

FERTILIZATION

Ms. Manochitra

Guest Lecturer

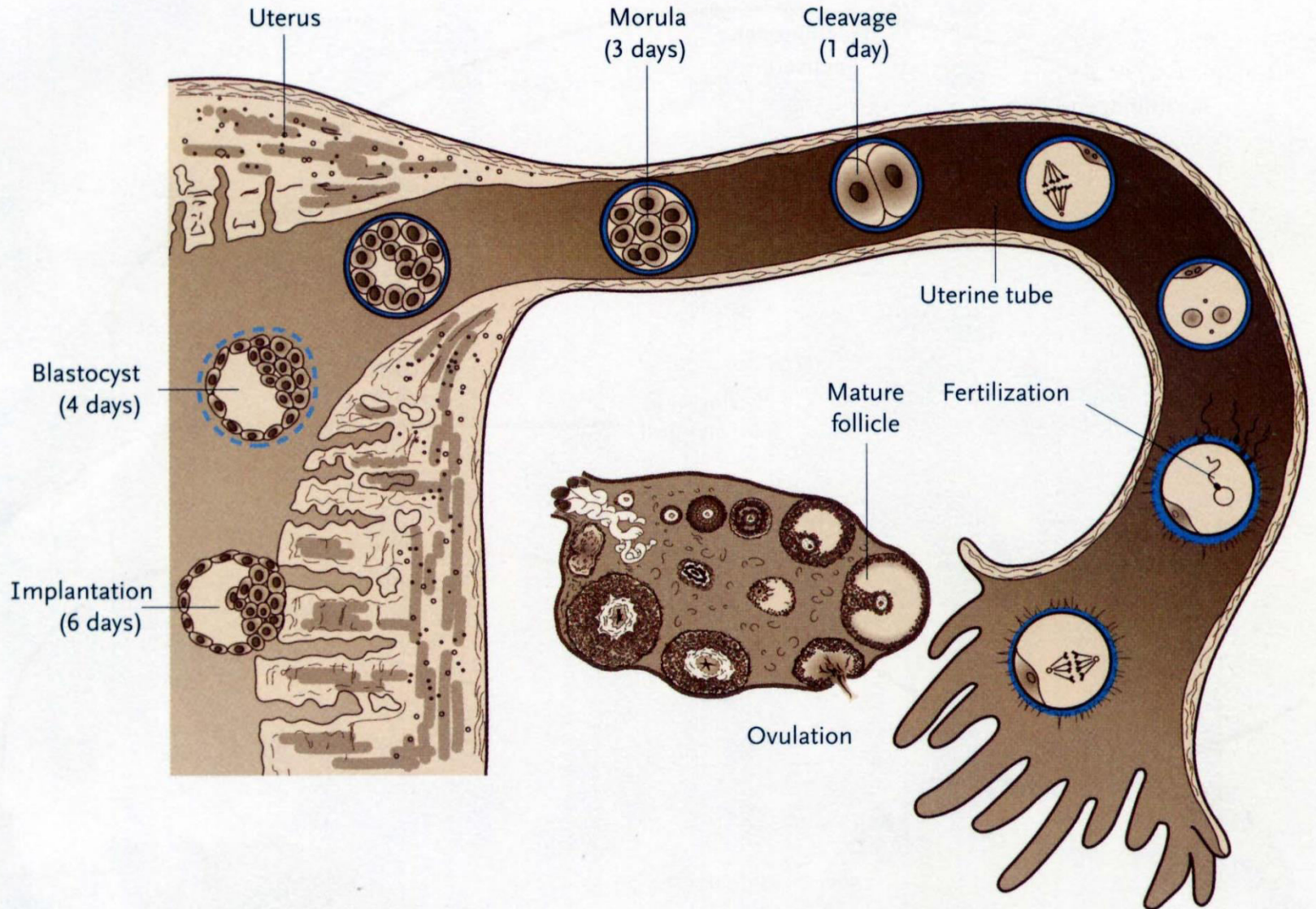
Department of Biomedical science,
Bharathidasan University, Trichy

