B.Sc. (Vth Semester) Examination, 2015-16
Zoology
Paper: LZC-503 (AV-8914)
(Reproductive & Developemental Biology)
Model answer

Section A:

1.

i. (a)

ii. (c)

iii. (a)

iv. (d)

v. (b)

vi. (a)

vii. (b)

viii. (b)

ix. (c)

x. (b)

Section B:

Answer No. 2.

The reproductive mode is characteri zed by the egg-type (size, yolk amount and distribution, egg envelopes), and by the type of development (direct, or indirect with larval stage and metamorphosis; external or internal to the maternal body). The reproductive strategy, the main factor of which is usually the mode of reproduction, is determined by the way an individual or a population responds, under given environmental conditions.

Following reproductive strategies are generally shown by the vertebrates:

1. External and Internal fertilisation
2. Oviparity, ovoviviparity and viviparity

There are two basic types of reproduction, asexual and sexual. Sexual reproduction is much more common among vertebrates. Sexual reproduction involves specialized reproductive cells or gametes. These cells are haploid, and are usually produced by meiosis. Sexual reproduction involves fertilization, the union of gametes to form a zygote. The zygote is a single cell, and it is genetically different from either of the parents due to recombination during meiosis, and due to the union of genetic material from two different organisms.

There are following types of fertilization in vertebrates:

1. External fertilization
2. Internal fertilization

EXTERNAL FERTILISATION	INTERNAL FERTILISATION
Syngamy occurs outside of the body of organisms.	Syngamy occurs inside of the body of organisms.
Large number of gamets (male & female) are released into surrounding medium. E.g. bony fish, amphibians	Number of ova are less, but large number of male gametes are formed. E.g. birds, mammals, earthworm.

External fertilization in an aquatic environment protects the eggs from drying out. Broadcast spawning can result in a greater mixture of the genes within a group, leading to higher genetic diversity and a greater chance of species survival in a hostile environment. While internal fertilization has the advantage of protecting the fertilized egg from dehydration on land. The embryo is isolated within the female, which limits predation on the young. Internal fertilization also enhances the fertilization of eggs by a specific male.

In terms of offspring production, sexual reproduction has 3 main forms:

1. **Oviparous**
   I. internal or external fertilization
   II. development in the egg in the environment
   III. with or without parental care
   Example: fish, amphibians, reptiles, birds, mammals

2. **Ovoviviparous**
   I. internal fertilization
   II. development in the egg within the female body
   III. egg hatches within the body just prior to birth
   Example: Some fishes, reptiles

3. **Viviparous**
   I. internal fertilization
   II. young develop internally
   III. young receive nourishment from mother
      - via placenta
      - from surface of uterine wall

- via specialized structures
- via production of excess eggs

Example: Elasmobranchs, amphibians, reptiles, mammals

Answer No. 3

Menstrual cycle:

The menstrual cycle is the cycle of natural changes that occurs (in the human fertile females and other female primates) in the uterus and ovary. The menstrual cycle is essential for the production of eggs, and for the preparation of the uterus for pregnancy. The cycle occurs only. In human females, the menstrual cycle occurs repeatedly between the age of menarche, when cycling begins, until menopause, when it ends.

