

1.5. Determinate and Indeterminate Cleavage

Cleavages may be classified into determinate and indeterminate types based on the potentiality of the blastomeres for the future development.

1. **Determinate:** the developmental fate of each embryonic cell is established very early. If a cell is isolated from the 4-cell stage the embryo will not fully develop. This is because the fate of each blastomere is predetermined in the early embryonic stage itself. Annelids, mollusks and ascidians which produce mosaic type of eggs exhibit determinate cleavage.
2. **Indeterminate:** early embryonic cells retain capacity to develop into a complete embryo if isolated from other cells. Cleavage produces blastomeres which are qualitatively equipotential or totipotent. When they are isolated, they develop into complete embryos. This is because the fates of blastomeres are not predetermined in the early embryonic period. Vertebrates and certain invertebrates such as echinoderms which produce regulative type of eggs exhibit indeterminate cleavage.

2. Blastulation- types & mechanism

Blastulation is the formation of a blastula from a morula. The morula is an embryo filled evenly with cells (blastomeres), but the blastula contains a fluid cavity called blastocoel. In mammals, the blastula is called a blastocyst which consists of inner cell mass, trophoblast and blastocoel.

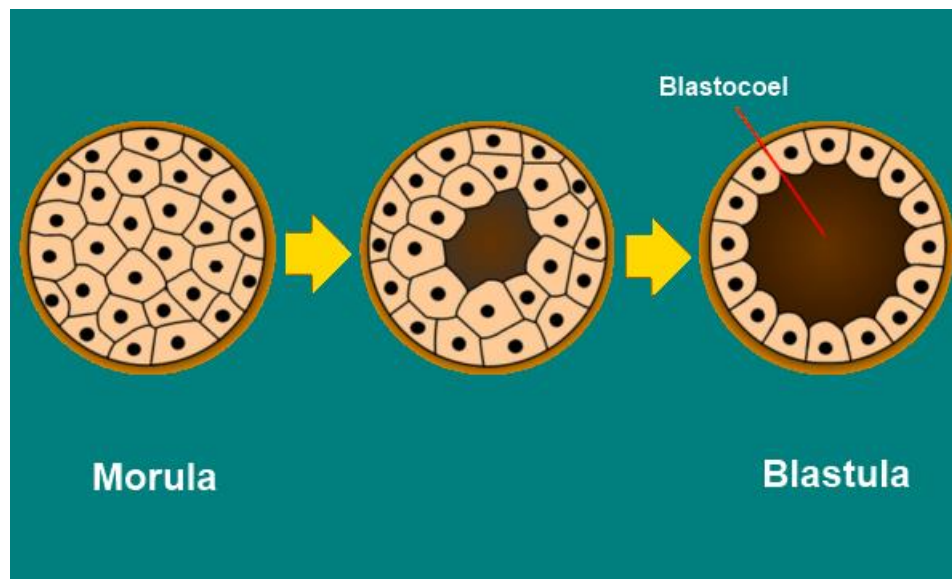


Figure.8. Blastula formation

During blastulation, cells continue to divide and begin to differentiate. The outer cells of the morula are polarized. That is, one side of the cell differs from the other side. The outer, polar cells give rise to trophoblast and the inner, apolar cells become the inner cell mass. The watery fluid of the blastocoel is secreted by trophoblast cells and transported in from the exterior. For the human, the blastocyst is formed by days 5 to 6 after fertilization. At this time, the blastocyst has reached the uterus, but has not yet implanted into the uterine wall. On day 5, preimplantation human embryo contains 200 to 250 cells, only 30 to 34 of which are inner cell mass cells.

In subsequent development, the cells of the inner cell mass will give rise to all tissues of the embryo's body. The embryonic stem cells are derived from the inner cell mass.