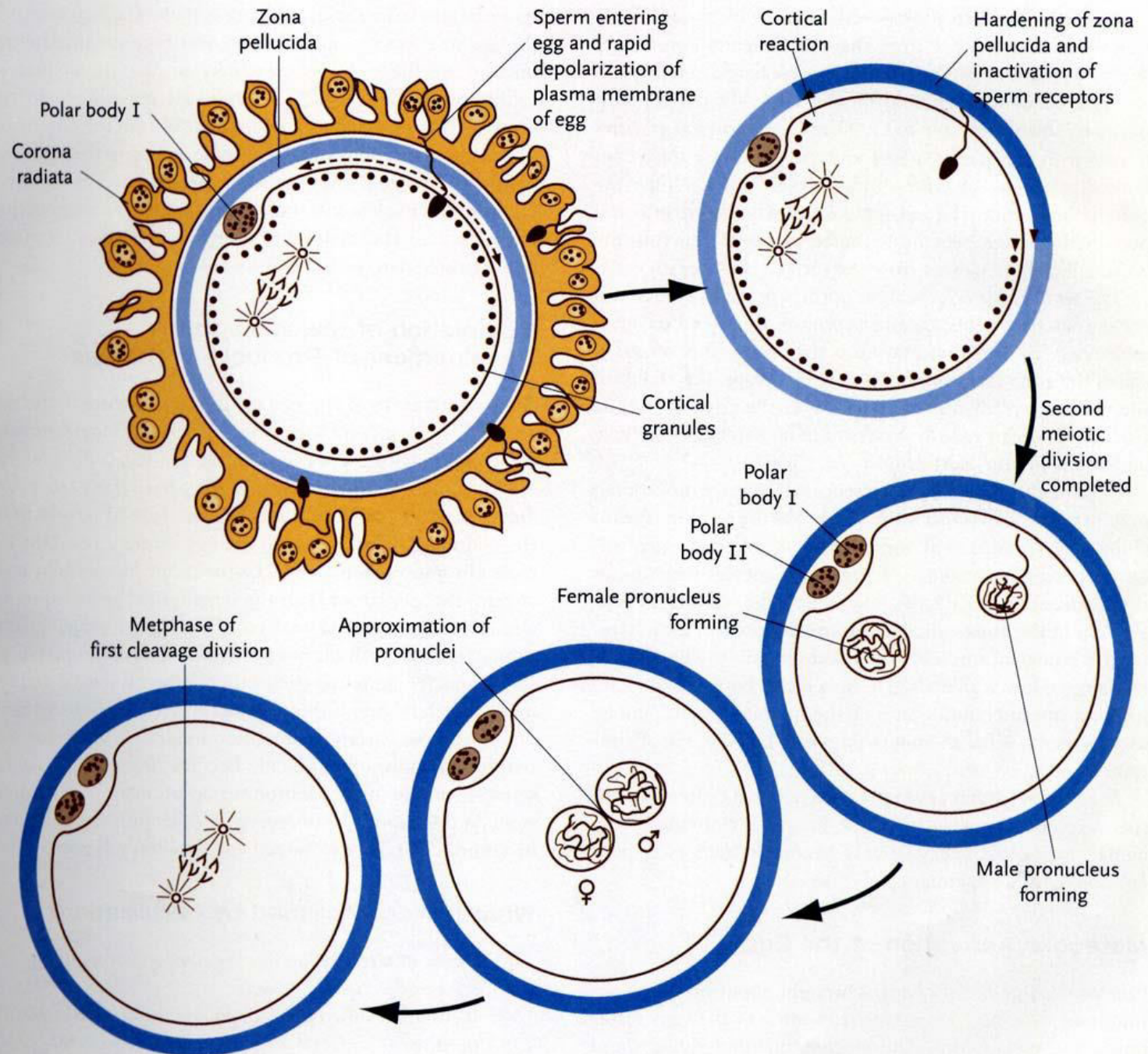
Fertilization

Fertilization, the process by which male and female gametes fuse, occurs in the **ampullary region of the uterine tube**. This is the widest part of the tube and is close to the ovary

Fertilized ovum - consists of a soft jelly-like material enclosed in a membrane and containing a vesicle or small spherical body inside which are one or more denser spots - This may be regarded as a **complete cell**.

