diabetes mellitus, high blood pressure, stroke, gout, and gall bladder disease, in old people a lack of vitamins causes vitamin deficiency. Antioxidants are natural substances that may help to prevent ageing –related diseases.

With age, the efficiency of antioxidant enzymes declines and ROS induced damage increases. To compensate for antioxidant enzyme failure, food supply in antioxidant is necessary. The best way to get anti-oxidants is by eating fruit and vegetables rather than by taking vitamin pills but more research is needed before specific recommendations can be made:

Hormone replacement therapy:

Hormone replacement therapy (HRT) can ease symptoms of menopause and protect against risk of heart disease, stroke, and osteoporosis.

However, all treatments related to hormone replacement should be undertaken with caution since several side effects may be observed.

Memory loss prevention:

Memory loss is not inevitable. Some simple devises may help to keep the memory intact: Writing things down, always putting frequently used items in the same place, repeating information that one needs to remember over and over again, making associations and relying on situation to rigger memory (for example, leaving an umbrella by the door).

Physical exercise:

Physical exercise is essential for a successful ageing. It helps to keep cardiovascular fitness reduces risks of osteoporosis and increases the sense of equilibrium.

Q.2 Explain ageing of following
(i) Organ ageing
(ii) Brain ageing
(iii) Ear ageing

Ans. Organ ageing : the ageing process manifests itself within numerous organs. Central nervous (Particularly brain), immune, endocrine and cardiovascular systems functioning are impaired with age. Alter-nations in conjunctive and muscular tissues are other familiar ailments common to ageing humans.

Brain ageing: Brain damage due to ageing alone (as opposed to pathological ageing) is minimal. Although the ageing brain may lose 100,000 neurons a year, the brain seems to compensate for these losses. This compensation could be positively influenced by intellectual challenge (by mental exercise). In fact, appropriate brain stimulation may cause millions of additional connections (synapses), between brain cells and compensates cell loss.

Ageing is also often associated with memory loss and learning difficulties.

Although certain aspects of learning such as task acquisition seen to deteriorate with age, keeping the mind active aids effective learning through out life.

Ear ageing: Ageing is associated with hearing problems: words are hard to understand, another person's speech is difficult to understand, especially when there is background noise, certain sounds are annoying or loud, and within the ear a hissing or ringing is heard in the background. Presbycusis (an on going loss of hearing linked to changes in the inner ear) is the most common hearing problem in older people. Tinnitus (a symptom associated with a variety of hearing diseases and disorders such as a ringing, roaring, or other sound inside the ear) is also common.

Q.3 Write short notes on eye ageing, endocrine system ageing and immune system ageing.

Ans. Eye ageing: With age, eves change. Among older people, low vision can results from cataracts, macular degeneration, glaucoma, and diabetic retinopathy. In some cases medication or surgery are necessary to improve or prevent vision-related condition; in others the prescription of corrective lenses or rehabilitative services can help older people to maintain or restore their sight.

Endocrine system ageing:

The endocrine system is particularly sensitive to age. Alterations may be due to the:

- Diminution of the synthesis of most of hormones;
- Impaired functioning of hormone receptors;
- Defective binding between hormone and its receptor;
- Premature programmed death (apoptosis) of hormone producing cells;
- Auto-immune reactions;
- Cancerous transformations.

Endocrine system alterations are linked to the apparition of several ageing related diseases such as diabetes, disorders in thyroid gland functioning and sexual hormone deficiencies.

In ageing men, a progressive diminution of circulating level of androgens and testosterone is observed (andropause). This diminution is often treated by testosterone replacement therapy.

In women, female hormone production is progressively slowed and finally stops (menopause). It is treated by progesterone and estrogen replacement.

Immune system ageing:

The immunological theory of ageing proposes that alterations in the immune system contribute to the changes associated with old age. With age, the immune system is thought to become less efficient, with a reduced capacity to deal with infection and a greater likelihood of auto-immune reactions.

Although I is well established that the functional properties of T-cells decrease with age, it biochemical and molecular nature is poorly understood. The available data suggests that changes in the signal transduction machinery are responsible for the impairment of T-cell function during ageing.

Q.4 What effect does age takes on Proteins, Lipids and Genetic material.

Ans. Proteins: With age, protein molecules are broken down or changed by isomerization, cross linking, impaired turnover. Under normal conditions cellular proteins are repaired by molecular chaperones" or are eliminated by proteolysis. With age, an imbalance between alteration and repair phenomena occurs. This imbalance results in the accumulation of abnormal proteins. A decrease in the amount of repairing proteins (such as "molecular chaperones" or Heat Shock Proteins) or a defect in proteolysis system efficiency could clearly contribute to such an accumulation.

Lipids: Lipids are major components of cell membranes. With age, lipids are oxidized (per –oxidized). Lipid per oxidation leads to the impaired functioning of cell membranes and may induce numerous pathologies including arteriosclerosis or Alzheimer's disease.

Genetic material

With age, genetic material is altered at different levels. The stability of DNA is decreased; the DNA transcription and the translation of proteins are impaired. The alternation in the transmission of the genetic information result in accumulation or abnormal, no functional protein ("error theory") leading to cellular impairment, ageing and death.

Q.5 Explain Alzheimer's disease.

Ans. Alzheimer's disease, the most common cause of dementia among older people, is evident by a progressive, irreversible decline in mental functioning. The symptoms, including thinking, understanding, and decision-making impairment are followed by such behavioral alterations as agitation aggression, depression, wandering, memory loss and decline in cognitive abilities.

Alzheimer's disease is characterized by the presence on intracellular and inter cellular plagues composed of a protein fragment called beta amyloidal. The exact role of these plagues in the disease process is not yet known but it is possible that they play an active role in neurons and provoke neuronal death.

A possible association between gene and Alzheimer's exist but environmental factors may also be responsible for the initiation of this disease.
There are no know treatments or medications for curing this disease; however, clinical studies indicate a potential for delaying its onset or improving the functional ability of persons with it. For example, estrogen replacement may help to slow the decline in memory in post-menopausal women.

Q.6 What kind of disease is Osteoporosis. What is its cure?

Ans. Osteoporosis is as disease that thins and weakens bones (especially bones in the hip, spine, and wrist) to the point where they break.
Osteoporosis is preventable. A diet rich in calcium and vitamin D and a lifestyle that includes regular weight-bearing exercise is the best way to prevent osteoporosis. Osteoporosis can be treated by hormone replacement therapy (HRT).

Q.7 Write down the applications of gene cloning.

Ans. Sense multiple copies of a gene are produced by gene cloning; this technique has been used in molecular analysis and to convert bacteria into 'factories' producing desired productions.

(i) For molecular analysis: The cloned DNA can be removed from the bacteria cultures by breaking the bacteria and separating the DNA content by centrifugation. The molecular biologists then analyze the cloned DNA, determine the nucleotide sequence of a gene. Scientists use the 'southern blot' analysis in DNA fingerprinting to locate a specific gene.

(ii) A number of human diseases are caused by failure of gene to make specific proteins. Gene cloning has been used to produce commercially or medically desirable products such as insulin. People suffering from 'diabetes mellitus, cannot produce insulin due to failure of a gene in pancreas. Such people have to rely on injections of hormones to prevent their blood glucose level becoming high. Earlier, insulin was obtained from pigs and cattle. With the recent techniques of gene cloning, it has become possible to produce human insulin on commercial scale. In 1982, genetically engineered insulin for diabetes became the first DNA drug produced by gene cloning. Since then the engineered bacteria have been used to produce valuable human protein like growth hormone and anti-hemophilic globulin. These proteins have been commercially manufactured by recombinant DNA in E. coli.

(iii) In food industry, rennin, an enzyme (present naturally in the stomach of calves) required for cheese making, is obtained from genetically engineered bacteria on a large scale.

(iv) E. coli have been engineered to make protein called interferon. These proteins are formed in the cells in response to viral attack. These proteins have been tested against many diseases.

(v) Gene cloning has been used in transferring the nitrogen fixing genes of bacteria into the major food crops (like cereals) for better food production and reducing the need to apply artificial fertilizers.

Q.8 What is the future of animal cloning?

Ans. Form nuclear transfer technology arise a range of beneficial applications. Among these are:

More efficient production of transgenic animals: Transgenic animal has received genetic material from another species. On the horizon the transgenic cattle, goats or sheep (sometime called "pharm" animals) whose milk contains therapeutic proteins which may be used to nourish premature infants or to treat emphysema, cystic fibrosis, burns, gastrointestinal infections, aids and other immunodeficiency diseases. Nuclear transfer cloning technology offers more effective means of generating large numbers of transgenic animals which can produce potentially valuable pharmaceutical products.

Animal health and medical research: Animals are often used as models for research. A large number of test variables can prevent scientists from determining the effects of experiment drugs, nutrition or hosing conditions cloning could help to make such effects clearer by reducing variability factors.

Xenotransplantation: This is the medical term for replacing diseased human organs within animal organs, a procedure made necessary by the chronic short age of human organs available for transplantation. Nuclear transfer technology may enable additional genetic modifications in donor animals which would make these kinds of operations more viable.

Long Answer

Q. 1 Introduce the application of stem cell. What is the role of stem cell there in disease caused by cell failure?

Ans. Application:

1. Current research on stem cells is focused on how stem cells differentiate into specific types of cells. The researchers' goal is to figure out what genetic and environmental signals trigger the stem cell to develop into a specific type of cell. We need to determine which factors "tell" the cell to divide or specialize. Studying the development of normal cells and tissues will lead to a better understanding of abnormal growth and development, which could lead to new ways to prevent birth defects and cancer.
2. Stem cells could be used in testing medicines. Pharmaceutical companies currently rely on test subjects to see the effects of medicines. The use of stem cells would enable scientists to culture more and more human cells for testing purposes, to study the good and bad effects of a drug on a particular type cell. This would potentially reduce the numbers of animal and human testing.
3. Stem cells can be used to cure diseases caused by the premature death of cells. Other researchers hope to utilize them to produce replacement of human organs.
4. It is also possible that stem cell research may hold the key to slowing down the ageing process.

I. Role of Stem Cells in Diseases Caused by Cell Failure

(a) Heart damage: The heart's cardiac muscle, do not regenerate by itself, so a damaged heart stop working. There is hope that the stem cell therapy can repair heart muscles and save lives. Stem cell therapy for heart disease is envisioned as having generic stem cells grown into cardiac muscle cells. These cells would then be injected into the heart, where they would grow and reinforce the existing heart tissue. Experiments shown that transplanted heart muscle cells successfully augment and integrate with the host cells. The unfortunate few who get the disease now may be able to rely on stem cell therapy.

