Embryology

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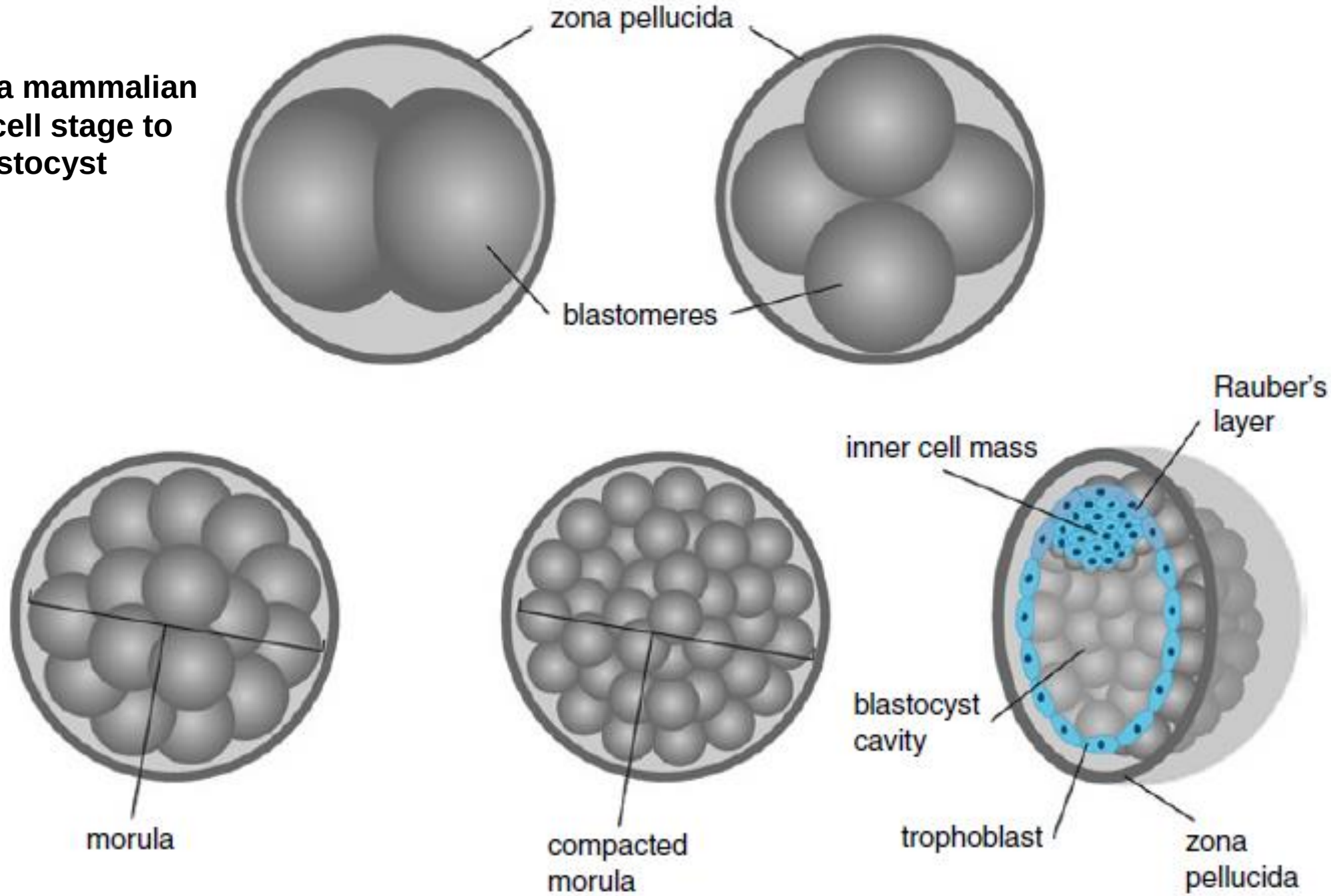
Year 2