Fertilization





Phases of Fertilization

- ☐ **Phase 1** - penetration of the corona radiata
- ☐ **Phase 2** - penetration of the zona pellucida
- ☐ **Phase 3** - fusion of the oocyte and sperm cell membranes

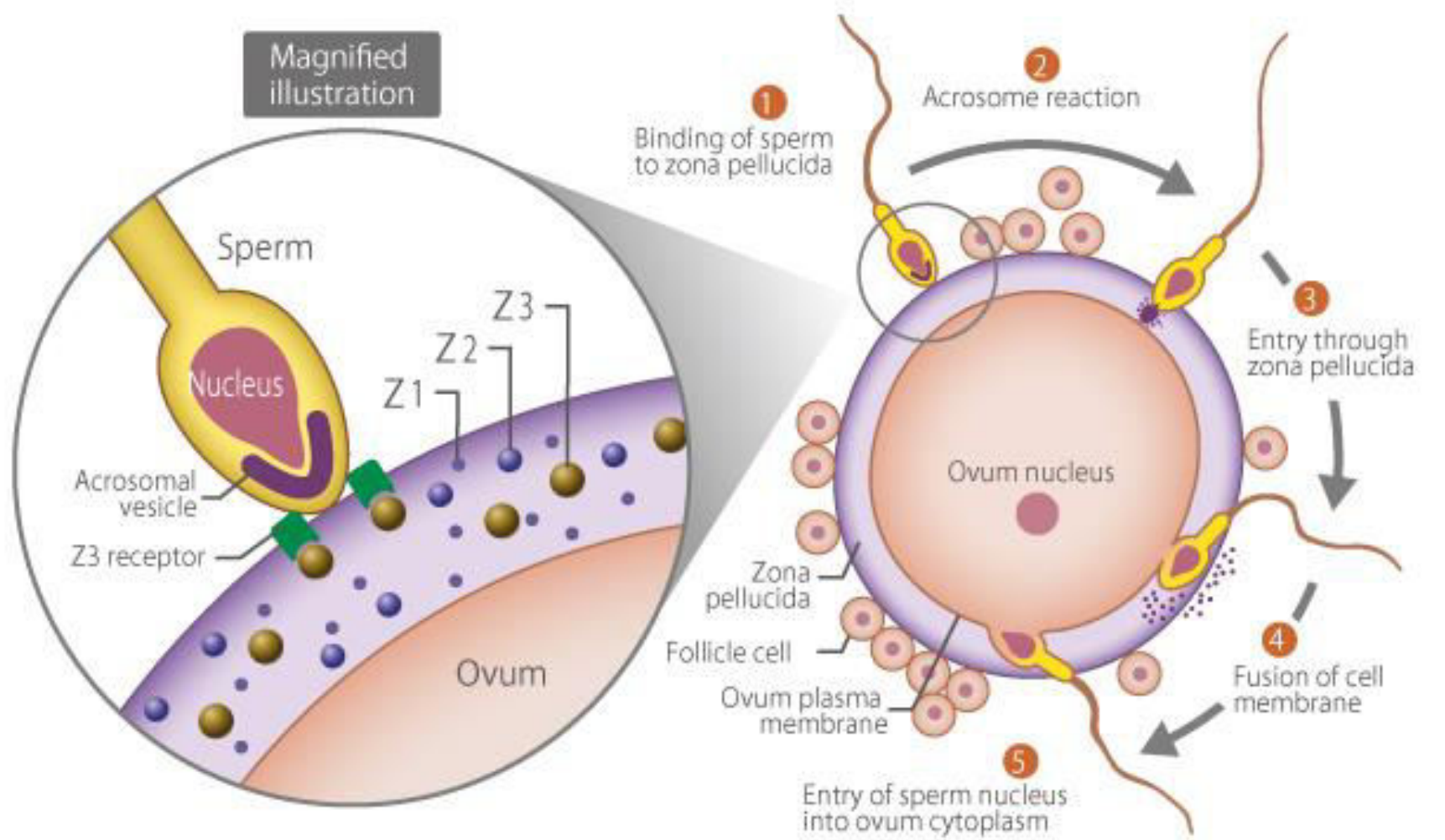
PHASE 1: PENETRATION OF THE CORONA RADIATA

*Of the 200 to 300 million spermatozoa deposited in the female genital tract, only 300 to 500 reach the site of fertilization.