(b) Myocarditis results in inflammation or degeneration of the heart muscle. Although it is often caused by other diseases, it can occur as a stand-alone disease in adults or as a result of ageing. Heart attacks occur when not enough oxygen reaches the cardiac muscle. Cardiac muscle requires a constant supply of oxygen; it will die rapidly if blood stops purpling through the body. The heart is thus weakened, and may not be able to pump as effectively. Regenerating cardiac tissue is what researchers hope to achieve. In cases of extreme heart damage or deformation, a heart transplant may be necessary. With stem cell technology, scientists may be able to grow heart form a patient's own stem cells. Heart transplants today are high risk because the receiver's immune system may see the donor organ as foreign and attempt to destroy it. Recipients usually must take anti rejection drugs for the rest of their lives to retain the organ. Cloned hearts, since they are from the same person, would not be at risk of rejection.

(c) Diabetes: Diabetes is a disease where the production of insulin is disrupted, or where the insulin produced by the body is defective. Diabetics must periodically inject themselves with insulin to ensure that they get enough glucose. In type I diabetes, the production of insulin is disrupted in some way. The specialized cells, called islet cells, do not produce the necessary insulin. There is research that suggests transplantation of either the entire pancreas of isolated islet cells could reduce or do away with the need for insulin injection. The treatment for diabetes would use stem cells to make islet cells for diabetes research and then hopefully transplantation. Sufferers of diabetes can look forward to a needle free future.

(d) Treating Other Diseases: Diseases such as cancer are different in that they are malignant growths of cells. Scientists will be able to use the knowledge gained from studying stem cells to treat cancer, potentially by using chemical signaling to tell the cancerous cells to stop dividing. The growth of the tumor could then be halted, and if another growth appeared, the same approach could be used. Studies on cancer cells have shown that some types strongly resemble stem cells, and studies on these cells may prove to be useful.

Treating Cell Failure: Spinal cord injuries, Parkinson's disease, leukemia, AIDS and Alzheimer's disease all kill cells. The detrimental effects of these diseases stem from the loss of critical cells. In spinal cord injuries, Parkinson's disease, Huntington's disease, and Alzheimer's disease, neurons are lost or damaged. This most often results in paralysis and/or loss of control of the motor system.

A recent procedure conducted on a person with Parkinson's used pig stem cells. They were injected into his brain, and had an amazing effect, improving his motor skills drastically. This procedure has been conducted on many people, and most

have shown a positive response to the therapy. The procedure could potentially be used on patients with other types neurological disorders.
New research has shown that there are often reserves of stem cells left inactivated throughout the body. If scientists can figure out how the activate these reserves, no injections of cells will be needed for treatment. The AIDS virus attacks the CD-4 immune cells, essential disease-fighting cells. Using stem technology, scientists may be able to make these cells and bolster a patient's immune system.

Q.2 What do you know about problems related to stem cell research? Write in detail.

Ans. Problem related to stem cell Research:

1. Researchers still have a lot of work to do in using stem cells to treat disease becomes common place. Scientists will need to figure out how to direct stem cells to become specific types of cells, and how to grow an unlimited supply of cells from them.
2. The methods of chemical signaling in stem cells are still very poorly understood. More basic research is required to understand the cellular events that lead to cell specialization in human cells.
3. If embryonic stem cells (ES cells) are used in treatment, the genetic makeup of the cells and that of the patient will be different. That means that embryonic stem cells will be subject to the problem of immune rejection. Future research will need to focus on modifying human plural potent stem cells to make sure they are not rejected.
4. Another difficulty ES cells have is that they grow vigorously, so much that they could potentially form tumors. If placed in the wrong part of the body, and left alone, they would form a teratoma (tumor). This would be different from cancer in that the tumor would be normal tissue, but it would be in the wrong place.
5. Adult stem cells hold many difficulties. Most importantly, adult stem cells have not been derived from all parts of the body. There have been no adult cardiac stem cells or adult pancreatic stem cells identified. Adult stem cells are also often present in only tiny quantities, are harder to isolate, and get scarcer at higher ages. There is also evidence that adult stem cells may contain more DNA errors, caused by exposure to sunlight, toxins, and by the expected errors made in DNA replication during the course of a lifetime. Evidence also points to the fact that adult stem cells may not have the same capacity to spread as well.
6. There are also problems with using a patient's own stem cells. If the disease is very serious, there may not be enough time to grow enough cells for treatment. In disorders caused by genetic errors, the errors would most likely be present in the patient's stem cells, may also be more limited in capability than embryonic stem cells, and would there fore not be as useful.
7. Currently, multi-potent stem cells can be found in some types of adult tissue. Cells like the blood stem cell (hematopoietic) are present to replenish the supply cells in our body that wear out.

8. It was previously thought that no pluripotent stem cells were present in adult humans, but the latest research may prove otherwise. Mouse muscle stem cells have grown neurons instead of muscle, a completely different type of cell.
9. Getting adult stem cells involves a lot of work. They have to be isolated, purified and grown in culture to sufficient quantities.
10. Adult pluripotent stem cells have been isolated from any different types of tissue, but not from all. Lung, pancreas, and kidney stem cells have not been derived, and this is where embryonic stem cells may have to step in Using adult stem cells allows for a simpler method of treatment. If they could be isolated from the patient, cultured to their needed types, and transplanted back into the patient, there would be virtually no risk of rejection. Using adult stem cells also avoids the touchy business of using embryonic stem cells.
11. The scientists believe that the dozen or so existing cell lines (essentially self-replenishing colonies of stem cells) offer too little genetic diversity. Each cell line is subtly different, and researchers have yet to determine which one will be best. The most roust cell lines may not yet exist. Only when there are a few hundred cell lines, say scientists, will be truly know what stem cells are capable of doing.
12. Scientists aren't to sure and not yet clear whether adult stem cells will prove as versatile as embryonic ones particularly in developing cures for Parkinson's disease and diabetes. Researchers also note that it is more difficult to produce large quantities of adult stem cells, and fear they may lose their potency over time.

Q.3 Describe the biochemical mechanism of chemical teratogensis and phenytion teratogencity.

Ans. Biochemical Mechanisms of Chemical Teratogernesis:-

Many drugs and environmental chemicals, xenobiotics, are though to cause toxicity in the embryo or foetus via a reactive intermediate. The parent compound, called a proteratogen, is relatively nontoxic, but can be converted in vivo to a short-lived and highly toxic reactive intermediate directly or indirectly will react irreversibly with cellular macromolecules such as DNA, protein and lipid. When such molecular damage exceeds compensatory function and the capacity for repair, developmental processes are altered, resulting in utero death or developmental anomalies, termed teratogenesis, in surviving offspring.

Xenophobic-initiated teratology anomalies include not only the commonly appreciated structural defects such as cleft lips or absent arms, but also biochemical and functional abnormalities, including the development of cancer decades after birth, and intellectual dysfunction.

Bioactivation and Detoxification:- The teratogenicity of amany xenobiotics has been postulated to be due to their oxidation to highly reactive, electron deficient (electrophonic) intermediary metabolites, such as epoxies and arena oxides. Enzymes catalyzing this bio activation vary with the substrate, and include P450s,

prostaglandin H syntheses (PHS), and possibly lipoxygenases (LPOs). If not immediately detoxified by enzymes such as peroxide hydrolase's and glutathione S-transfrees (GST), the electrophonic (positively charged) center of the xenophobic reactive intermediate reacts with electron-rich groups, such as protein thiols, on cellular macromolecules, forming an irreversible, and covalent bond. If not repaired, this covalent binding, or adduct formation, is thought to initiate a process that ultimately results in utero death or teratogenesis.

A number of xenobiotics are thought to initiate teratogenicity via Bio-activation and the direct formation of a reactive free radical inter-mediate, and/or subsequent indirect formation or reactive oxygen species (ROS). Several bioactivating enzymes, particularly peroxides, have been postulated to catalyze the one-electron oxidation of xenobiotics (loss of one electron) to teratogenic free radical intermediates. Peroxides such as PHS and related enzymes such as LPOs are particularly attractive as putative embryonic bio-activating enzymes because, unlike most P450s, they are present with high content and activity in both rodent and human embryos during organogenesis. The xenophobic free radicals and/or ROS can oxidize, as distinct from covalently binding to, molecular targets such as DNA, protein, and lipid in a process referred to oxidative stress, which is thought to alter cellular function potentially resulting an utero death or teratogenesis.

Cyto-protection: A number of pathways are cytoprotective in that they protect the cell without directly detoxifying a xenophobic reactive intermediate. Selenium-dependent GSH peroxides, using GSH as a cofactor, can detoxify hydrogen peroxide (H_2O_2) and lipid hydro peroxides (LOOH). Several students have shown the potential embryo protective role of GST. In a study, pregnant CD-1 mice fed a selenium deficient diet were more susceptibility was inhibited by selenite rescue, which restored GHS peroxides activity. Super oxide dismutase(SOD) and catalase were also important in embryportection. SOD and catalase, which, respectively, detoxify super–oxide and H_2O_2 was observed in embryo culture, where the addition of either of these anitpxidative enzymes increased embryonic activity and blocked DNA and protein oxidation initiated by phenytoin, benzi (a) pyrene, and hyperglycemia.

Molecular damage and repair: With DNA, protein and lipid as potential targets, in general, the types of xenobiotic-initiated molecular damage include:

1. Covalent biding of primarily electrophonic but in some cases free radical, reactive intermediates and
2. Free radical-initiated oxidative stress resulting in target oxidation.

The fundamental importance of DNA lesions in mediating chemical teratogenesis is suggested by the observation that pregnant transenic mice with a herediatary deficiency in the p53 tumor suppressor gene, which is necessary for DNA repair, are more susceptible to the teratogenicity of both benzoic (a) pyrene and phenytoin.

Biochemical mechanisms of phenytoin teratogenecity

Phenytoin ((diphenylhydantoin, Dilation) was introduced in 1938 for the ptreatment of grand mal seizures, and has since become the most efficacious and widely used anticonvulsant in North America. A side effect of phenytoin is teratogenicity in mice, rats, rabbits, chickens, and humans. Characteristic alterations in fetal structures, growth and performance caused by phenytoin and related gydantoins have been

characterized as the Fetal Hydration syndrome (FHS) – Epileptic women generally continue anticonvulsant therapy throughout pregnancy to avoid the dangers to themselves and their fetus from untreated seizilures, Since up to 0.5% of pregnant women are epileptic, the risk of phenytoin teratogenicity represents a medical concern.

The basic FHS consists of variable degrees of hyperplasia (decreased number of cells) and ossification (hardening) of the distal phalanges and craniofacial abnormalities. Clinical features of broad nasal bridge, wide fontanes, low set hairline, broad alveolar ridge, metopic ridging short neck, ocular hypertelorism microcephaly, cleft lip/palate, abnormal or low-set ears, epicanthal folds, ptosis of eyelids, coioboma, coarse scalp hair, small or absent nails, hyperplasia of distal phalanges, altered palmer crease, digital thumb, and dislocated hip. Several mechanisms underlying phenytoin teratogenicity have been proposed, including: (1) drug-induced folate deficiency; (2) a glucocorticoid mediated mechanism; (3) metabolism to a reactive intermediate and binding to embryonic macromolecules; and (4) embryonic hypoxia/ischemia by adverse reaction of phenytoin on embryonic heart.