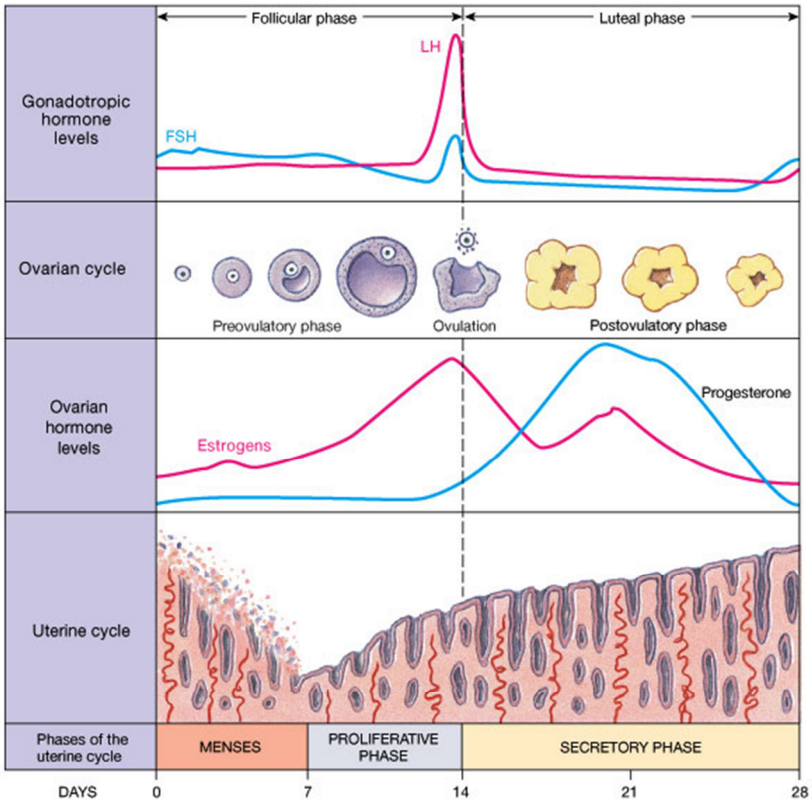


Figure showing different hormonal level during different menstrual cycle stages

It comprises of three ovarian and three uterine cycle phases:

Ovarian cycle phases:

1. **Follicular phase**

   The follicular phase is the first part of the ovarian cycle. During this phase, the ovarian follicles mature and get ready to release an egg. Through the influence of a

rise in follicle stimulating hormone (FSH) during the first days of the cycle, a few ovarian follicles are stimulated.

2. **Ovulatory phase**
   Ovulation is the second phase of the ovarian cycle in which a mature egg is released from the ovarian follicles into the oviduct. During the follicular phase, estradiol suppresses production of luteinizing hormone (LH) from the anterior pituitary gland.
3. **Luteal phase**
   The luteal phase is the final phase of the ovarian cycle and it corresponds to the secretory phase of the uterine cycle. During the luteal phase, the pituitary hormones FSH and LH cause the remaining parts of the dominant follicle to transform into the corpus luteum, which produces progesterone.

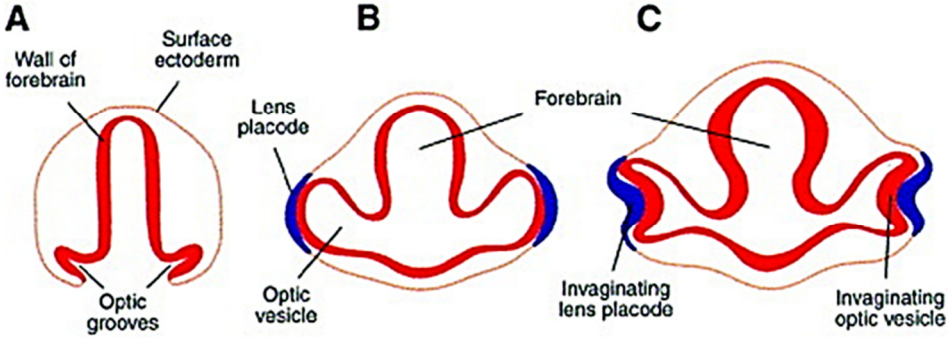
Uterine cycle phase:

1. **Menstruation phase**
   Menstruation is the first phase of the uterine cycle.
2. **Proliferative phase**
   The proliferative phase is the second phase of the uterine cycle when estrogen causes the lining of the uterus to grow, or proliferate, during this time. As they mature, the ovarian follicles secrete increasing amounts of estrogen.
3. **Secretory phase**
   The secretory phase is the final phase of the uterine cycle and it corresponds to the luteal phase of the ovarian cycle. During the secretory phase, the corpus luteum produces progesterone, which plays a vital role in making the endometrium receptive to implantation.