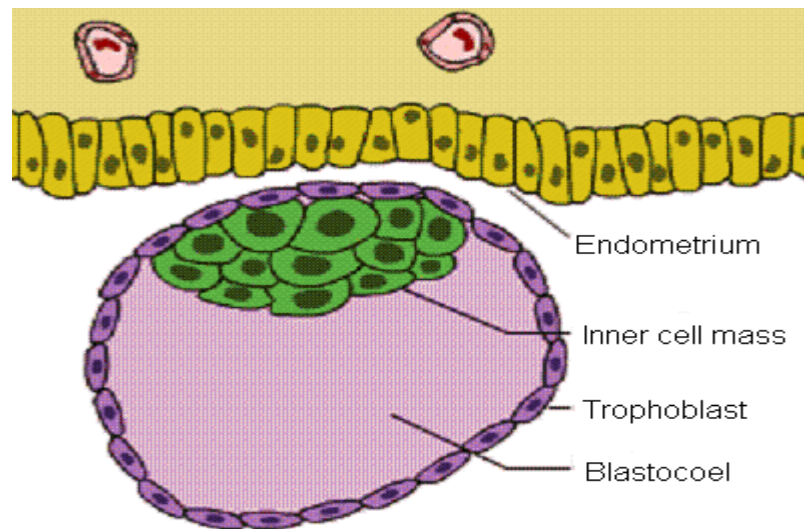


Figure.9. Blastocoel formation

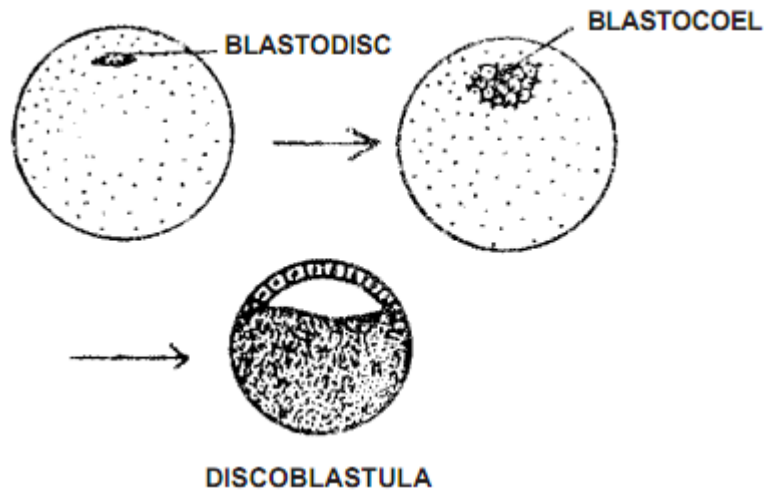
The blastula of various groups of animals differs in form and structure depending upon a variety of factors such as the size of the amount and distribution of yolk etc. The following categories of blastulae have been recognized in different groups of animals.

1 **Coeloblastula:** It is a hollow blastula containing a large spacious blastocoel. Usually, the blastocoel is filled with a fluid containing mucopolysaccharides. The blastula resulting from holoblastic equal cleavage, as in the case of echinoderms and amphioxus, is called equal coeloblastula. In this case, the blastoderm is single layered. Holoblastic unequal cleavage, as

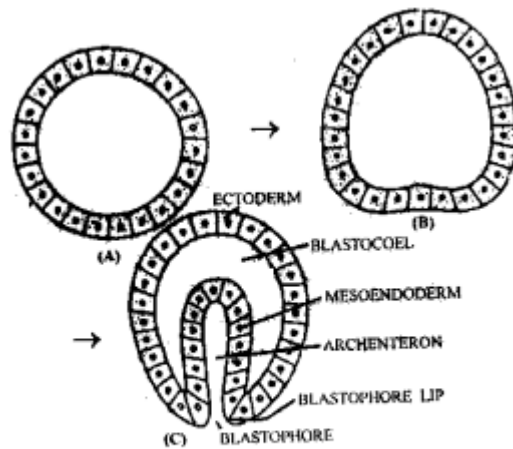
in frog, results in unequal coeloblastula. It has a blastocoel displaced towards the animal pole and a multilayered blastoderm.

2. Stereoblastula: This type of blastula is composed of an aggregate of larger sized and relatively lesser number of cells without or with extremely small blastocoelic space in the centre. Stereoblastula occurs in a variety of animals such as insects, some worms like *Nereis*, mollusks like *Crepidula*, gymnophionan amphibians and certain fishes.

3. Discoblastula: Discoblastula consists of a disc - shaped mass of blastomeres overlying a large yolk mass. This blastula is the result of meroblastic discoidal cleavage as in most fishes, reptiles and birds. There is no blastocoel, instead a slit like cavity called subgerminal cavity appears in between the blastoderm and the yolk mass.

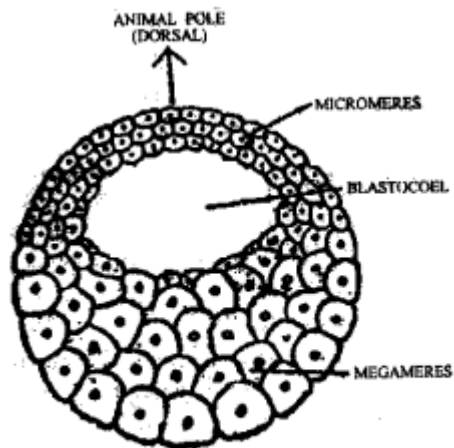


4. Blastocyst: It is the blastula stage of mammals; it consists of a hollow spherical vesicular blastula, containing an inner cell mass at the animal pole. The embryo proper develops from the inner cell mass. The outer single layer of cells which encloses the blastocoel is called the trophoblast. The trophoblast establishes relations with uterine wall and helps in nutrition of the developing embryo



(Blastulation in isolecithal Eggs)

5. Periblastula: a stage in the embryonic development of most arthropods having centrolecithal eggs. The periblastula is a vesicle whose wall consists of one layer of cells and whose cavity is filled with unbroken yolk. It forms as a result of the superficial segmentation of the egg.



(Blastula of Telolecithal frog Eggs)