1. Folate deficiency: Patients on long-term anticonvulsant therapy have been observed to develop folate deficiency, and anticonvulsant therapy during pregnancy could exacerbate a borderline folate deficiency in pregnant patients. The mechanism responsible for phenytoin –induced folate deficiency is unknown. When folate supplements were given concurrently with phenytion treatment. Effect of pheytoin on embryonic folate concentrations, but another had no effect. Overall, there is no definitive data to support a role for folate deficiency in phenytoin-induced embryo toxicity.
2. Phenytoin and Glucocorticoids: It has been reported that phenytoin and glucocorticoids disrupt normal palatal development by the same or a very similar mechanism. With respect to their embryo toxicity, these compounds share several features. Mice of the C57B2/6J strain are resistant to both henytoin and glucocorticoid-induced or facial clef ting, while A/J mice are sensitive to both compounds. Additionally, both compounds decrease DNA and protein synthesis in the palate. The role of glucocorticoids and the glucocorticoid receptor in phenytoin-induced embryo toxicity are still not clear and need further characterization.
3. Reactive intermediate-mediated mechanism: Phenytoin is extensively metabolized with 10% or less of an ingested dose of the drug excreted as the parent compound in urine. The major route of phenytoin metabolism is medicated by cytochrome P-450. The predominant urinary metabolite is 5(4-hydroxyphenyl)-5 phenylhydration (pHPPH), which is present in human urine as 50-75% of an ingested dose. It was first postulated that phenytoin is a proteratogen bioactivities by P-450 to a reactive electrophonic arene oxide intermediate that, if not detoxified, binds covalently to essential fetal macromolecules, which is thought to initiate teratogeneses. Several studies supported this hypothesis, including a role for epoxide hydrolas's and GSH in the detoxification of the arene oxide intermediate.

4. Embryonic hypoxia/ischemia:- A recent theory suggests that phenytoin tertogeni city is mainly initiated by adverse pharmacological action on the embryonic heart during a sensitive stage, resulting in embryonic hypoxia/ischemia. The embryonic hypoxia has been associated with specific pathological changes such as vascular disruption, hemorrhage, and finally tissue necrosis of embryonic tissues. The tissue necrosis, manifested as malformations in the fetus at term, may be a direct consequence of the hypoxia and/or generation of reactive radical oxygen species (ROS) at reoxygenation. Recent evidence has been presented from in vitro embryo culture indicating that ROS are generated within the embryo as a result of reoxygenation after transient episodes of hypoxia/ischemia. The malformations induced by phenytoin are almost identical to those that can be observed after clamping of uterine vessels. In addition, maternal hayperoxia has been shown to greatly reduce the incidence of phenhytoin induced malformations.
   A recent in vitro study shows that phenytoin has the capacity to cause transient episodes of hypoxia in emproyonic tissies due to embryonic brdycardia and arrhythmia. It strongly indicates that phenytoin has a pharmacological effect on the fetal side besides the mild effect on the maternal side. The maternal bomodynamic alterations of phenytoin may alos aggravate the embryonic hypoxia/ischemia in vivo. The result of this study support the hypothesis that phenytoin teratogenicity is initiated by pharmacologically induced embryonic hypoxia, followed by vascular disruption and tissue necrosis as a result of ischemic damage and/or generation of ROS at reoxygenation.

Q.4 Describe xenobiotics, its sources and distribution.

Ans. Xenobiotics are biologically active substances that are "foreign to a given species. The most practical example is pesticides. For many pesticides to be effective, they must enter the phloem. Foliar-applied substances may diffuse into leaf through cuticle or enter stomata.

Movement through the plasmalemma is dependent upon polarity/hydrophobic. This is why pesticide formulations are so important. The body is exposed to foreign chemicals from many sources. Studies have shown that the "total load" of toxins to which the body is exposed is inversely related to its ability to detoxify them. Increased exposure to xenobiotics and antitoxins results in decreased detoxication capacity. Reducing exposure to toxin helps not only by decreasing toxicity directly but also by increasing the body's ability to defend itself against remaining toxins. Lifestyle, environment and dietary factors play a significant role in determining the body's total load of toxins. For example, Sources and distribution of xenobiotics. Large quantities of toxic chemicals are produced each year from industrial sources. Many of these pollutants are introduced directly into the environment while others are released over time from products used in homes and workplaces. Examples of toxic ingredients include volatile organic compounds such as solvents and formaldehyde which are found in an extremely wide range of products, from automotive fuels to households cleaners and building materials. Avoiding exposure may require significant changes in lifestyle and in the living environment.

A significant proportion of toxins released in the environment find their way into the food chain and water supplies. Numerous studies have shown that contamination of residential water supplies in the U.S. is a serious and widespread problem. Toxicological testing of water samples can be used to identify the presence of certain toxins. The use uncontaminated water sources or of water purification system can be an effective means of reducing xenobiotic exposure.

Foods represent the most common source of exposure to xenobiotics. Approximately 3,000 chemicals are used by the food industry during processing. An additional 12,000 chemicals are used in food packaging materials. Numerous studies have found pesticide residues in a significant percentage of food samples. The use of organically grown and unprocessed foods can be an effective means of reducing exposure to food borne toxins.

Xenobiotics are introduced into the environment and may reach several sites and places all over the world. They can be distributed in water, soil, air and biota. To estimate the exposure of xenobiotics to organisms and to understand which chemical reactions taken place in each compartment, the concentrations of semeiotics in the compartments and the distribution of the xenobiotics over the different compartments are of paramount importance.

Environmental Chemistry does not concern the emissions of xenobiotic chemicals into the environment. It examines the distribution by geochemical and biological processes. Wind speed and direction are important for the (global) distribution in air, water velocity and direction for the (global) distribution in water, and transport phenomena in soil for the (more locally) distribution in soil. Organisms take up xenobiotics from their environment, the route of uptake being dependent on habitat and species. In addition, organisms may disrtribute xenobiotics globally by migration.

Q.5 Explain nuclear transfer techniques in detail.

Ans. Each cell of living organisms contains a "blueprint" for its development. These instructions are composed of DNA which is located in the nucleus of cell. Soon after egg has been fertilized the cells of the developing embryo begin to acquire specialized functions, becoming for instance, brain cells or skin cells. This is called cell differentiation. Once a cell has become differentiated, it never reverts to the prior undifferentiated state.

Somatic Cell Nuclear Transfer (SCNT) Method First explored by Hans Spemann in the 1920's to conduct genetics research, nuclear transfer is the technique currently used in the cloning of adult animals. All cloning experiments of adult mammals have used a variation of nuclear transfer.

A somatic cell is any cell other than a sperm, egg, or cell that gives rise to a sperm or egg. Nuclear transfer requires two cells, a donor cell and an acolyte, or egg cell. The nucleus of the egg (containing its DNA) is removed and replace with the nucleus (and its DNA) of a somatic cell (such as skin of blood) from the recipient. Research has proven that the egg cell works best if it is unfertilized, because it is more likely to accept, the donor nucleus as its own. The egg cell must be enucleated, which eliminates the majority of its genetic information. The donor cells is then forced into the Gap Zero, or Go cell stage, a dormant phase, which causes the cell to shut down

but not die. In thins state, the nucleus is ready to be accepted by the egg cell. The donor cell's nucleus is then placed inside the egg cell, either through cell fusion or transplantation. The egg cells is then prompted to begin forming an embryo. (To harvest stem cells, the egg containing the transferred nucleus is encouraged to divide until it reached the blast ocyst stage, at which time the cell of the inner cell mass are removed and cultured. These are known as embryonic stem cells or ESP's). The embryo is transplanted into a surrogate mother if stem cell are not the goal. If all is done correctly, occasionally a perfect replica of the donor will be born.

1. The roslin Technique- The Roslin Technique for cloning (so named because it was developed at the Roslin Institute in Roslin; Scotland) was pioneered by IanWilmot and Keith Cambell. The technique is aimed at synchronizing the cells cycle of the donor and egg cells. To synchronize the cells, the donor cell is essentially "starved," only receiving enough nutrients to keep it alive. This is done to make the donor cell go into a suspended, quiescent state, known as the Go stage. Next, the enucleated egg cell is placed next to the donor cell. After that, an electrical pulse is fired to fuse the donor and enucleated egg cells together and activates the embryo. Any surviving embryo is placed into the uterus of a surrogate mother ewe. If all has gone, well, a cloned sheep will develop.

The invention is covered by two patent application fields by roslin institute (Edinburgh) with a priority date of 31 august 1995: pct/gb96/02099, entitled – quiescent cell populations for nuclear transfer and pct/gb96/0298, entitled-inactivated oocytes as cytoplast recipients for nuclear transfer. These application cover use in all animals and in most countries of the world.

Creation of dolly using nuclear transfer technique:

In the 1980s, scientists cloned a sheep embryo using a nuclear transfer technique. Two groups of cells were used in this process one group of unfertilized eggs and one group of undifferentiated embryonic cells. The nuclei were removed from the unfertilized eggs (stripping them of DNA) and replace with undifferentiated embryonic cells. This was done to transfer the embryos' DNA into the unfertilized egg cells. The embryonic clones created from this technique were then implanted in the uteruses of genetically unrelated sheep for the remainder of their gestation.

An elaboration of the nuclear technique allows the cloning of mature organisms. This is done by placing the differentiated cells of the donor organism in a culture that cause them to return to their undifferentiated state before proceeding with nuclear transfer. "Dolly," a sheep produced in Scotland, was the first successful clone on an adult animal. The production of Dolly was significant because this meant an animal with known properties, such as rate of growth and milk production could be cloned, whereas the productivity traits of offspring cloned from embryos remain unknown until these animals mature.

The most popular clone, Dolly the lamb, was created using the Nuclear Transfer Technique. The first process of this technique is to extract and culture embryos, causing them to produce multiple genetically identical individuals. Several months later, when the embryos, also known as donor cells, are ready for cell transfer, the egg, or recipient cell, must be prepared. Chromosomes (one of the primary genetic components of a species) are removed from the egg with laser precision using a

process known a micromanipulation. The donor cell also must be prepared. It must "forget that it was specialized and return to a non-specialized, embryonic state", Placing the cell in a salt solution deprives it of necessary nutrients, causing the cell to "forget its specialization." When an egg is first formed and begins to grow, its cells are non-specific and only later learn to grow into specialized body parts like arms or organs. By "non-specializing" the donor cell, it will create an entire organism, instead of the specialized organ in eventually became. In addition the donor cell will not be rejected by the egg during nuclear transfer. The donor cells is the ready to be fused with the egg. Originally, scientists believed the nuclear transfer technique would not likely be applied to humans because the genetic composition of human is much more complex then of a sheep. Because of the human cell's more complex DNA structure, placing a human egg cell in salt solution does not have the same "non-specializing" effect of animals cells New research suggests that the Nuclear Transfer method could be used after all. A clone's genetics produced by the nuclear Transfer method technique are identical to those of the donor, and completely independent of the recipient egg cell. Therefore, any egg cell, such as a cow, can be used to produced clones of different species just by implanting a donor cell from the desired species into the cow egg cell.