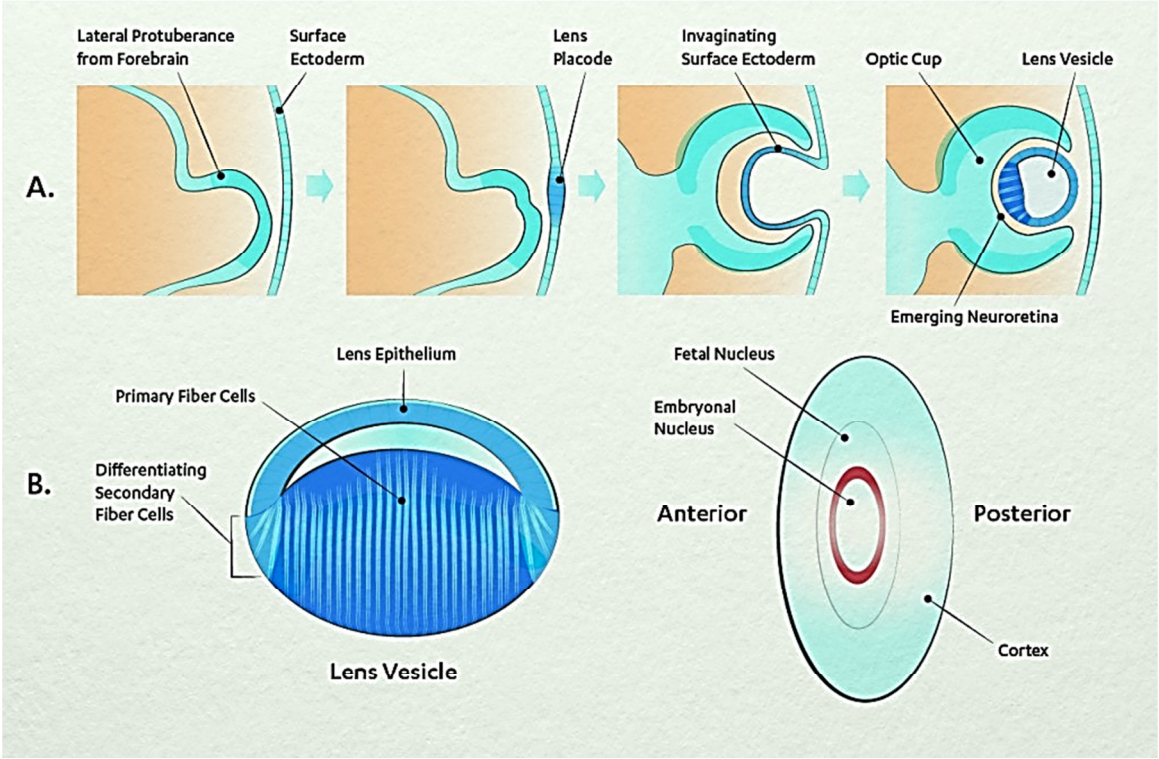
Answer No. 4

Development of eye:

Chorda mesoderm, the primary organizer induces the formation of fore-brain and optic area in the anterior part of the embryo. The optic area evaginates forming the optic vesicle. By invagination it changes into a double walled cup-like structure, the optic cup which acts as secondary organizer to induce the formation of tertiary organizer to form cornea.



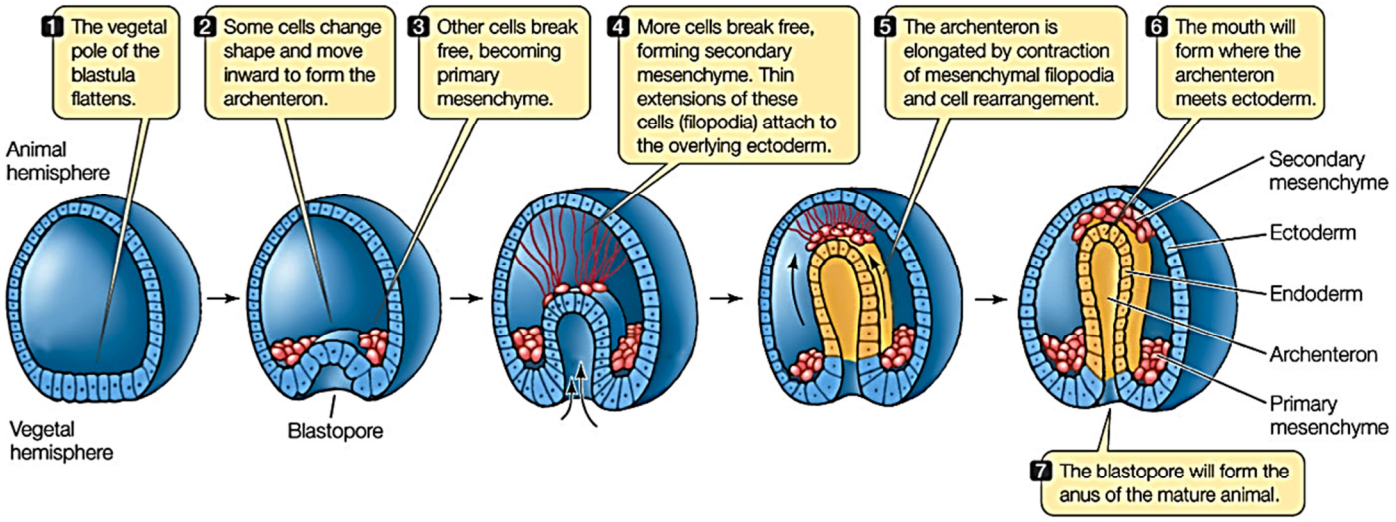
The layer of mesenchyme left in front of the anterior chamber of eye combines with the overlying somatic ectoderm (epidermis) and forms cornea, choroid and sclera.Thus the whole process of development seems to be a cause of induction and interaction only. Number of inductions are secondary or tertiary such as nasal-groove, optic vesicle, lens, cornea and so on involve ectodermal reactions.