*Only one of these fertilizes the egg.

*It is thought that the others aid the fertilizing sperm in penetrating the barriers protecting the female gamete.

*Capacitated sperm pass freely through corona cells.



PHASE 2: PENETRATION OF THE ZONA PELLUCIDA

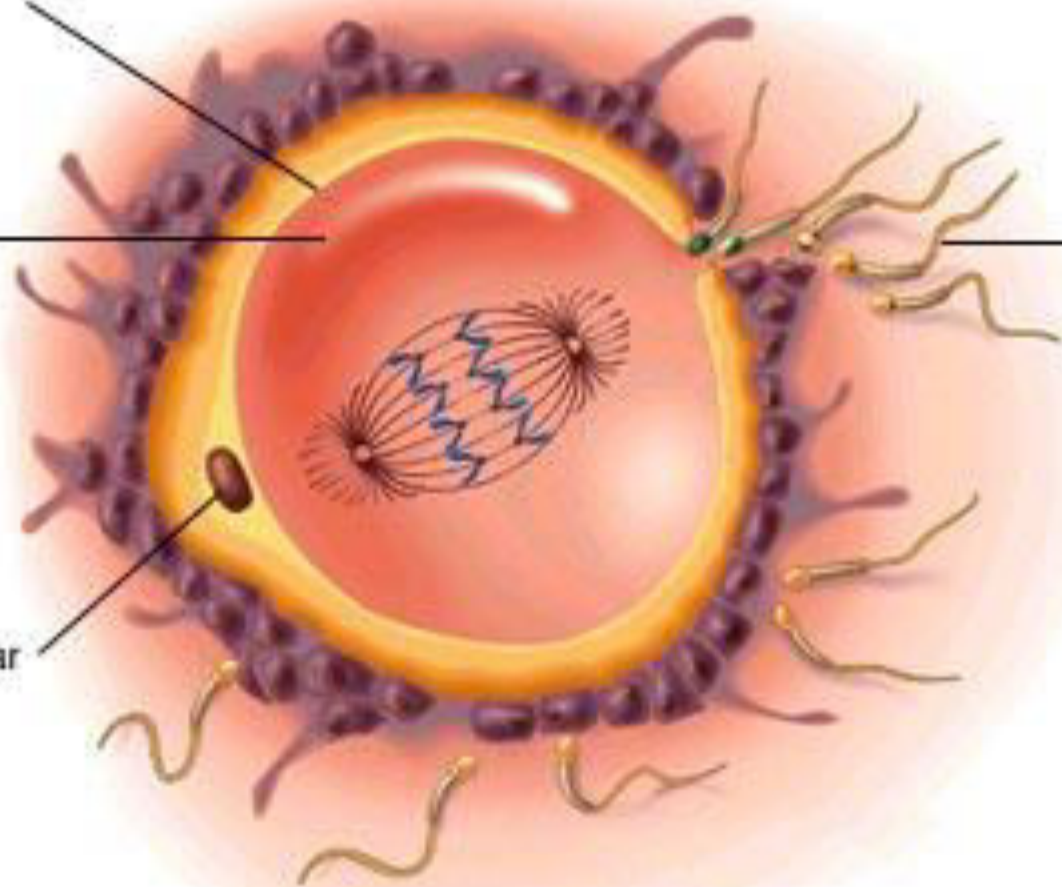
- The zona - glycoprotein shell surrounding the egg that facilitates and maintains sperm binding and induces the acrosome reaction.
- Both binding and the acrosome reaction are mediated by the ligand **ZP3**, a zona protein.
- Release of acrosomal enzymes (**acrosin**) allows sperm to penetrate the zona, thereby coming in contact with the plasma membrane of the oocyte.
- Permeability of the zona pellucida changes when the head of the sperm comes in contact with the oocyte surface.
- This contact results in release of lysosomal enzymes from cortical granules lining the plasma membrane of the oocyte.
- In turn, these enzymes alter properties of the zona pellucida (**zona reaction**) to prevent sperm penetration and inactivate species-specific receptor sites for spermatozoa on the zona surface.
- Other spermatozoa have been found embedded in the zona pellucida, but only one seems to be able to penetrate the oocyte.