A research company known as ABC Global has taken new steps in the method by using a cow egg cell for multiple species. The cow egg cell is used because it is larger, and therefore, cheaper and easier to obtain for research purposes. The Nuclear transfer technique with recipient cow egg cell has already been used to produce sheep, monkeys, and pigs from donor cells taken from the ears of these animals. Between 7-9 days after the donor cell is implanted in the cow egg cell and the cells are electrically shocked, the combined cell is implanted into the uterus of a surrogate mother of the same species as the donor.

This new research strikes fear into the opposition to human cloning. The opposition was quelled by the assurance that the technological era could not produce a clone in the near future because of the difficulty to extract enough human cells to finally succeed in the process. (Dolly required 277 trails before success, and the complexity of the human cell suggested that the number of trials required to clone a human cell would be much greater). The ability to use cow egg cells has greatly increased the chances of a human clone in the near future. David Magnus, an ethicist and researcher at the Center for Bioethics at the University of Pennsylvania, stated, "Cloning experts have been saying we had some lead time before we had to worry cloning human beings, but because cow eggs can be harvested cheaply and easily, one crucial barrier to human cloning may have fallen".

2. The Honolulu Technique: The Honolulu Technique was developed at the University, of Hawaii, by Teruhiko wakayama and Ryuzo.

Yanagimachi- It significantly differs from the Roslin Technique in that if does not use the risky procedure of an electric charge for cell fusion. Instead, the donor cell's nucleus is transferred to an enucleated egg and then allowed to sit for an hour, after which it is treated in a chemical bath containing strontium and cytochalism B to activate the cell for five hours. Also, the Honolulu technique used three types of donor, cells, all of which are usually in or are close to the Go stage.

Sertoli, neuronal, and cumulus cells – These Scientists discovered that a relatively high proportion of the oocytes developed into blast ocysts and then further developed when we included a delay, He estimated that out of every 100 blastocyts transferred to wombs, seventy –one were able to take, from which between five and sixteen fetuses developed, and eventually two or three live mice were born. The Honolulu technique's high success rate (in comparison to the roslin technique) is a promising development in cloning research.

Multiple Choice Questions

Introduction of Development Biology

Q.1 Gradual growth through a series of progressive changes is called
(A) Growth (B) Development
(C) Cleavage (D) Transduction
Ans (B**)**

Q.2 The study of developmental changes is known as
(A) Embryology (B) Developmental biology
(C) Both A and B (D) Chrono-biology
Ans (C)

Q.3 As a fertilized egg develops into an embryo, it undergoes
(A) One meiotic cell division, only (B) Many meiotic cell divisions
(C) One mitotic cell division, only (D) Many mitotic cell divisions
Ans (D)

Q.4 Genes control development by:
A) Controlling where and when proteins are synthesized.
B) Containing small preformed body parts and organs that become "expressed" during development
C) directly controlling phenotypes, without intermediates or influence from the environment.
D) Acting as enzymes to build proteins.
E) Containing instructions which describe in detail the final form to be achieved during development
Ans (A)

Q.5 _____ designated the _____ as the primary organizer.
A. Hilde Proscholdt, cytoplasm
B. Hans Spemann, dorsal lip tissue
C. Hans Spemann, cytoplasm
D. Friedrich Wolff, yolk
E. Friedrich Wolff, cytoplasm
Ans (B)

Q.6 The concept that an egg or sperm cell contained a very small but fully developed individual was called
A. Induction
B. Pronuclei
C. Preformation
D. Holoblastism
E. Epigenesis
Ans (C)

Q.7 The concept that an egg contains the building material that must somehow be assembled is called
A. Induction
B. Pronuclei
C. Preformation
D. Holoblastism
E. Epigenesis
Ans (E)

Q.8 Which term is NOT related to the others?
A) Gametogenesis
B) Oogenesis
C) Mitosis
D) Spermatogenesis
E) Sexual reproduction
Ans C

Q.9 Meiosis leads to all of the following EXCEPT
A) Gametogenesis
B) Oogenesis
C) Cloning
D) Spermatogenesis
E) Haploid cells
Ans C

2. Gametogenesis

Q.10 Regarding oogenesis, all statements are correct, EXCEPT:

A) It starts during fetal life.
B) It is completed during puberty.
C) It continues till menopause.
D) Primary oocytes are formed after birth.

Ans (D)

Q.11 Regarding spermatogenesis:

A) It starts before birth.
B) Primary spermatocytes have a haploid number of chromosomes.
C) Spermiogenesis is a process by which a spermatid is transformed into a mature sperm.
D) Spermiogenesis occurs in the fallopian (uterine) tube.
E) The first meiotic division is a reduction division by which a secondary spermatocyte divides into two spermatids.

Ans (C)

Q.12 Where in the human male does spermatogenesis occur?

A) Ovaries
B) Testes
C) Epididymus
D) Prostate gland
E) Seminal vesicle

Ans B

Q.13-Which term is NOT related to the others?

A) Gametogenesis
B) Oogenesis
C) Mitosis
D) Spermatogenesis
E) Sexual reproduction

Ans C

Q.14-Meiosis leads to all of the following EXCEPT

A) Gametogenesis

B) Oogenesis
C) Cloning
D) Spermatogenesis
E) Haploid cells

Ans C

Q.15-The polar body is

A) Another name for an egg cell.
B) A precursor cell that becomes an egg cell.
C) A nonfunctional cell made at the same time as an egg cell.
D) The cell produced when fertilization occurs.
E) A specialized sperm cell

Ans C

Q.16- Why do polar bodies form?

A) They nurse the egg as it leaves the follicle.
B) This is extra chromosomal material representing the X chromosome in each female cell.
C) They orient the sperm toward the egg.
D) They allow a reduction in chromosomes while preserving all the food for one egg.
E) They orient the egg for penetration by the sperm.

Ans D

Q.17 Although the sperm and egg are both produced by the process of meiosis, they differ in which of the following ways?

A) From a genetic point of view each gene stands an equal chance of ending up in a sperm but has a 50% chance of being discarded in the polar body in egg production.
B) They have a different allocation of cellular food supply.
C) They differ in motility.
D) In humans, meiosis in egg cells doesn't complete unless fertilization occurs.
E) All of the choices are correct.

Ans E

Q.18 Which cells of the testis provide nourishment to spermatozoa?

(A) Sertoli cells
(B) Leydig cells
(C) Interstital cells
(D) Spermatogonia

Ans (A)

Q.19 Which cells of the testis provides nourishment to spermatozoa?
(A) Sertoli cells
(B) Leydig cells
(C) Interstital cells
(D) Spermatogonia

Ans (A)

Q.20 Which cells of the testis provide nourishment to spermatozoa?
(A) Sertoli cells
(B) Leydig cells
(C) Interstital cells
(C) Spermatogonia

Ans (A)

Q.21 Spermiogenesis changes
(A) Spermatogonium to primary spermatocyte
(B) Primary spermatocyte to secondary spermatocyte
(C) Secondary spermatocyte to spermatid
(D) Spermatid to sperm

Ans (D)

Q.22 Spermatozoa are nourished during their development by
(A) Sertoli cells
(B) Interstitial cells
(C) Connective tissue cells
(D) None of the above

Ans (A)

Q.23 Spermatogonia undergo a growth phase to become
(A) spermatozoa
(B) Primary spermatocyte
(C) Secondary spermatocyte
(D) Spermatid

Ans (A)

Q.24 Spermatogenesis without meiosis occurs in
(A) birds
(B) bees
(C) bat
(D) none of the above

Ans (B)

Q.25 Sperm of animal species a cannot fertilise ovum of species b because
(A) Fertilizins of a and b are not compatible
(B) Antifertilizins of a and b are not compatible
(C) Fertilizin of a and antifertilizin of b are not compatibel
(D) Antifertilizin of a and fertilizing of b are not compatibel

Ans (D)

Q.26 Sperm capacitation involves
(A) Change in shape
(B) Release of mitochondria
(C) Removal of membrane fatty acids
(D) Hyaluronic acid

Ans (C)

Q.27 Smooth muscles lining the wall of scrotum are called
(A) Deltoid muscles
(B) Dartos muscles
(C) Gluteal muscles
(D) Latissimus dorsi muscles

Ans (B)

Q.28 Site of vitellogenesis is
(A) Secondary oocyte in fallopian tube
(B) Primary occyte in graafian follicle
(C) Primary spermatocyte in testis
(D) Secondary spermatocyte in testis

Ans (B)

Q.29 Site of fertilization in a mammal is
(A) Ovary
(B) Uterus
(C) Vagina
(D) Fallopian tube

Ans (D)

Q.30 Sertoli cells occur in
(A) Heart
(B) Liver
(C) Ovary
(D) Seminiferous tubules

Ans (D)

Q.31 Sertoli cells are found
(A) between the seminiferous tubules
(B) In the germinal epithelium of ovary
(C) In the uppermost part of fallopian tube
(D) in the germinal epithelium of seminiferous tubules

Ans (D)

Q.32 Polar bodies develop during
(A) Oogenesis
(B) Spermatogenesis
(C) Spermiogenesis
(D) Soamtic hybridisation

Ans (A)

Q.33 Part of sperm involved in penetrating egg membrane is
(A) Tail
(B) Acrosome
(C) Allosome
(D) Autosome

Ans (B)

Q.34 Part of fallopian tube closest to ovary is
(A) Infundibulum
(B) Cervix

(C) Ampulla
(D) Isthmus

Ans (A)

Q.35 Ovulation occurs under the influence of
(A) LH
(B) FSH
(C) Estrogen
(D) Progesterone

Ans (A)

Q.36 Ovulation in human female occurs at
(A) beginning of proliferative phase
(B) end of proliferative phase
(C) middle of secretory phase
(D) end of secretory phase

Ans (B)

Q.37 Outer layer of blastocyst that gives rise to ectoderm is
(A) trophoblast
(B) germinal vesicle
(C) Cnidoblast
(D) amnion

Ans (A)

Q.38 Oocyte is liberated from ovary under the influence of LH, after completing
(A) Meiosis and before liberating polar bodies
(B) Meiosis I and before liberating polar bodies
(C) Meiosis
(D) Meiosis I after release of polar body

Ans (D)

Q.39 Onset of menstrual cycle at the time of puberty is called
(A) Menopause
(B) Menarche
(C) Menstruation
(D) Metamerism

Ans (B)

Q.40 One primary spermatocyte produces four spermatozoa but one primary oocyte produces
(A) Four ova
(B) One ovum
(C) Two ova
(D) Sixteen ova

Ans (B)

Q.41 Nutritive cells of seminiferous tubules are
(A) Sertoli cells
(B) Leydig cells
(C) Spermatogonial cells
(D) Spermatocytes

Ans (A)

Q.42 Number of eggs released in the life time of a woman is approximately
(A) 40
(B) 400
(C) 4000
(D) 20000

Ans (B)

Q.43 Middle piece of mammalian sperm contains
(A) Nucleus
(B) Vacuole
(C) Mitochondria
(D) Centriole

Ans (C)

3. Fertilization and cleavage

Q.44 The point of fertilization occurs when
(A) Sperm are deposited in the vagina
(B) Sperm reaches the outer jelly coating of the egg
(C) The sperm contacts the vitelline envelope
(D) The sperm sheds the tail

(E) The sperm nucleus and egg nucleus unite to form a zygote

Ans (E)

Q.45 Before fertilization, as an egg cell matures, its nucleus increases RNA content and it is called

(A) A pronucleus
(B) The fertilization cone
(C) A cleavage furrow
(D) A germinal vesicle
(E) A blastomere

Ans (D)

Q.46 Generally, only one sperm fertilizes an egg because

(A) There are so few sperm that two are unlikely to arrive at the same time
(B) Sperm compete and only the most fit one is accepted
(C) The small entry hole called the blastopore allows just one sperm to fit through and then it seals
(D) Many sperm enter but only one set of chromosomes fuses with the egg nucleus; excess sperm are absorbed
(E) When the first sperm membrane fuses with the egg membrane, it separates the fertilization membrane and forms a barrier to other sperm

Ans (E)

Q.47 What prevents a foreign species' sperm from fertilizing an egg?