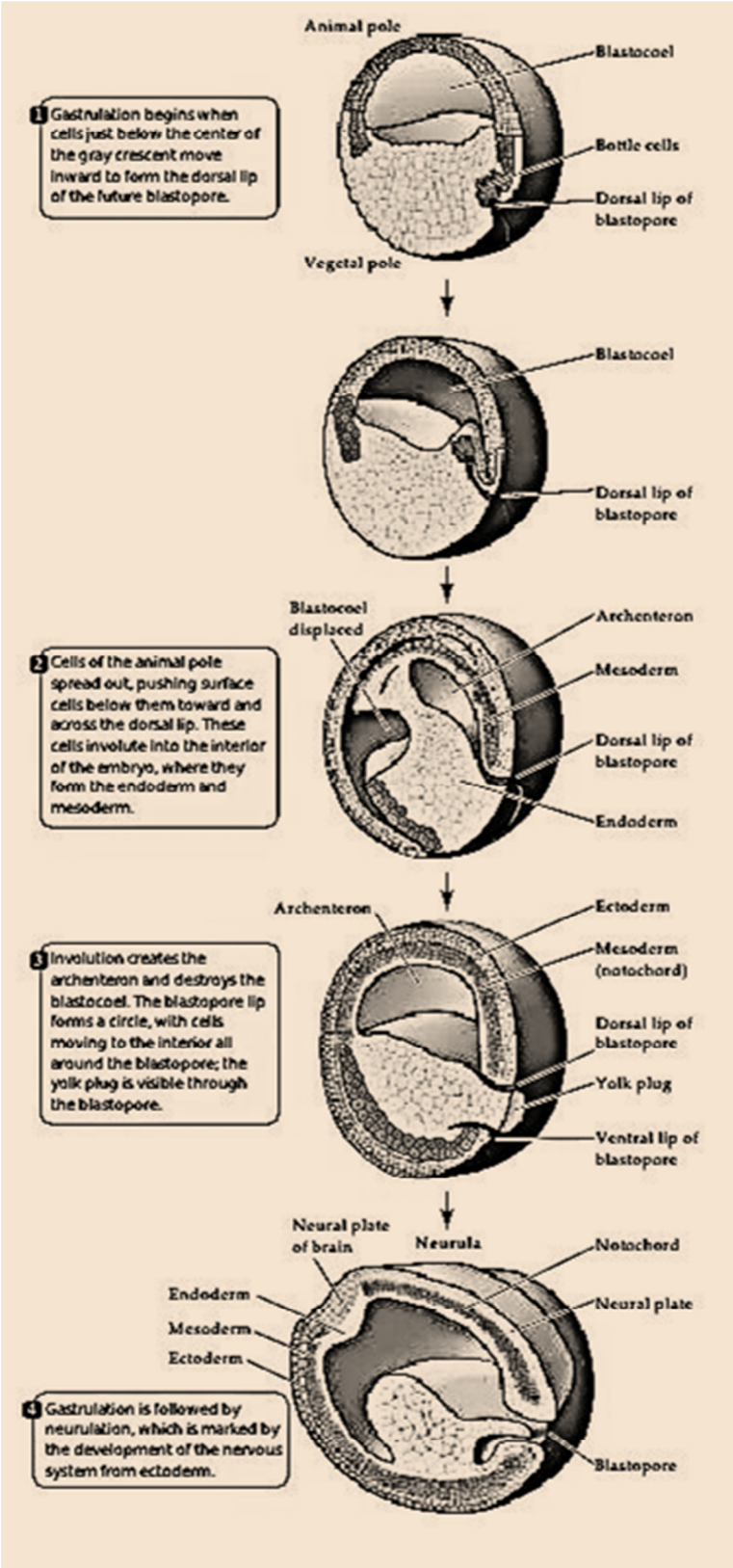
The induction of the eye starts at gastrulation, the involuting endoderm and mesoderm interact with the adjacent prospective head ectoderm to give the head ectoderm a lens-forming bias. The activation of the head ectoderm's latent lens-forming ability and the positioning of the lens in relation to the retina is accomplished by the optic vesicle. It extends from the diencephalon, and when it meets the head ectoderm, it induces the formation of a lens placode, which then invaginates to form the lens. The optic vesicle becomes the two-walled optic cup, whose two layers differentiate in different directions. The cells of the outer layer produce melanin pigment and ultimately become the pigmented retina. The cells of the inner layer proliferate rapidly and generate a variety of glia, ganglion cells, interneurons, and light-sensitive photoreceptor neurons. Collectively, these cells constitute the neural retina. The retinal ganglion cells are neurons whose axons send electrical impulses to the brain. Their axons meet at the base of the eye and travel down the optic stalk. This stalk is then called the optic nerve.