Cell membrane of ovum

Cytoplasm
of ovum

First polar
body

Sperm



PHASE 3: FUSION OF THE OOCYTE AND SPERM CELL MEMBRANES

The initial adhesion of sperm to the oocyte is mediated in part by the interaction of integrins on the oocyte and their ligands, disintegrins, on sperm. After adhesion, the plasma membranes of the sperm and egg fuse .

Because the plasma membrane covering the acrosomal head cap disappears during the acrosome reaction, actual fusion is accomplished between the oocyte membrane and the membrane that covers the posterior region of the sperm head.

- In the human, both the head and tail of the spermatozoon enter the cytoplasm of the oocyte, but the plasma membrane is left behind on the oocyte surface.
- As soon as the spermatozoon has entered the oocyte, the egg responds in three ways:

1. Cortical and zona reactions

As a result of the release of cortical oocyte granules, which contain lysosomal enzymes, (a) *the oocyte membrane* becomes impenetrable to other spermatozoa, and (b) *the zona pellucida* alters its structure and composition to prevent sperm binding and penetration. These reactions prevent polyspermy (penetration of more than one spermatozoon into the oocyte).

- **2. Resumption of the second meiotic division**

The oocyte finishes its second meiotic division immediately after entry of the spermatozoon. One of the daughter cells, which receives hardly any cytoplasm, is known as the second polar body; the other daughter cell is the definitive oocyte.

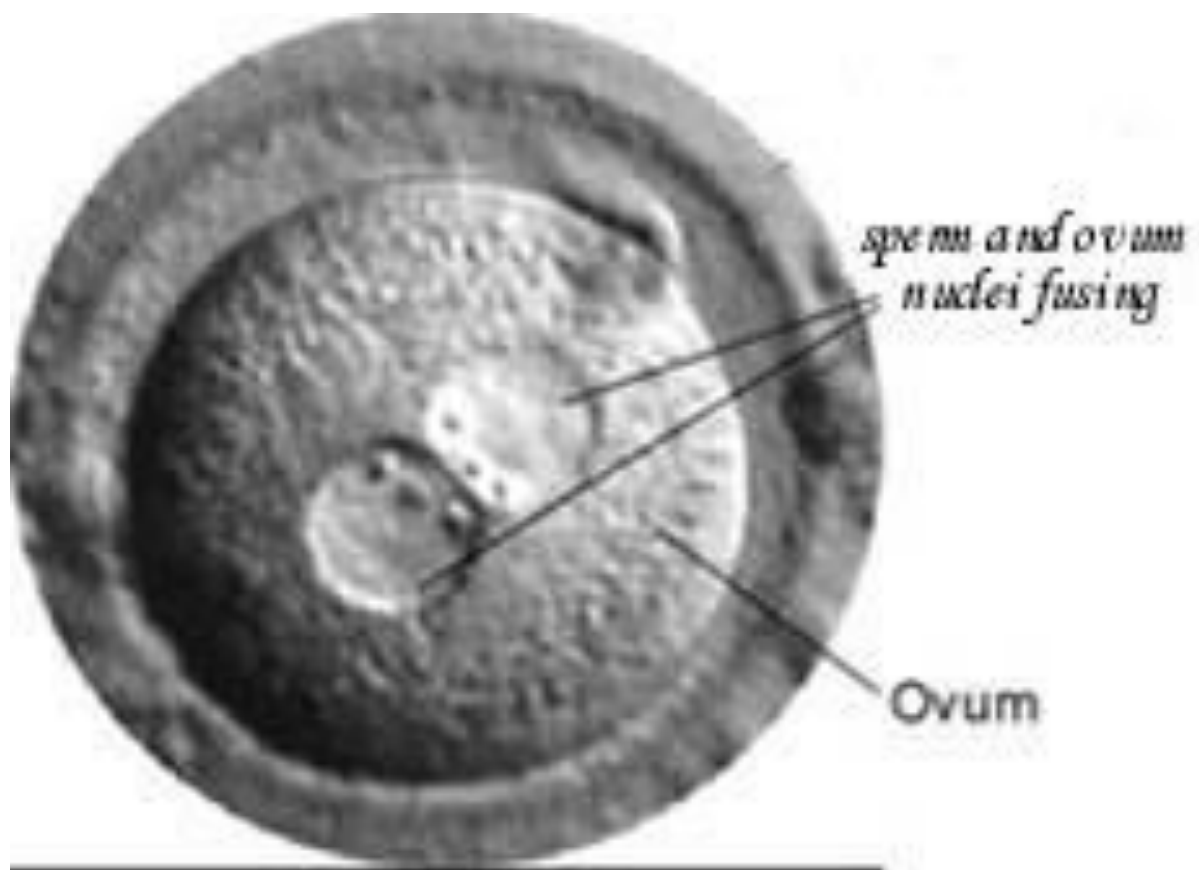
Its chromosomes (22+X) arrange themselves in a vesicular nucleus known as the female pronucleus .