(A) Nothing prevents fertilization if chemical and other behavioral cues allow mating
(B) Egg recognition proteins on the acrosomal process bind to specific sperm receptors on the vitelline envelope
(C) Only failure to match chromosomes and genes prevent development of hybrids
(D) The size and shape of sperm must fit the hole in the egg membrane
(E) The cortical reaction by the egg actively draws in the sperm

Ans (B)

Q.48 The response to sperm fusing with the egg membrane causes enzyme-rich granules to ultimately cause the separation of the vitelline envelope and the egg membrane; this is called
(A) Polyspermy
(B) Pronucleation
(C) Polarity
(D) The cortical reaction
(E) Cytoplasmic localization

Ans (D)

Q.49 Entrance of more than one sperm
(A) Is called polyspermy and is disastrous for animal zygotes
(B) Results in epigenesis
(C) Is neutralized by fusion with polar bodies
(D) Results in formation of a large pronucleus
(E) Initiates cleavage

Ans (A)

Q.50 _____ occurs when a fertilized egg enters cell division without further growth in volume.
(A) Cleavage
(B) Gastrulation
(C) Differentiation
(D) Morphogenesis
(E) Embryology

Ans (A)

Q.51 Fertilizins are emitted by
(A) Immature eggs
(B) Mature eggs
(C) Sperms
(D) Polar bodies

Ans (B)

Q.52 Fertilization of ovum occurs in
(A) Fimbriac of oviduct
(B) Isthmus of oviduct
(C) Ampulla of oviduct
(D) None of the above

Ans (C)

Q.53 Fertilization is
(A) Union of diploid spermatozoon with diploid ovum to form diploid zygote
(B) Union of haploid sperm with haploid ovum to form haploid zygote
(C) Union of haploid sperm with haploid ovum to form diploid zygote
(D) Union of diploid sperm with haploid ovum to form triploid zygote

Ans (D)

Q.54 During cleavage
(A) size of resulting cells decreases
(B) Size of resulting cells increases
(C) Size of early embryo increases
(D) Size of early embryo decreases

Ans (A)

Q.55 Merobalstic cleavage is
(A) Total
(B) Spiral
(C) Incomplete
(D) Horizontal

Ans (C)

Q.56 The product of cleavage in a zygote produces a cluster of small cells called
(A) Pronuclei
(B) Blastomeres
(C) Yolk
(D) Polar bodies
(E) Meroblasts

Ans (B)

Q.57 In human beings the type of cleavage is
(A) Holoblastic and complete
(B) Meroblastic and incomplete
(C) Holoblastic and incomplete
(D) Meroblastic and complete

Ans (A)

Q.58 The effect of yolk on cleavage is that
(A) Yolk promotes faster cleavage
(B) Yolk promotes spiral cleavage in all cases
(C) Yolk slows down and indirectly determines the type of cleavage to take place
(D) Yolk is the origin of all cleavage planes
(E) There is no effect of yolk on cleavage

Ans (C)

Q.59 Cleavage on the surface of the yolk of the chicken egg is partial because cleavage furrows cannot cut through; this is called
(A) Meroblastic
(B) Holoblastic
(C) Isolecithal
(D) Indirect development
(E) Indeterminant

Ans (A)

Q.60 In animals, indirect development
(A) Occurs only in mammals
(B) Lacks a larval stage
(C) Involves a larval stage
(D) Occurs only when eggs develop without being fertilized
(E) Involves continued nuclear divisions without cytoplasmic cleavage

Ans (C)

Q.61 Radial cleavage is found in
(A) Birds
(B) Mammals
(C) Most protostomes
(D) Sea stars
(E)None of the choices are correct

Ans (D)

Q.62 Spiral cleavage is found in
(A) Amphibians
(B) Mammals
(C) Annelid worms
(D) Sea stars
(E) Birds
Ans (C)

Q.64 A characteristic of development of Deuterostomia is
(A) Spiral cleavage
(B) Mosaic development
(C) The mesoderm developing from a special blastomere called the 4d cell
(D) Radial cleavage
Ans (D)

Q.65 Rotational cleavage is unique to
(A) Amphibians
(B) Mammals
(C) Protostomes showing spiral cleavage
(D) Sea stars
(E) Lophotrochozoa
Ans (B)

Q.66 Cleavage in mammals
(A) Is faster than most other groups
(B) Does not begin, like most other animals, with a first cleavage plane through the animal-vegetal axis
(C) Is only on the surface, with many rounds of nuclear division before cytoplasmic division
(D) Is asynchronous, meaning that all blastomeres do not divide at the same time
(E) Is very loose, with cells drifting about in a loose amorphous, bubble-like mass
Ans (D)

Q.67 In the human, which part of the blastocyst will develop into the embryo proper (versus the supporting placenta)?
(A) Archenteron
(B) Blastopore
(C) Chorion
(D) Trophoblast
(E) Inner cell mass

Ans (E)

Q.68 Superficial cleavage is found in
(A) Amphibians
(B) Mammals
(C) Protostomes showing spiral cleavage
(D) Sea stars
(E) Insects

Ans (E)

Q.69 When the central mass of yolk restricts cleavage to the surface of the egg, and 8 rounds of mitosis without cytoplasmic division pepper the surface with nuclei that eventually are enclosed, this is _____ cleavage.
(A) Radial
(B) Spiral
(C) Holoblastic
(D) Superficial
(E) Trophoblastic

Ans (D)

Q.70 Implantation in the human uterus begins at the end of the
(A) Fertilization
(B) First week
(C) Second week
(D) Second month
(E) Fourth month

Ans (B)

Q.71 A solid ball of cells with a hollow cavity inside is the
(A) Animal pole
(B) Blastula
(C) Blastocoel
(D) Gastrula
(E) Neurula

Ans (B)

Q.72 The correct sequence of process of development after fertilization and cleavage is
(A) Gastrulation-Organogenesis-Growth
(B) Organogenesis-Gastrulation-Growth
(C) Gastrulation-Blastulation-Growth

(D) Organogenesis-Morulation-Blastulation

Ans (A)

Q.73 In Hen the egg is fertilized at the stage of

(A) Primary oocyte (B) Secondary oocyte
(C) Ootid (D) Both A and B

Ans (A)

Q.74 During development of chick the fertilized egg is laid _____ hours after the fertilization.

(A) 24 (B) 36
(C) 40 (D) 45

Ans (A)

Q.75 The process, by which developing cells achieve their functional, mature identity a sliver, or muscle, or nerve is called:

(A) Cleavage division
(B) pattern formation
(C) morphogenesis
(D) differentiation

Ans (D)

4. Gastrulation

Q.76 During gastrulation size of embryo remains constant but metabolic rate

(A) increases
(B) decreases
(C) is unchanged
(D) none of the above

Ans (A)

Q.77 Mosaic development in animals

(A) Is a type in which each of the fate of a blastomere is heavily determined by its neighbor cells
(B) Is synonymous with regulative development
(C) Is a type in which each of the early blastomeres lacks the potential of

developing into a complete organism and removing a blastomere eliminates a future body part
(D) Occurs in most deuterostomes but usually does not occur in protostomes
(E) None of the choices are correct

Ans (C)

Q.78 Regulative development in animals
(A) Is a type in which the fate of a blastomere is heavily determined by its neighbor cells
(B) Is a type in which removing a blastomere causes the remaining blastomeres to "fill in" for the lost cell
(C) Usually does not occur in protostomes
(D) All of the choices are correct
(E) Occurs in most (but not all) deuterostomes

Ans (E)

Q.79 Neighboring cells influence the development of each other, either by direct contact or by production of chemical signals, in
(A) Neurulation
(B) Gastrulation
(C) Induction
(D) Maternal determinants
(E) Homeotic pattern formation

Ans (C)

Q.80 The difference between primary and secondary induction is a difference between
(A) "hard-wired" commands and chance development
(B) Effects of the dorsal lip organizer and effects of the subsequent cell's induction
(C) Nuclear and cytoplasmic determinants
(D) Paternal and maternal determinants
(E) Homeotic pattern formation and regular structural gene effects

Ans (B)

Q.81 Cytoplasmic specification is less important in vertebrate
(A) Embryos
(B) Placentas
(C) Pupae
(D) Adults
(E) None of the choices are correct

Ans (A)

Q.82 During cleavage, what is true about cells?
(A) Nucleocytoplasmic ratio remains unchanged
(B) Size does not increase
(C) There is less consumption of oxygen
(D) The division is like meiosis

Ans (B)

Q.83 It is series of mitotic cell division that changes zygote into multicellular embryo
(A)Gastrulation (B)Gametogenesis
(C)Blastulation (D)Cleavage

Ans (D)

Q.84 Cell divisions, migrations, and rearrangements produce three germ layers in
(A) Morulation (B) Blastulation
(C) Gastrulation (D) All, A, B and C

Ans (C)

Q.85 The pattern of cleavage in which only part of the ovum is divided into cells. It is also called incomplete cleavage and is usually observed in embryos with large amounts of yolk.
(A) Meroblastic cleavage (B) Discoidal cleavage
(C) Holoblastic cleavage (D) Both A and B

Ans (D)

Q.86 The egg of Hen is
(A) Alecithal (B) Meolecithal
(C) Mesolecithal (D) Polylecithal

Ans (D)

Q.87 In Hen the egg is released from the ovary as
(A) Primary oocyte (B) Secondary oocyte
(C) Ootid (D) None of these

Ans (A)

Q.88 Animals begin their lives as a single, diploid cell called
(A) Zygote (B) Embryo
(C) Gastrula (D) All A, B and C

Ans (A)

Q.89 Increase in size of organs to attain maturity is called
(A) Differentiation (B) Localization
(C) Growth (D) Both B and C