Cleavage

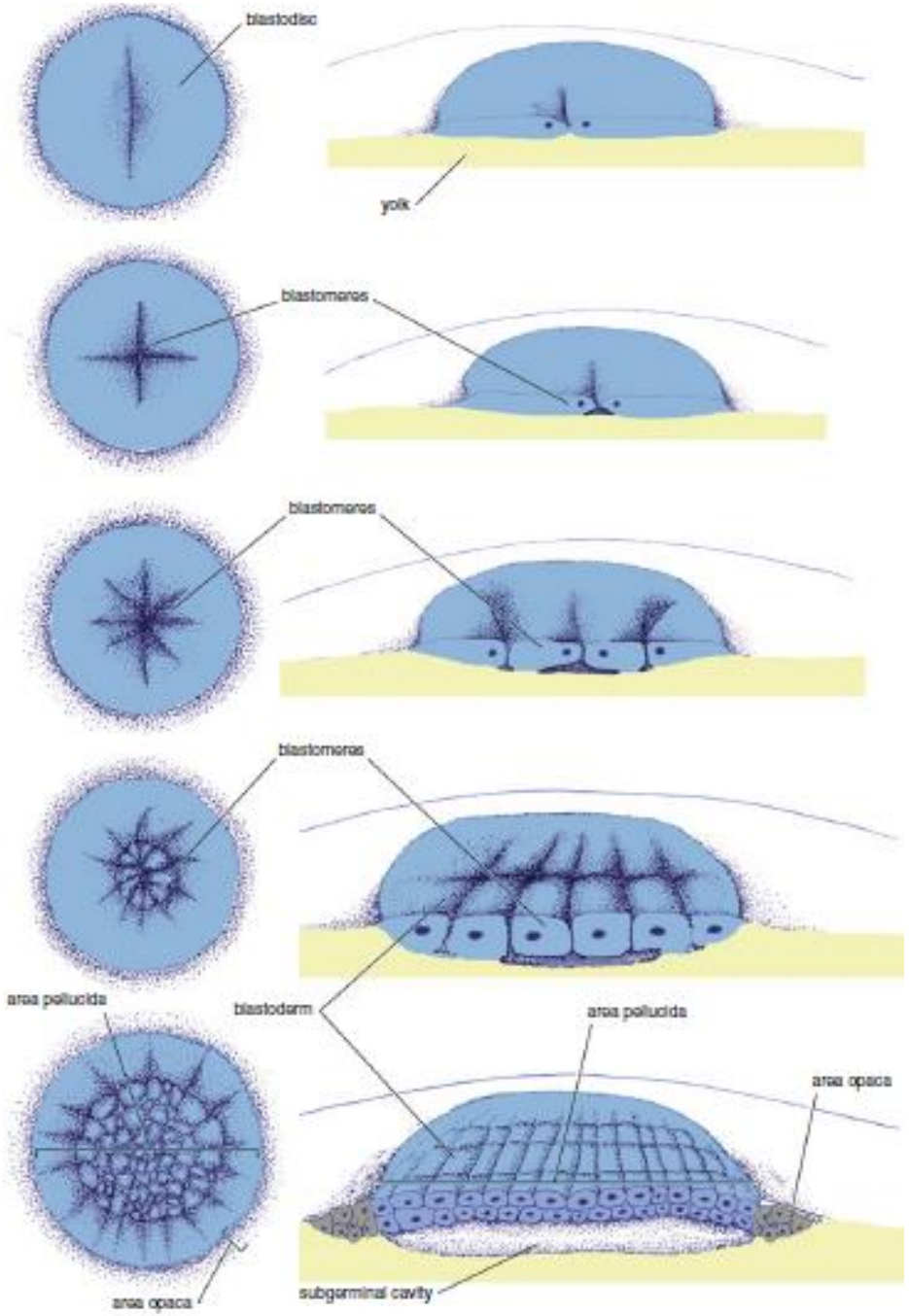
Cleavage

- The zygote undergoes several mitotic divisions, a process termed cleavage.
- **Blastomeres** are the two daughter cells produced by the first mitotic division of the zygote.
- Repeated division of the blastomeres results in formation of a sphere of cells, the **morula**.
- Compaction of the blastomeres occurs in mammalian embryos.
- The superficial cells of the morula form the **trophoblast** (trophoectoderm).
- The embryo develops from the inner cell mass, at this stage of development, the mammalian embryo is called a **blastocyst**.
- **Compaction:** At a stage early in cleavage, the shapes of blastomeres change as they become compressed against each other, thereby increasing cell-to-cell contact and facilitating the development of special junctional complexes. It gives the blastomeres a defined orientation for the first time. After several cleavage divisions, the resultant group of blastomeres constitutes a compact sphere of cells,
- the morula, consisting of a superficial layer around a central core of cells.