Answer No. 5

Sea urchin gastrulation:



Amphibian gastrulation:



Answer No. 6

Organizer has the ability for self-differentiation and organization. It also has the power to induce changes within the cell and to organize surrounding cells, including the induction and early organization of neural tube. Primary organizer determines the main features of axiation and organization of the vertebrate embryo.

The Functions of the Organizer

The properties of the organizer tissue can be divided into five major functions:

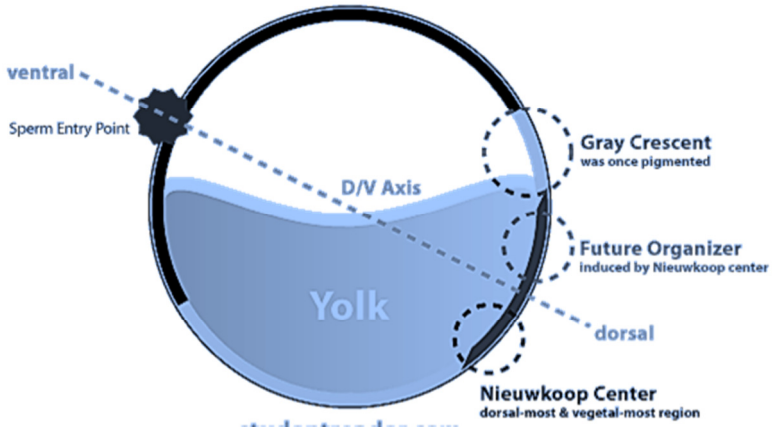
1. The ability to become dorsal mesoderm (prechordal plate, chordamesoderm, etc.)

2. The ability to dorsalize the surrounding mesoderm into lateral mesoderm (when it would otherwise form ventral mesoderm)

3. The ability to dorsalize the ectoderm into neural ectoderm

4. The ability to initiate the movements of gastrulation

5. The ability to cause the neural plate (the induced neural ectoderm) to become the neural tube



The Nieuwkoop Center is the dorsal- and vegetal-most cell of the early blastula. It gives rise to thePrimary Organizer, which is the dorsal lip of the blastopore (DLB). The Primary Organizer has a dorsalizing effect, and together with the Sperm Entry Point (SEP) gives rise to the dorsal/ventral axis. Dorsalized tissue gives rise to somites and pronephric tubules.

The Primary Organizer is also called the Spemann(-Mangold) Organizer/Node after Spemann and Mangold, whose experiments found that the DLB dorsalizes surrounding tissue, thus forming (along with the SEP) the dorsal-ventral axis. Thus the DLB was named after them.