Ans (C)

Q.90 After _____days of incubation, the chick finally begins its escape from the shell.
(A) 16 (B) 19
(C) 20 (D) 21

Ans (D)

Q.91 The divided germinal disc of a megalecithal egg forms a layer of cells termed as
(A) Blastoderm (B) Blastocoel
(C) Blastocyst (D) Both A and C

Ans (A)

Q.92 The peripheral region of the chick blastodisc surrounding the area pellucida and in direct contact with the yolk is
(A) Area ascarosida (B) Area vitellina
(C) Area opaca (D) Area vasculosa

Ans (C)

Q.93 One of a pair of twisted, cords of albumen found at each of an egg, joining the shell membrane to the yolk and supporting the yolk centrally within the shell is
(A) Nucellus (B) Chalaza
(C) Choenoderm (D) Latebra

Ans (B)

Q.94 The central region of blastodisc is known as
(A) Area pellucida (B) Area vitellina
(C) Area opaca (D) Area vasculosa

Ans (A)

Q.95 Cells of the blastoderm surface migrate posteriorly and medially and involute (turn in) along a line called the
(A) Hypoblast (B) Germinal disc
(C) Primitive streak (D) Latebra

Ans (C)

Q.96 Due to the migration of mesodermal cells from the epiblast, a groove is formed known as
(A) Neural groove (B) Primitive groove
(C) Somatopleure (D) Splanchnopleure

Ans (B)

Q.97 The hypoblast is mainly presumptive
(A) Ectoderm (B) Endoderm
(C) Mesoderm (D) Blastoderm

Ans (B)

5. Egg

Q.98 Eggs with very little yolk that is evenly distributed in the egg are called
(A) Mesolecithal
(B) Holoblastic
(C) Isolecithal
(D) Telolecithal
(E) Centrolecithal

Ans (C)

Q.99 Eggs with a moderate amount of yolk concentrated at the vegetal pole are called
(A) Mesolecithal
(B) Holoblastic
(C) Isolecithal
(D) Telolecithal
(E) Centrolecithal

Ans (A)

6. Placenta and Embryonic membrane

Q.100 In mammals, the organ of exchange between the mother and fetus is the
(A) Amnion
(B) Placenta
(C) Chorion
(D) Yolk sac
(E) Allantois

Ans (B)

Q.101 The allantois
(A) Becomes the chorionic villi
(B) Lies next to the shell in chicks
(C) Is a structure composed of two germ layers
(D) Has the same function in chicks as humans
(E) Gives rise to umbilical blood vessels in humans

Ans (E)

Q.101 Which is NOT an extraembryonic membrane?
(A) Amnion
(B) Placenta
(C) Chorion
(D) Yolk sac
(E) Allantois

Ans (B)

Q.102 The placenta develops from
(A) Fetal membranes only
(B) Maternal tissue only
(C) Both fetal and maternal tissue
(D) Polar bodies that develop just the placental tissues
(E) none of the choices are true

Ans (C)

Q.103 In land vertebrates, the function of the chorion is to
(A) Become umbilical cord
(B) Enclose the entire embryonic system and then fuse to form the chorioallantoic membrane
(C) Grow from the embryonic hindgut to become a repository for the wastes of metabolism
(D) Surround the embryo and provide a marine environment for development
(E) None of the choices are correct
Ans (B)

Q.104 The sac that surrounds the fetus and usually ruptures just before childbirth is the
(A) Amnion
(B) Placenta
(C) Chorion
(D) Yolk sac
(E) Allantois
Ans (A)

Q.105 In an amniotic egg, the amnion
(A) Serves as a repository for wastes produced by the developing embryo
(B) Serves as a respiratory surface for the exchange of oxygen and carbon dioxide
(C) Is a fluid-filled sac that protects the embryo from shocks and adhesions
(D) Develops into the chorio-allantoic membrane
(E) None of the choices are correct
Ans (C)

Q.106 Which association is NOT correct?
(A) Chorion-gas exchange
(B) Amnion-blood vessels
(C) Allantois-waste storage
(D) Chorio-allantoic membrane-"lung"
(E) Yolk sac-food storage
Ans (B)

Q.107 The remarkable feature of the human uterus is that it
(A) Provides all food and removes wastes through a small absorptive surface equal to the area of the infant's skin
(B) Does not reject the embryo as foreign tissue
(C) Directs the development of the embryonic cells
(D) Stores all fetal wastes until the placenta is shed as afterbirth
(E) All of the choices are true

Ans (B)

Q.107 The neural tube of vertebrates develops by
(A) Folding of ectoderm tissue
(B) Migration of mesoderm cells
(C) Fusion of ectoderm and mesoderm
(D) Extension of endoderm into a thin spinal column
(E) Contraction of the endoderm away from the mesoderm

Ans (A)

Q.108 What experiment was crucial in determining that axons themselves determined their growth pattern into tissues?
(A) Radioisotopes were used to trace the movement of axons in development
(B) Tissue culture of nerve cells allowed experimentation with and observation of axon growth
(C) Administration of neurological drugs demonstrated the action of axon growth
(D) Our understanding of molecular chemistry simply makes the pattern of growth logical
(E) All other factors were eliminated and nothing else could be located that determined axon growth pattern

Ans (B)

Q.109 At which stage do we begin to see development of the mesoderm germ layer?
(A) Gastrulation
(B) Neurulation
(C) Blastulation
(D) Cleavage
(E) Pupation

Ans (A)

Q.110 Somites, which form segmental muscles and vertebrae, develop from which germ layer?
(A) Epidermis
(B) Ectoderm
(C) Endoderm
(D) Mesoderm
(E) Myoderm
Ans (D)

Q.111 The nervous system develops from which germ layer?
(A) Epiderm
(B) Ectoderm
(C) Endoderm
(D) Mesoderm
(E) Myoderm
Ans (B)

Q.112 The formation of the heart to pump blood is best described as
(A) Delayed, since the circulatory system is the last system needed to complete the embryo
(B) Centralized, with heart muscle and blood cells forming at about the same time from ectoderm
(C) A gathering together of blood cells and clusters of mesoderm that form tubes that become the heart
(D) Continuous development of the yolk sac
(E) A gradual infolding of the umbilical structures that began as the allantois
Ans (A)

Q.113 Eggs with abundant yolk that is concentrated at the vegetal pole are called
(A) Mesolecithal
(B) Holoblastic
(C) Isolecithal
(D) Telolecithal
(E) Centrolecithal
Ans (D)

7. Development of chick

Q.113 The membrane composed of ectoderm and somatic mesoderm is known as
(A) Somatopleure (B) Splanchnopleure
(C) Visceralopleure (D) All of these

Ans (A)

Q.114 The cellular layer consisting of splanchnic mesoderm and endoderm is known as
(A) Somatopleure (B) Splanchnopleure
(C) Visceralopleure (D) Parietopleure

Ans (B)

Q.115 The lateral plate mesoderm is differentiated into 2 sheet like layers i.e. somatic mesoderm and
(A) Chorda mesoderm (B) Proper mesoderm
(C) Splanchnic mesoderm (D) Dermatogenic mesoderm

Ans (C)

Q.116 In chick gastrula _____ and _____ formation do not occur.
(A) Somatopleure, Splanchnopleure
(B) Primitive streak, Dorsal lip
(C) Invagination, Archentron
(D) Primitive streak, Ventral lip

Ans (C)

Q.117 Mesomere somite gives rise
(A) Digestive system (B) Muscles
(C) Skeleton (D) Excretory system

Ans (D)

Q.118 Muscles, axial skeleton and connective tissues are differentiated from
(A) Epimeres (B) Mesomere
(C) Hypomere (D) Endoderm

Ans (A)

Q.119 Coelom is formed from
(A) Epimere (B) Hypomere
(C) Mesomere (D) none of these

Ans (B)

Q.120 In 24 hours chick embryo the foldings of neural plate are clearly visible. At this stage embryo is called-
(A) Morula (B) Blastula
(C) Neurula (D) Blastocyst

Ans. (C)

Q.121 A tube of tissue formed by a thickening and rolling up of the neural plate during embryonic neurulation. It will later form the brain and spinal cord of the animal. This is called
(A) Neurocoel (B) Neural groove
(C) Neurospore (D) Neural tube

Ans (D)

Q.122 _____is the process of selection of activation of some genes by a cell, which are not activated by other cells of the embryo.
(A) Cell induction (B) Cell transformation
(C) Cell differentiation (D) Cell mediation

Ans (C)

Q.123 When the primitive streak reaches its maximum length, the cells of the most anterior region of the streak appear morphologically distinct. This region is known as
(A) Node of Raniver (B) Schwan's node
(C) Henson's node (D) None of these

Ans (C)

Q.124 Mechanism of differentiation depends up on _____ organization of unfertilized egg.
(A) Homogenous (B) Heterogeneous
(C) Exogenous (D) All A, B and C

Ans (B)

Q.125 The situation where one embryonic tissue influences an other so that the responding tissue differentiates is known as
(A) Instruction (B) Evocation
(C) Induction (D) None of these

Ans (C)

Q.126 The control development of cap in Acetabularia is through production of developmentally active substance in
(A) Nucleus (B) Cytoplasm
(C) Gray crescent (D) Both A and B

Ans (A)

Q.127 The technique of producing a genetically identical copy of an organism by replacing the nucleus of an unfertilized ovum with the nucleus of a body cell from the organism is
(A) Test tube baby (B) Cloning
(C) In vitro fertilization (D) All A, B and C

Ans (B)

9. Ageing and Teratology

Q.128 The study of degenerative changes in aging is called
(A) Developmental biology (B) Paedology
(C) Gerontology (D) Choronology

Ans (C)

Q.129 The science of studying and treating malformations and monstrosities of organisms is called
(A) Gerontology (B) Teratology
(C) Dermatology (D) Etiology

Ans (B)

Q.130 The normal process of development is disturbed by abnormalities. These abnormalities are due to
(A) Abnormal functioning of glands
(B) Abnormal Chromosomal number
(C) UV radiations

(D) All of these

Ans (D)

Q.131 In birds and mammals regeneration is mostly limited to the small wounds by the formation of a new tissue

(A) Callus (B) Scar
(C) Serous (D) None of these

Ans (B)

Q.132 Notochord is formed from

(A) Epimeres (B) Mesomeres
(C) Hypomeres (D) Henson's node

Ans (D)

Q.133 A condition in which heart is present towards right side of the chest is called

(A) Sinistrocardia (B) Dextrocardia
(C) Laterocardia (D) Both A and B

Ans (B)

Q.134 Decreased ability or inability of blood to clot is

(A) Thalassemia (B) Sickle cell anemia
(C) Haemophilia (D) Haemolysis

Ans (C)

Q.135 Turner's syndrome is

(A) Female sexual defect (B) Male sexual defect
(C) Autosomal recessive trait (D) Infectious disorder

Ans (A)

Q.136 A condition characterized by split in the upper lip and gap in the roof of mouth is

(A) Microcephaly (B) Polydactyly
(C) Klinefelter's syndrome (D) Cleft palate

Ans (D)

Q.137 Which one of the following is correct about Thalassemia

(A) Decreased clotting ability (B) Increased clotting ability

(C) Abnormal sickle shaped RBC (D) Fragile RBC cause hemolytic anemia

Ans (D)

Q.138 Which one of the following is correct about Microcephaly
(A) Small skull (B) Five fingers
(C) Gap in the roof of the mouth (D) Upper lip folded

Ans (A)

Q.139 Gray crescent is present in
(A) Eye of frog (B) Retina of cockroach
(C) Brain of frog (D) Zygote of frog

Ans (D)

Q.140 Which of the following reflects Weismann's model of development?