Stages of cleavage in a mammalian embryo from the two-cell stage to the formation of a blastocyst



Stages of cleavage in the avian embryo from the first cleavage division to the formation of a blastoderm. Blastodisc viewed from above (left), and in cross-section



***Depending on the amount of the yolk present in mammalian oocytes, there are three subdivisions of the class Mammalia:**

1. **Prototheria**: oocytes contain large amounts of yolk, its main source of nutrition for the developing embryo.

2. **Metatheria**: oocytes contain a moderate amount of yolk, the developing embryo derives its nourishment *in utero* through a primitive choriovitelline placenta.

3. **Eutheria**: oocytes contain minimal yolk and the developing embryo is nourished *in utero* through a placenta which persists throughout pregnancy.

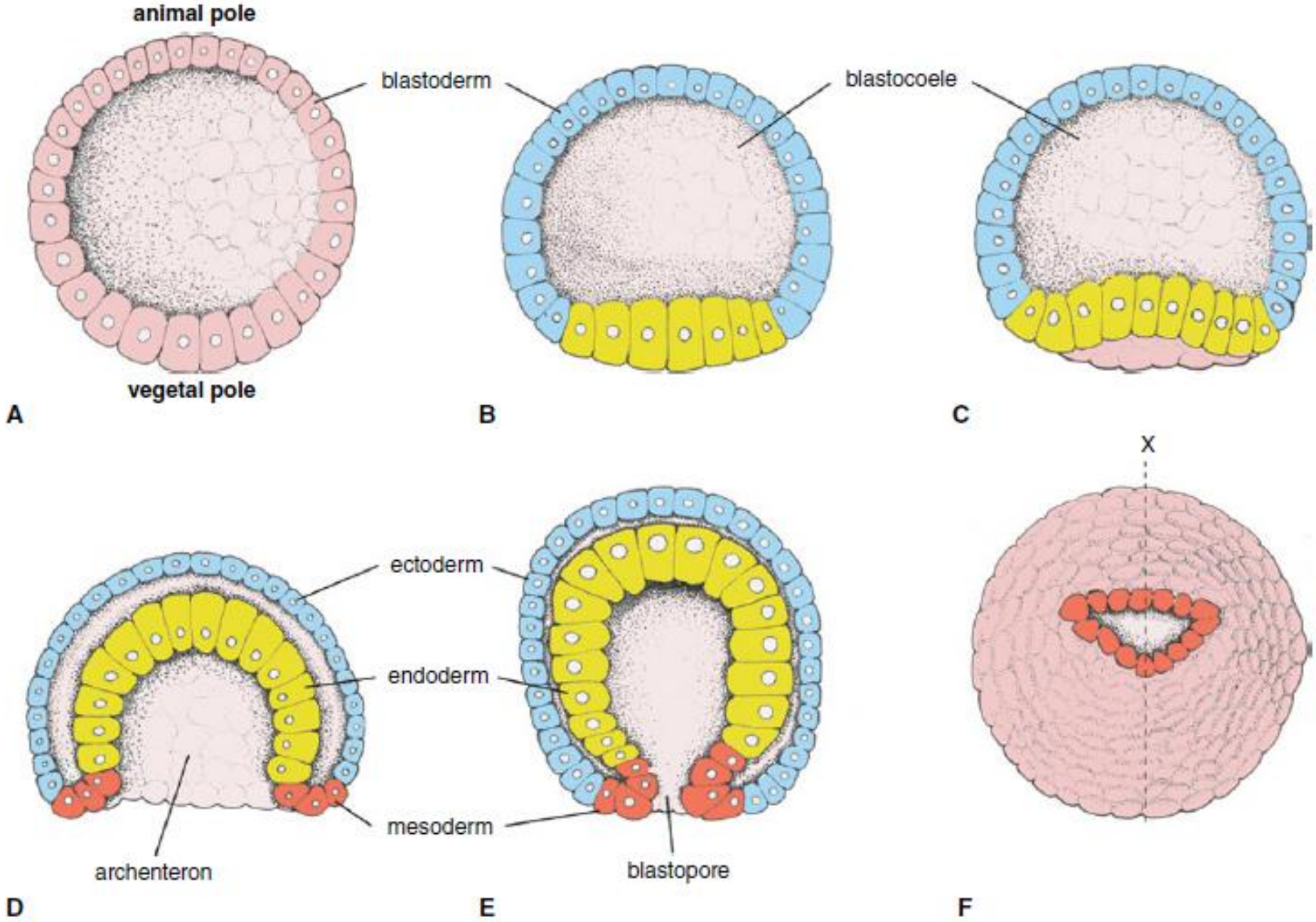
Gastrulation

is the process of germ layer formation and it is the stage of embryological development during which the single-layered blastula is converted into a trilaminar structure consisting of an outer ectodermal, a middle mesodermal and an inner endodermal layer.

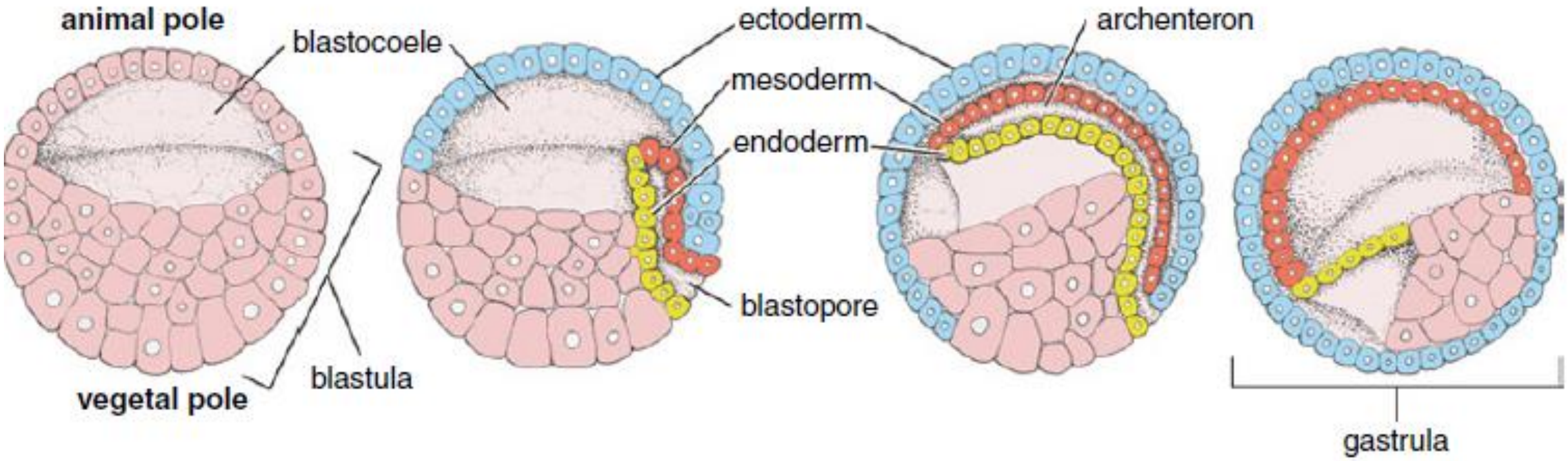
- These changes occur through a series of orderly cell migrations from the surface of the blastula into its interior.
- Cells arising from each germ layer ultimately give rise to specific tissues and organs.

1. **Ectoderm** differentiates into the epidermis of the skin and into neural tissue.
2. **Endoderm** forms the lining of the gastrointestinal and respiratory tracts.
3. **Mesoderm** forms the urogenital, circulatory and supportive muscular and skeletal systems.

- Three germ layers (ectoderm, mesoderm and endoderm) are formed during gastrulation.
- The pattern of gastrulation is similar in mammals and avian species.
- In mammals, the hypoblast and epiblast are derived from the inner cell mass.
- The primitive streak acts as the initiation site for gastrulation.
- Cells of the epiblast migrate to the primitive streak and move into the space between the epiblast and hypoblast.
- A proportion of these cells displace the hypoblast, forming endoderm, the inner germ layer.
- Mesoderm, the middle germ layer, develops from migrating epiblast cells which lie between the epiblast and the primordial endoderm.
- The remainder of the cells of the epiblast differentiate into ectoderm.