Answer No. 7

Potency is taken from the Latin term "potens" which means "having power." Cell potency is a cell's ability to differentiate into other cell types. The more cell types a cell can differentiate into, the greater its potency.

Potency specifies the differentiation potential (the potential to differentiate into different cell types).

1. Totipotent cells can differentiate into embryonic and extraembryonic cell types. Such cells can construct a complete, viable organism
2. Pluripotent cells are the descendants of totipotent cells and can differentiate into nearly all cells i.e. cells derived from any of the three germ layers.
3. Multipotent cells can differentiate into a number of cell types, but only those of a closely related family of cells.
4. Oligopotent cells can differentiate into only a few cell types, such as lymphoid or myeloid stem cells.
5. Unipotent can produce only one cell type, their own.

Stem cells:

Stem cells are undifferentiated biological cells that can differentiate into specialized cells and can divide (through mitosis) to produce more stem cells.

Properties

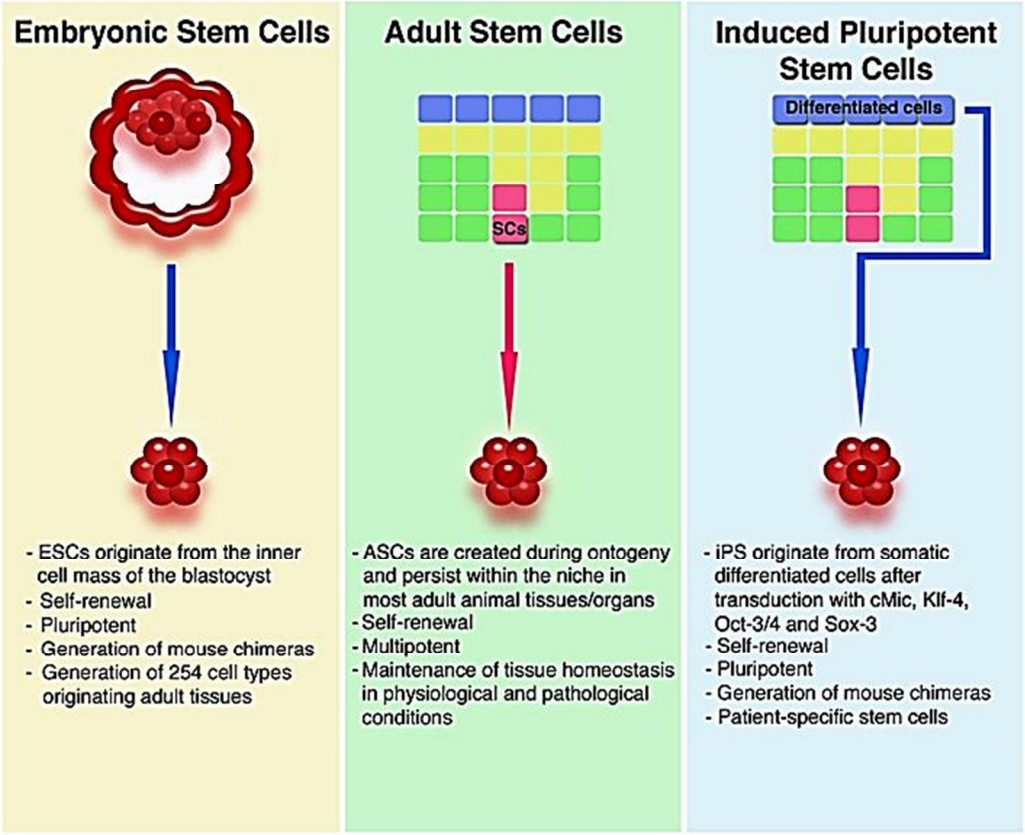
1. Self-renewal: the ability to go through numerous cycles of cell division while maintaining the undifferentiated state.
2. Potency: the capacity to differentiate into specialized cell types.

Stem cell can be categorized into following types:

1. Embryonic stem cells. These stem cells come from embryos that are three to five days old. At this stage, an embryo is called a blastocyst and has about 150 cells.
2. Adult stem cells. These stem cells are found in small numbers in most adult tissues, such as bone marrow or fat. Compared with embryonic stem cells, adult stem cells have a more limited ability to give rise to various cells of the body.