(A) Somatic development and change does not contribute directly to the characteristics of the next generation.
(B) Factors, or "determinants", in the nucleus regulate development.
(C) Asymmetric divisions resulted in unequal distribution of developmental determinants to daughter cells.
(D) Development is "mosaic".
(E) All of the above were important to Weismann's view of biological development

Ans (E)

Q.141 The experiments of Spemann and Mangold first defined what feature of amphibian embryos?

(A) The zygote
(B) The blastopore
(C) The neural tube
(D) The organizer
(E) The blastocoels

Ans (D)

Q.142 The folding of sheets of cells, the migration of cells, and cell death are all mechanisms of:

(A) Cleavage division
(B) Pattern formation
(C) Morphogenesis
(D) Differentiation
(E) Growth

Ans (C)

Key Terms

Acrosomal vesicle - membrane-bound organelle in the sperm head derived from the golgi apparatus; the vesicle containing enzymes that digest proteins and complex sugars in the outer coverings of an egg. Fusion of the acrosomal vesicle with the plasma membrane of the sperm (in the "acrosome reaction") exposes receptors that bind to the egg surface and is necessary for fertilization

Agglutination - the state of joining or clumping together by adhesion.

Aggregate - collection of units or particles (e.g., cells) forming a body or mass. (verb) - to form such a body or mass.

Albumen - The "white" of a bird's egg which provides both protein and water for the growing embryo.

Allantois - extra-embryonic membrane emerging as a sac from the hindgut's ventral wall; formed from the splanchnopleure (combination of endoderm and splanchnic mesoderm). Found in amniotes, it is one of the four extraembryonic membranes (chorion, amnion, allantois and yolk sac) that are adaptations of the terrestrial egg. It collects waste materials from the embryo, and as a part of the chorio-allantoic membrane can be a site of gas exchange.

Allometric growth or allometry - phenomenon whereby parts of the same organism grow at different rates. Contrast with isometric growth.

Amniocentesis - prenatal diagnostic procedure in which amniotic fluid is withdrawn from amniotic sac in order to obtain fluid and fetal cells which are analyzed for metabolic and/or genetic disorders, and to test the maturity of the fetus' lungs.

Amnion - the innermost membranous sac enclosing the embryo of an amniote; it becomes filled with amniotic fluid. One of the four amniote extraembryonic membranes; derived from the somatopleure (combination of ectoderm and somatic mesoderm)

Amniote - higher vertebrate capable of terrestrial reproduction, and having an amnion during its development. Includes reptiles, birds and mammals, which share a common ancestor.

Ampulla - upper region of the mammalian oviduct, near the ovary. Fertilization typically takes place in this region.

Analogous structures - structures having similar function or superficial appearance, but not necessarily sharing a common evolutionary origin (contrast with homologous structures).

Blastocoel - fluid-filled cavity found in the interior of a blastula or blastocyst.

Blastocyst - cleavage stage mammalian embryo; a hollow ball of cells made of outer trophoblast cells and an inner cell mass.

Blastoderm - cell layer formed during cleavage of telolecithal and centrolecithal eggs.

Blastomere - any embryonic cell formed during cleavage.

Blastopore - site of gastrulation initiation and later the opening of the archenteron at the vegetal region of certain embryos (e.g., echinoderm and amphibian); in deuterostome embryos it is the future anus of the organism.

Blastula - a cleavage stage embryo, typically a hollow ball of cells surrounding a cavity called the blastocoel; this term is used for (among others) echinoderm and amphibian embryos.

Capacitation - change in mammalian sperm that occurs after exposure to female genital tract making the sperm competent to undergo the acrosome reaction; this change is necessary for penetration of the cumulus matrix and for fertilization. Numerous molecular changes in the sperm are associated with capacitation, but the extent to which each event causes sperm capacitation is uncertain.

Chorion - one of the four extraembryonic membranes of amniotes; it forms from the somatopleure (ectoderm and somatic mesoderm). In birds and reptiles, the membrane adheres to the shell and is highly vascularized to serve in gas exchange. In mammals, it forms the fetal contribution to the placenta, made by trophoblastic tissue and extraembryonic mesoderm, containing blood vessels that allow exchange of materials with maternal circulation.

Chorionic somatomammotropin - aka placental lactogen, a hormone that promotes maternal breast development during pregnancy.

Cloning vector - intentionally designed artificial DNA construct used by molecular biologists to amplify selected pieces of DNA inserted into the construct; examples include plasmid, phage, phagemid, cosmid, fosmid, yeast artificial chromosome (YAC) and bacterial artificial chromosome (BAC). Cloning vectors minimally contain an origin of replication, selectable marker gene (e.g., ampicillin resistance gene), and multiple cloning site containing unique restriction enzyme sites; other useful features may also be present.

Compaction - event in early cleavage-stage mammalian embryo during which blastomeres become tightly joined, forming gap junctions enabling the exchange of ions and small molecules to pass from one cell to the next.

Delamination - splitting of one cellular sheet or layer into two parallel layers.

Differentiation - process whereby cells acquire their mature morphological and biochemical characteristics. Differentiation is often considered a 'final step' of development in which cells take on their mature function.

Differentiation-inducing factor (DIF) - a low molecular weight lipid that induces posterior cells of a *Dictyostelium* slug to differentiate as stalk cells as opposed to spore cells.

Discoidal cleavage - incomplete division of the blastodisc, a region of yolk-free, active cytoplasm; characteristic of birds, fishes and reptiles.

Ectoderm - (1) the outer cellular membrane of a diploblastic animal. (2) a: the outermost of the three primary germ layers of a triploblastic embryo. b: a tissue (as neural tissue) derived from this germ layer.

Endoderm - One of the three primary germ layers formed in the embryo, moved into interior by cell movements during gastrulation. In vertebrates, this innermost layer of cells goes on to form the linings of the gut (esophagus, stomach, intestines, rectum, colon), pharyngeal pouch derivatives (tonsils,thyroid, thymus, parathyroid glands), lungs, liver, gall bladder, pancreas. In amniotes, extraembryonic endoderm participates in the formation of the allantois and yolk sac.

Endostyle - a ciliated, mucus-secreting groove in the ventral surface of the pharnyx of non-vertebrate chordates (e.g, tunicates and lancelets); it aids in transporting food to the esophagus. Recent molecular evidence supports the traditional view that the endostyle is homologous to the vertebrate thyroid gland.

Embryology - study of embryogenesis, the development of animals and plants from fertilization to birth/hatching.

Epiboly - The growth of epidermal ectoderm to cover the surface of the embryo during gastrulation.

Epigenesis - theory holding that development is a gradual process of increasing complexity. (This contrasts with preformationism, which holds that the organism is already present in the gamete(s), merely growing and unfolding during development.) For example, organs are formed de novo in the embryo rather than increasing in size from pre-existing structures.

Epithelial - belonging to a sheet of tightly joined, polarized cells.

Fate map - diagram that takes the larval or adult structure of an organism and "maps" it onto the region of the embryo from which it arises

Fertilization cone - a prominence extending from the surface of some eggs at the moment of, or in some cases allegedly shortly before contact with a sperm.

Fission - asexual reproduction in which the parent organism divides into two or more parts, each developing into genetically identical individuals.

Gastrulation - stage in animal development following cleavage characterized by extensive cell movement and rearrangement to form a "three-layered" embryo of ectoderm, mesoderm and endoderm.

Gene cloning - isolation and amplification of selected pieces of DNA by recombinant DNA techniques.

Hensen's node - regional thickening of cells at the top (anterior) of the primitive groove through which gastrulating cells migrate anteriorally to form tissues in the future head and neck. Found in birds, reptiles and mammals, it is the functional equivalent of the dorsal lip of the blastopore in amphibians. Also known as the primitive knot.

Holoblastic cleavage - complete cleavage - major pattern of embryonic cell divison in which cytokinesis completely separates cells during division; it is typically seen in smaller eggs containing moderate (mesolecithal) to sparse (isolecithal) yolk. Examples of eggs that divide holoblastically include those of amphibians, mammals, non-vertebrate chordates, echinoderms, most molluscs, annelids, flatworms, nematodes.

Homologous recombination - process whereby stretch of DNA in a chromosome is replaced by a homologous (highly similar) DNA molecule for the purpose of altering the gene's function.

Hyalin - protein released by cortical granules forming a coating around the sea urchin egg; the hyaline layer provides support for the blastomeres during cleavage.

Hyaluronidase - enzyme that degrades hyaluronic acid (a glycosaminoglycan extracellular matrix constituent).

Invagination - the infolding of a sheet of cells, much like the indenting of a hollow rubber ball when poked.

Involution - a type of cell movement during gastrulation which involves the inturning or inward movement of an expanding outer layer so that it spreads over the internal surface of the remaining external cells.

Isogamous - having haploid gametes that are similar in size, structure and motility.

Larva - immature (non-reproductive) post-embryonic form of many animals, which hatches from an egg and may look significantly different than the adult (reproductive) form.

Lanugo - Thin and closely spaced hairs which are the first hairs in the human embryo. This type of hair is usually shed before birth and is replaced by the short and silky vellus.

Macromere - large blastomere; in the sea urchin embryo, the four relatively large cells that result from the fourth cleavage of the vegetal tier are macromeres. Contrast with micromere and mesomere.

Marginal zone - region near the equator of the amphibian blastula, where the animal and vegetal hemispheres meet; gastrulation begins among these cells.

Meroblastic cleavage - incomplete cleavage, characteristic of zygotes with large accumulations of yolk.

Merogones - egg fragments (in sea urchins) that can divide and develop, even if they have only a haploid nucleus.

Mesenchyme - mesodermal cells in a developing embryo with the ability to move freely and individually.

Mesoderm - primary embryonic germ layer of triploblastic animals found between the outer ectoderm and the inner endoderm, which (in chordates) gives rise to notochord, bone, cartilage, muscle, other connective tissues, somatic gonad, urogenital tracts, kidneys, heart and circulatory system, blood, and portions of extraembryonic membranes (in amniotes).

Neural tube - hollow cylindrical structure of neuroepithelial cells (in chordate embryos) that will give rise to the brain and spinal cord; an ectodermal derivative.

Neuroblast - dividing neuronal precursor cell

Neurula - vertebrate embryo during neurulation.