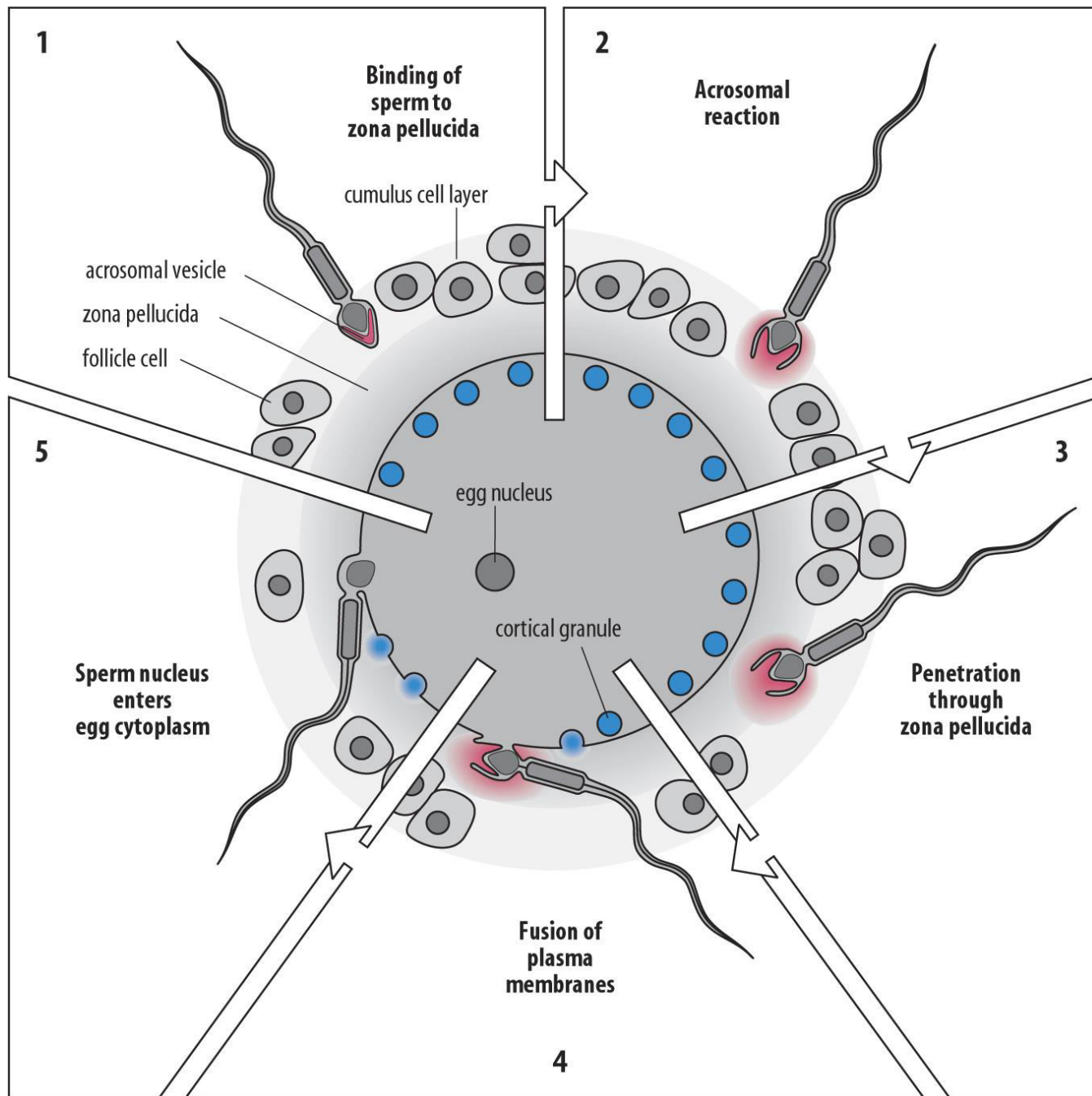
- **3. Metabolic activation of the egg**