Sections showing sequential stages of gastrulation in *Amphioxus* from the blastula stage A to the gastrula stage E. The section shown in E is at the level indicated in the embryo at the gastrula stage in F

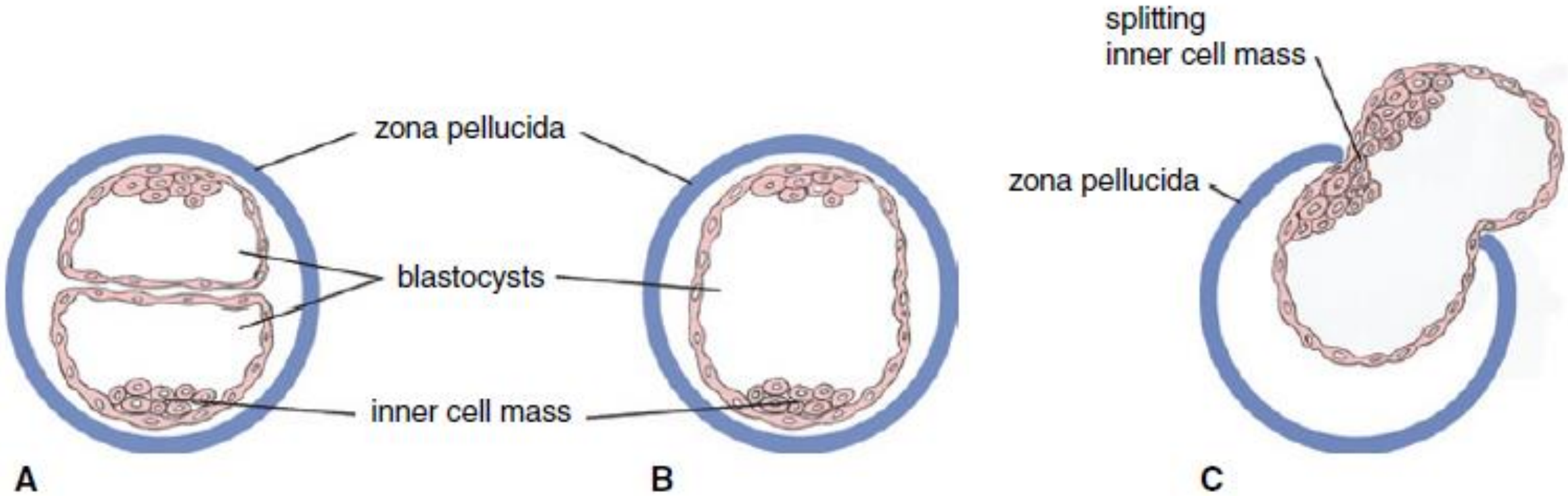


Sequential stages of gastrulation in amphibians from the blastula stage to the gastrula stage

- **Twinning**
- Twins: identifies two individuals which develop in the same pregnancy in animals that are normally monotocous. Two distinct types of twins are recognized:

1. **Dizygotic twins** arise from two oocytes, derived from two separate ovarian follicles, each fertilized by separate spermatozoa during a single breeding cycle.

2. **Monozygotic twins** arise from a single oocyte fertilized by a single spermatozoon. The two-blastomere stage is the earliest point in embryological development at which monozygotic twins can arise, each blastomere giving rise to a separate individual with its own foetal membranes



A. Formation of two blastocysts within a single zona pellucida.

B. Formation of two inner cell masses within a single blastocyst.

C. Division of a blastocyst as it emerges from the zona pellucida

- ❖ The frequency of twinning in sheep, which is from 2 to 5%, is higher in lowland breeds than in mountain breeds.
- ❖ In horses, the occurrence of multiple ovulations is reported to be up to 30%, yet the rate of twin births is less than 2%. This discrepancy between the high multiple ovulation rate and the low rate of twinning is attributed to the high prenatal mortality associated with twinning in mares.
- ❖ There is also evidence that innate physiological mechanisms inhibit twinning in mares.

Conjoined twins

Anomalous incomplete separation of two primitive streaks results in conjoined twins.

- In humans, it has been estimated that conjoined twins occur at a rate of 1 in 100,000 births.
- The rate in monozygotic twins is reported to be 1 in 400.
- The incidence of conjoined twins in cattle, which is reported to be higher than in other farm animals, occurs at a rate similar to that reported in humans.