Embryology

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Year 2

Fertilization

Fertilization: The process whereby a spermatozoon and an oocyte fuse to form a single-celled zygote is termed fertilization.

- Following penetration of the vitelline membrane by the spermatozoon, the activated oocyte completes meiosis and extrudes the second polar body.
- The chromosomes contained in the haploid male pronucleus align with their corresponding chromosomes in the female pronucleus.
- The paternal and maternal chromosomes condense, become attached to mitotic spindles and align themselves centrally.
- The first mitotic, or cleavage, division follows. The integration of the paternal and maternal genetic material.
- In mammals and avian species, fertilization occurs internally, in contrast to many aquatic animals.
- Although only one or a small number of oocytes are typically ovulated depending on the species, millions or billions of spermatozoa are deposited in the reproductive tract of the female.
- Transportation of spermatozoa from the site of deposition to the site of fertilization occurs in two phases, a rapid phase and a slow phase

Capacitation

- Before spermatozoa can fertilize oocytes, they must first undergo biochemical and physiological modifications within the female reproductive tract.
- This involves the removal of cholesterol and many glycoproteins from the surface of the spermatozoon, resulting in increased fluidity of the cell membrane. Capacitation, which commences in the uterus, is completed in the isthmus.

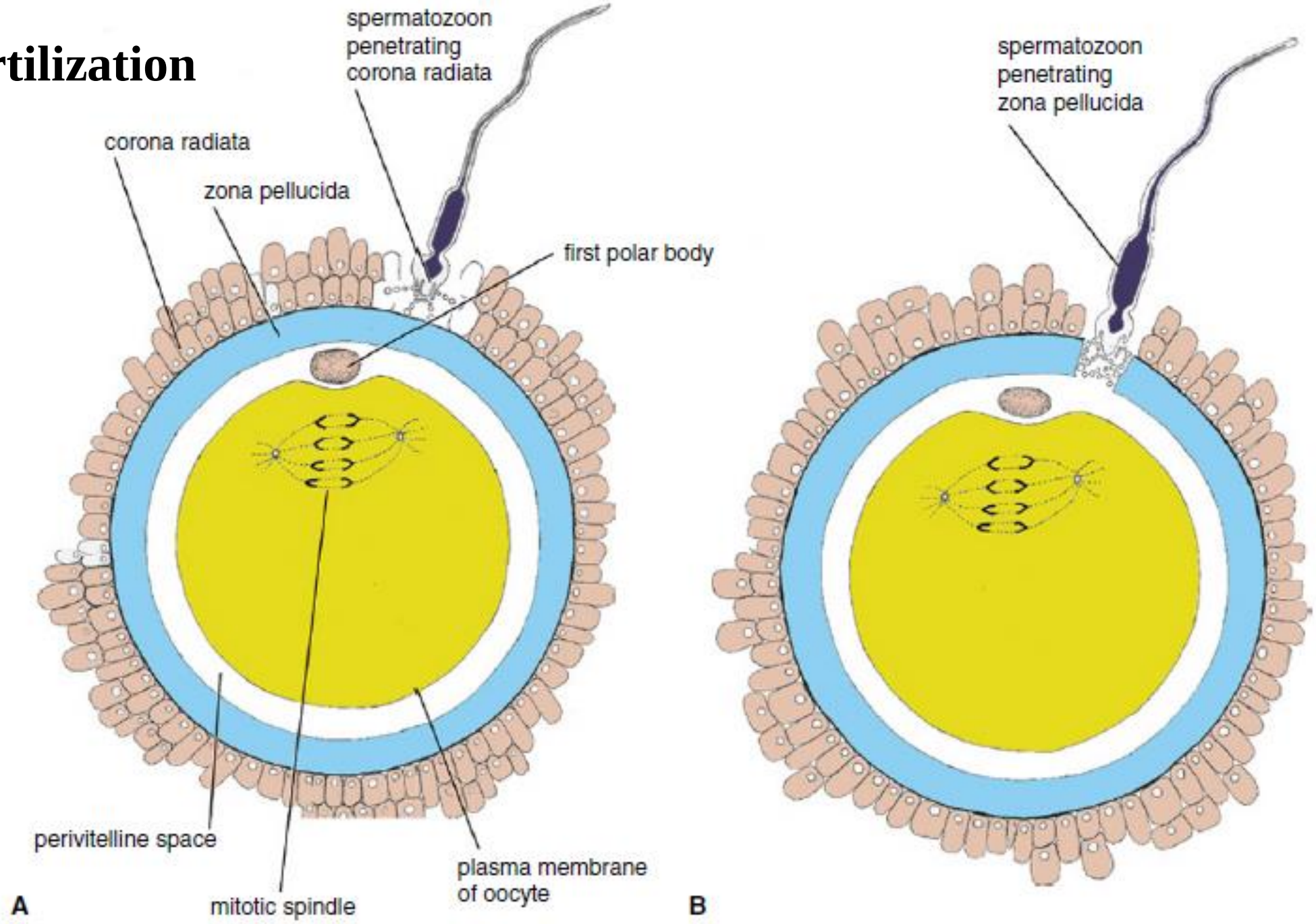
Barriers to polyspermy

- **Polyspermy** a condition of entering more than one spermatozoon into a mammalian oocyte, invariably leads to the death of the embryo.
- The mass movement of spermatozoa to the site of fertilization is prevented by the natural anatomical barriers of the female reproductive tract, the cervix and the utero-tubal junction.
- The oocyte has its own defense against polyspermy which normally prevents the entry of more than one spermatozoon. This defense, which is biphasic, operates at the zona pellucida and the cell (vitelline) membrane f the oocyte.
- In most mammals, both the zona pellucida and vitelline membranes undergo alteration after entry of the first spermatozoon, a change which makes these structures dense to additional spermatozoa.

Oocyte activation

- With fertilization, the secondary oocyte, which had been arrested in the metaphase of the second meiotic division, completes meiosis,
- The nucleus of the mature oocyte becomes the female pronucleus
- In the cytoplasm of the mature oocyte, the nucleus of the spermatozoon enlarges forming the male pronucleus.
- The first mitotic division of the fertilized oocyte, which is now referred to as a zygote,
- Subsequent mitotic division results in the formation of identical diploid daughter cells, ultimately leading to the development of a multicellular individual.

Stages of fertilization



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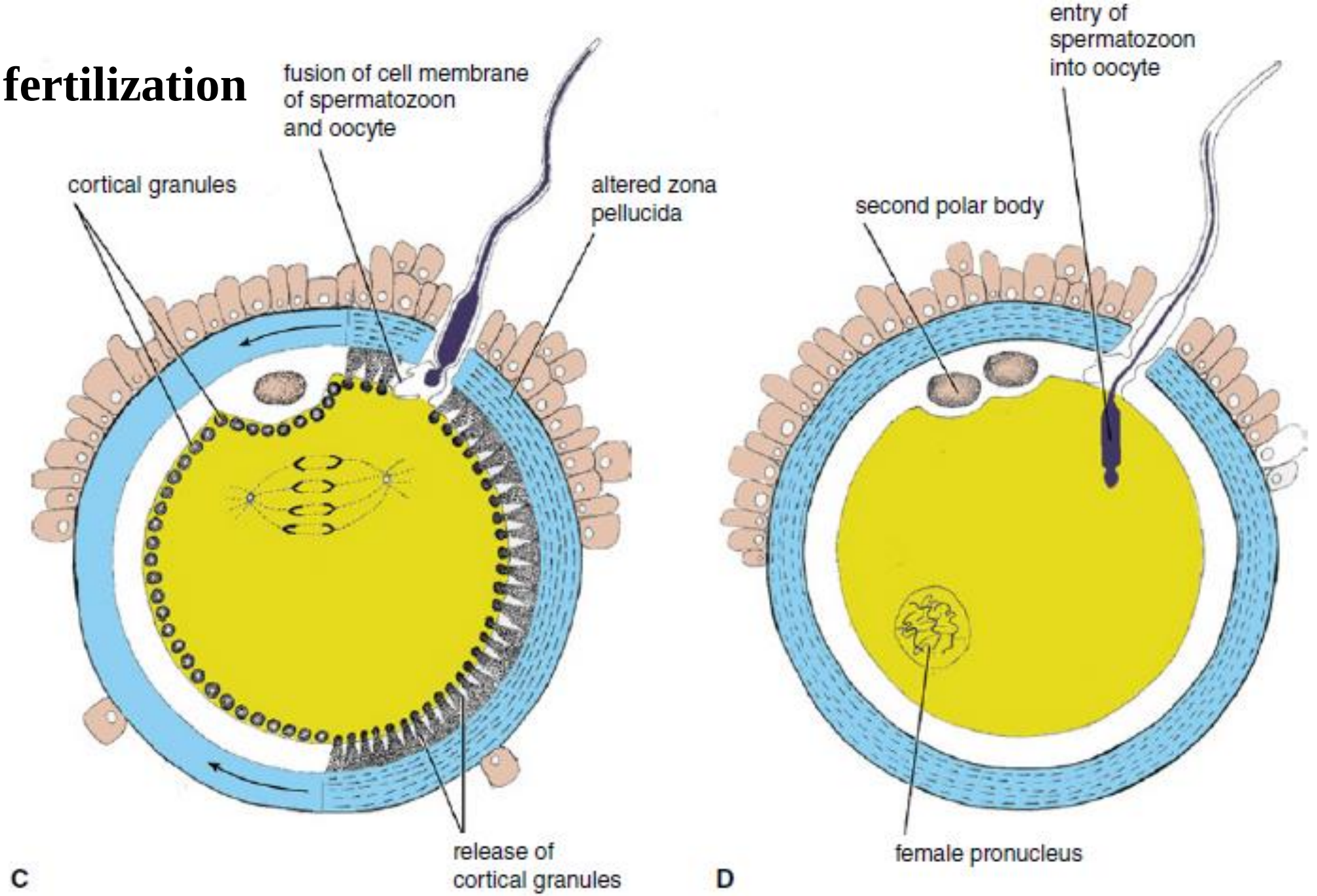