The activating factor is probably carried by the spermatozoon. Postfusion activation may be considered to encompass the initial cellular and molecular events associated with early embryogenesis.

Results/Effects of Fertilization:

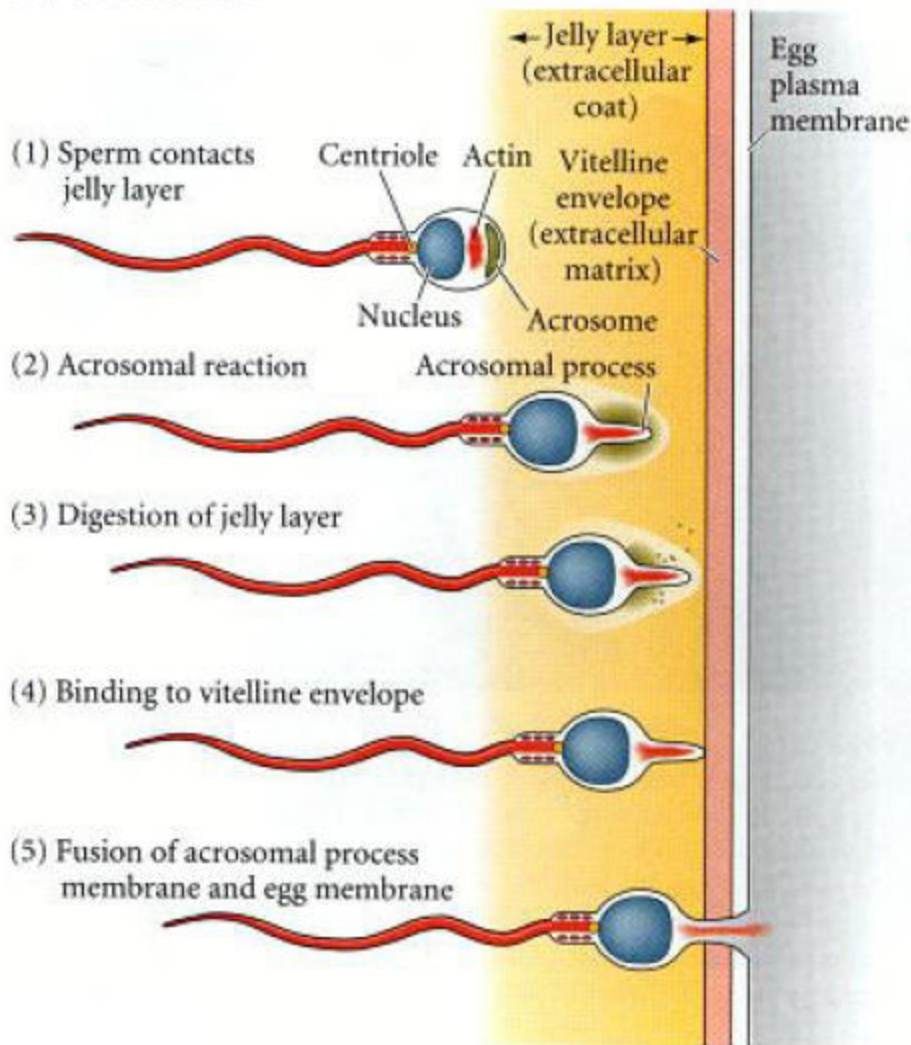
- **Restoration of the diploid number of chromosomes** - half from the father and half from the mother. Hence, the zygote contains a new combination of chromosomes different from both parents.
- **Determination of the sex of the new individual** - An X-carrying sperm produces a female (XX) embryo, and a Y-carrying sperm produces a male (XY) embryo. Hence, the chromosomal sex of the embryo is determined at fertilization.
- **Initiation of cleavage. Without fertilization** - the oocyte usually degenerates 24 hours after ovulation.