Neurulation - organogenesis of the nervous system in vertebrate embryos during which dorsal neuroectoderm cells of the neural plate (typically) roll up to form the neural tube which gives rise to the central nervous system.

Nieuwkoop center - vegetal cells of presumptive dorsal endoderm that signal overlying equatorial/marginal cells in the amphibian blastula to form dorsal mesoderm/organizer.

Notochord - rigid cartilaginous rod found at the dorsal midline in all chordate embryos (it is their defining feature) derived from dorsal mesoderm (chordamesoderm). In vertebrates, it is typically a transient embryonic structure.

Oogamy - a specialized form of heterogamy, which involves the production of large, relatively immotile eggs by one mating type and small, motile sperm by the other.
Organogenesis - creation of specific tissues and bodily organs by cell interaction and rearrangement following gastrulation
Parthenogenesis - special reproductive strategy in which unfertilized eggs undergo cell division and embryogenesis to develop into viable adult individuals ("virgin birth"). The embryo develops without a genetic contribution from the sperm, although in some species fertilization is necessary for egg activation.
Placenta - embryonic/maternal organ that serves nutritional and respiratory functions of the mammalian fetus; composed of embryonic chorion and maternal uterine endometrium, allowing provision of oxygen and nutrients to the fetus and removal of carbon dioxide and other waste products.

Primitive streak - thickening of the epiblast cell layer caused by movement of mesodermal cells into the blastocoel; this structure is characteristic of avian, reptilian and mammalian gastrulation.

Proliferate - to grow or multiply by rapidly producing new tissue, parts, cells, buds, or offspring.

Yolk platelets - membrane-bound discs containing high concentrations of yolk found in eggs.

Yolk plug - a patch of vegetal cells (endoderm) that remains exposed in the blastopore after the formation of the ventral lip during gastrulation.

Yolk sac - the first of four extraembryonic membranes of amniotes to form during embryogenesis. Like the allantois, it arises from the splanchnopleure (endoderm and splanchnic mesoderm) to surround the mass of yolk in reptile and bird eggs. It is connected to the midgut by the yolk stalk. The yolk sac also forms in mammals, despite the absence of yolk.

Zona pellucida - a thick extracellular matrix surrounding the mammalian ovum (egg) which binds sperm and initiates the acrosome reaction of the sperm.

Zygote - diploid cell created by the union of two haploid gametes; a fertilized egg.

B.Sc. (Part I) Examination, 2014

(Faculty of Science)

[Also common with subsidiary Paper of B.Sc. (Hons.)Part I]

(Three – Year Scheme of 10+2+3 Pattern)

Zoology

Third Paper

Gamete and Development Biology

Time allowed : Three Hour **Maximum Marks : 34**

Part I

1. Answer the following questions in one word or one sentence only :-

   (a) What is Parthenogenesis?

   (b) What is Blastema ?

   (c) Name two biological stains.

   (d) What are transgenic animals?

   (e) What are the three advantages of internal fertilization?

   (f) What are fate maps?

   (g) What are centrolecithal eggs?

   (h) What is discoblastula ?

   (i) What is a deciduate placenta?

   (j) Name the type of cleavage found in frog.

Part II

Attempt FOUR questions from Part II, selecting at least ONE question from each Section.

Each question carries 6 marks.

SECTION A

2. What is fertilization ? Describe the mechanism of fertilization and give its significance.

3. What is gametogenesis ? Give a comparative account of spermatogenesis and oogenesis.

4. Write short notes on :-
   (a) Parthenogenesis
   (b) Acrosome reaction.

SECTION B

5. Give definition, plane and pattern of cleavage in non-chordates and chordates.

6. Explain the different types of deciduate placenta found in mammals.

7. Write short notes on :-
   (a) Morphogenetic cell movement
   (b) Competence.

SECTION C

8. Write an essay on Regeneration.

9. Explain briefly cloning in animals. What are its advantages ?

10. Write Short notes on :-
    (a) Stem cells
    (b) Teratogenesis.

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B.Sc. (Part I) Examination, 2011

(Faculty of Science)

[Also common with subsidiary Paper of B.Sc. (Hons.)Part I]

(Three – Year Scheme of 10+2+3 Pattern)

Zoology

Third Paper

Gamete and Development Biology

Time allowed : Three Hour **Maximum Marks : 34**

Question No. 1 part-I is compulsory. Attempt four questions from Part-II selecting at least one question from each section. All questions in Part-II carry equal 6 marks.

Part – I

1. Answer the following question in one word or one sentence only 1x10=10

(a) What are blastomeres?

(b) Define gametogenesis.

(c) Acrosome contain…….enzyme.

(d) Outer shell of Hen's egg is made up of……

(e) Who propounded Biogenetic Law?

(f) What do you understand by differentitation?

(g) What is Aechenteron?

(h) Name two vital dyes.

(i) What are transgenic animals?

(j) Who established Primary Organizer concept?

Part II

Section-A

2. Describe the process of Oogenesis with suitable diagrams.
3. Describe basic features/stages of embroyonic development.
4. Write notes on any two:
   (i) Vitellogenesis
   (ii) Hen's egg
   (iii) Preformation theory.

Section-B

5. Which short notes on any two:
   (i) Fate map
   (ii) Blastulation
   (iii) Significance of gastrulation.
6. Define placenta and classify iton the basis of histology.
7. Describe various patterns of cleavage in animals.

Section-C

8. Describe the process of regeneration in different vertebrates.
9. Write an essay on teratogenesis.
10. Describe in brief animals cloning and its advantages.

B.Sc. (Part I) Examination, 2010

Zoology

Third Paper

Gamete and Development Biology

Time allowed : Three Hour **Maximum Marks : 34**

Question No. 1 part-I is compulsory. Attempt four questions from Part-II selecting at least one question from each section. All questions in Part-II carry equal 6 marks.

Part – I

1. Answer the following questions in 2 or 3 lines only (maximum 25 words) :

   (a) What is biogenetic law of development?

   (b) What are the structure present in the middle piece of spermatozoa?

   (c) Writ ethree advantages internal fertilization?

   (d) Define parthenogenesis.

   (e) What is spiral cleavage? Give one example.

   (f) What are application of fate maps?

   (g) Define epimorphic regeneration.

   (h) What do you understand by differentiation?

   (i) What are embryonic stem cells?

   (j) Write application of embroyo transfer technique. 1x 10 =10

Part II

Section-A

2. What is embryology? How does it differ from development biology? Write a brief historical account of embryology.

3. In which part of testis does spermatogenesis take place ? Write the various phases of spermatogenesis with suitable diagrams write chemical nature of acrosome.

4. Write short notes on any two of the following:

(i) Changes in the organization of the egg cytoplasm after fertilization.

(ii) Spermatogenesis

(iii) vitellogenesis

Section-B

5. Explain embryonic induction with the help of suitable diagrams.

6. Describe the development of chick during the first 24 hours with the help of suitable diagrams. What is the fate of primitive streak?

7. Write short notes on any two of the following:

(i) Significance of gastrulation

(ii) Types of placenta on the basis of histology

(iii) Primary organizer.

Section-C

8. Write various types of stem cells and their application in biomedical sciences.

9. Describe in brief the techniques of animal cloning.

10. Write short noes on any two of the following:

(i) Types of regeneration

(ii) Teratology

(iii) Causes of ageing

B.Sc. (Part I) Examination, 2009

Zoology

Third Paper

Gamete and Development Biology

Time allowed : Three Hour **Maximum Marks : 34**

Question No. 1 part-I is compulsory. Attempt four questions from Part-II selecting at least one question from each section. All questions in Part-II carry equal 6 marks.

Part – I

1. Answer the following question in 2 or 3 lines only (maximum 25 words) : 1 x 10 =10

   (a) What is ontogeny?

   (b) What is complete parthenogenesis? Give one example.

   (c) Name the proteins of the Avian yolk.

   (d) What is Heteromorphosis?

   (e) What is chalone?

   (f) What is teratogenesis?

   (g) What is epiblast?

   (h) Write names of principal hormones secreted by placenta.

   (i) Write the features of Down's syndrome.

   (j) Write changes which occur in mitochondria as a result of ageing.

Part II

Section-A

2. What is gemetogenesis? Give a comparative account of Spermatogenesis and oogenesis.

3. Describe the mechanism of fertilization with suitable diagrams.

4. Write short notes on the following:

   (a) Vitellogenesis

(b) Natural parthenogenesis

(c) Theory of epigenesist

Section-B

5. Describe various patterns and types of cleavage.

6. Describe various types of deciduate placenta found in mammals.

7. Write short notes on:

(a) Morphogenetic cell movement

(b) Extra embryonic membranes.

Section-C

8. Write an essay on regeneration.

9. What is ageing? Explain the effects and causes of ageing.

10. Write short notes on:

(a) Types of stem cells on the basis of potency

(b) Nuclear transfer technique.

B.Sc. (Part I) Examination, 2008

Zoology

Third Paper

Gamete and Development Biology

Time allowed : Three Hour **Maximum Marks : 34**

Question No. 1 part-I is compulsory. Attempt four questions from Part-II selecting at least one question from each section. All questions in Part-II carry equal 6 marks.

Part – I

1. Answer following questions in 2 or 3 lines only (maximum 25 words) : 1 x 10 = 10

   (a) What is Biogenetic law?

   (b) Name the cell organelle from which (a) Axial filament and (b) Acrosome of Sperm are formed.

   (c) What is the role of informosomes formed during oogenesis?

   (d) What is complete parthenogenesis ? Give one example.

   (e) Writ e name of egg membranes found in the egg of Hen.

   (f) Write names of germ layers from which (a) Kidney and (b) Liver are developed.

   (g) What is teratogenesis?

   (h) Give two examples of superficial implementation and interstitial implemtation.

   (i) Write changes which occur in mito-chondria as a result of Ageing.

   (j) Write characteristic features of Down syndrome.

Part II

Section-A

2. Write an account of growth phase during oogenesis.

3. Describe mechanism of fertilization with suitable diagrams.

4. Write short notes on the following:
   (a) Theory of Epigenesis
   (b) Acrosome Formation
   (c) Natural parthenogenesis

Section-B

5. Describe various patterns and planes of cleavage.
6. Describe morphogenetic cell movement and their significant in gastrulation.
7. Write an essay on extra embryonic membranes.

Section-C

8. Write short notes on:
   (a) Effect of Aging
   (b) Factors of Carcino Genesis
9. Describe nuclear transfer technique of somatic cell with suitable diagrams.
10. Write brief account on the following
   (a) Limb regeneration
   (b) Types of stem cell on the basis of source.

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Bibilography

- **Dye**, Human Life Before Birth
- **Gilbert**, Developmental Biology, Seventh Edition
- **Gilbert and Reunions** (Editors), Embryology, Constructing the Organism
- **Tyler**, Developmental Biology: A Guide for Experimental Study, Second Edition
- **K.C. Soni,** Gamete and Deveolopment Biology

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Notes

Notes