Except these two cell types an another stem type is also reported:

Induced pluripotent stem cells are a type of pluripotent stem cell that can be generated directly from adult cells.



Answer No. 8

Blastula

Blastula represents the first important stage after the fertilization and plays an important role in the development of organisms. It is a hollow, spherical, one celled thick structure formed by the process called blastulation. Both holoblastic and meroblastic cleavages give rise to blastula. The cavity inside the blastula is called blastocoel, and its outer single cell layer is called blastoderm.

Gastrula

The continuous development of blastula finally results the gastrula. The conversion process of the blastula into gastrula is called ‘gastrulation’. Gastrulation is followed by the organogenesis. Gastrula is composed of three primary germ layers, which eventually give rise to organs in the late embryo. The primary germ layers are ectoderm, mesoderm, and endoderm. Ectoderm is the outermost layer of gastrula, which differentiates into skin, brain, spinal cord, and nerves of embryo. Mesoderm is the middle layer, which forms muscles, connective tissues, reproductive

organs, cartilage, bones, and dermis of skin and dentine of teeth. Endoderm is the innermost layer of the embryo and basically differentiates into primitive gut.

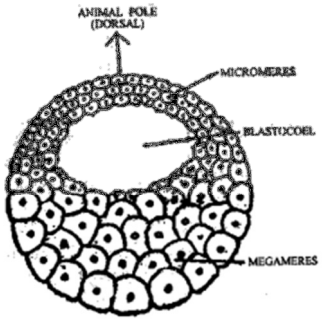
Difference between Blastula and Gastrula

(i) During the embryogenesis process, formation of blastula is followed by gastrula.
(ii) Formation of blastula is called blastulation, whereas the formation of gastrula is called gastrulation.
(iii) Rapid mitotic divisions of zygote results blastula while slow mitotic divisions of blastula results gastrula.
(iv) During the formation of blastula, cells do not move, but during the formation of gastrula, cell masses move by morphogenetic movements.
(v) Three primary germ layers are present in gastrula unlike in the blastula.
(vi) Blastula is often called a pre-embryo, whereas gastrula is referred to as a mature embryo.
(vii) Gastrula has more cells than blastula.
(viii) Gastrula has differentiated cells, while blastula has undifferentiated cells.

Types of Blastula of chordates:

In chordate the blastula are of following type –

a. Coeloblastula

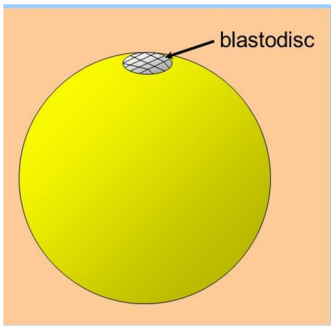


(Blastula of Telolecithal frog Eggs)

A blastula having cavity inside is called coeloblastula. It is formed through complete holoblastic cleavage. The blastoderm is formed of a single layer of cells. Its blastocoel is filled with mucopolysaccaharide.

e.g. Echinoderms and Amphibians

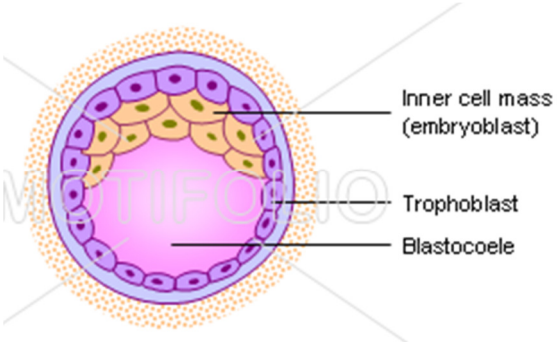
b. **Discoblastula**



It is formed as a result of discoidal cleavage. The blastocoel is small & it is called as subgerminal space. It is situated below the blastoderm.

eg. Bony fishes, reptile, birds & prototherian mammals.

c. **Blastocyst**



It is formed in mammals as a result of holoblastic cleavage.

Outer cells are called as trophoblasts or cells of Rauber. They form a trophoderm. This layer get attached to the uterine wall. Inner cells form the embryo are called as inner cell mass.

eg. Mammals (Human)

Resources: from different websites and text books.