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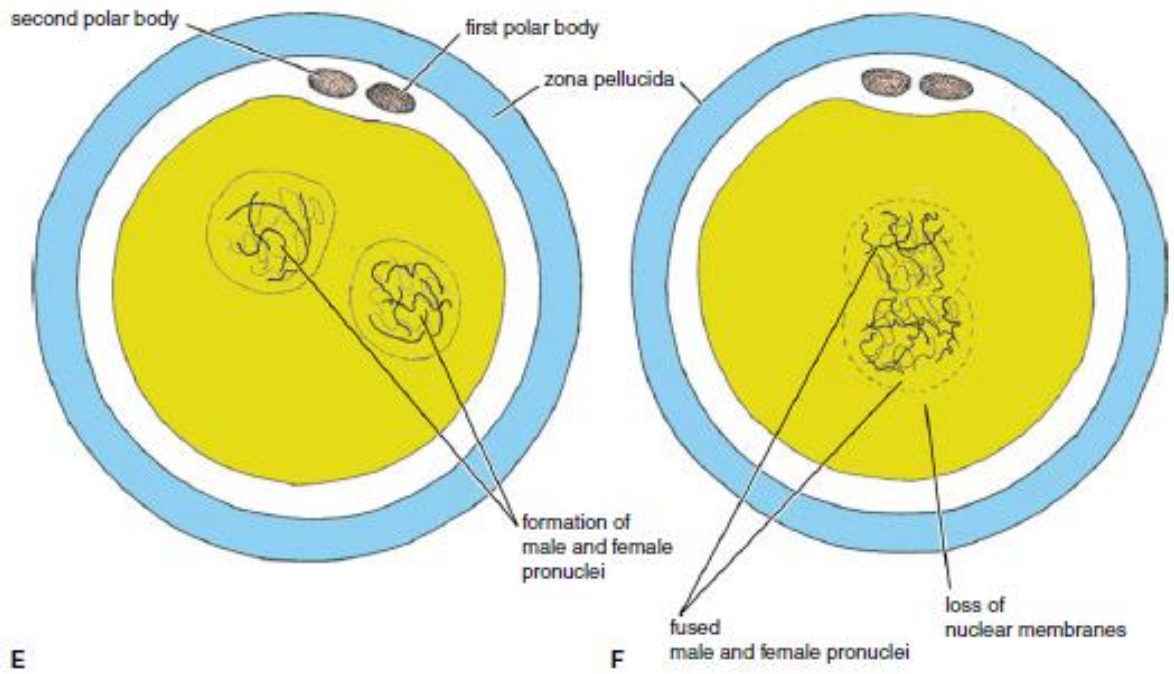

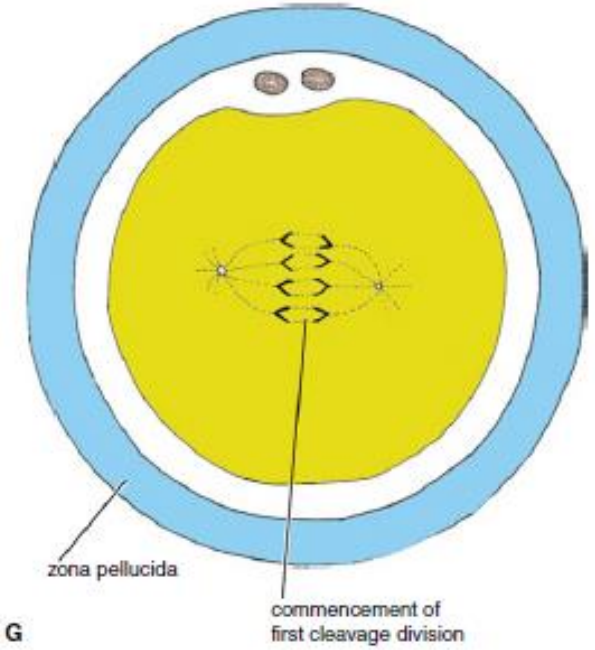

Cleavage

- 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.

Stages of cleavage from the 2-cell stage to the early blastula stage in Amphioxus, A, and amphibians, B.