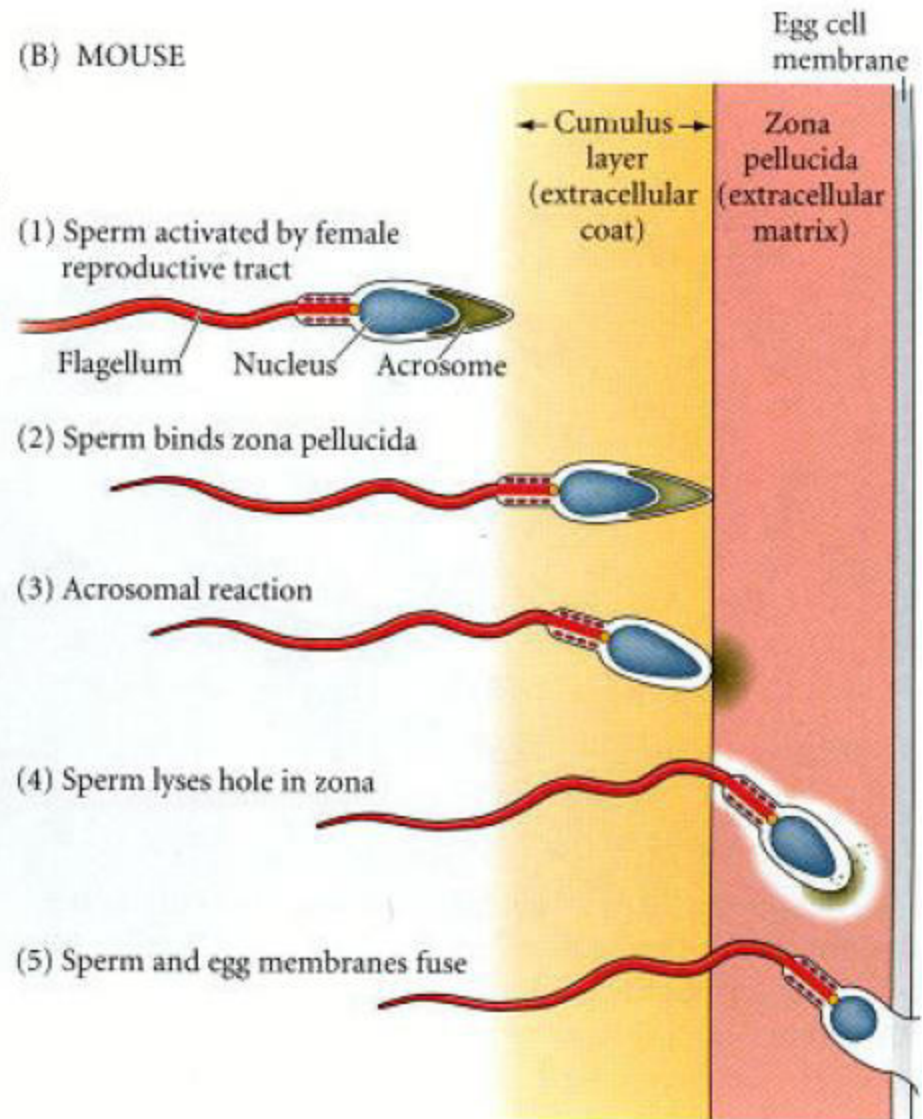


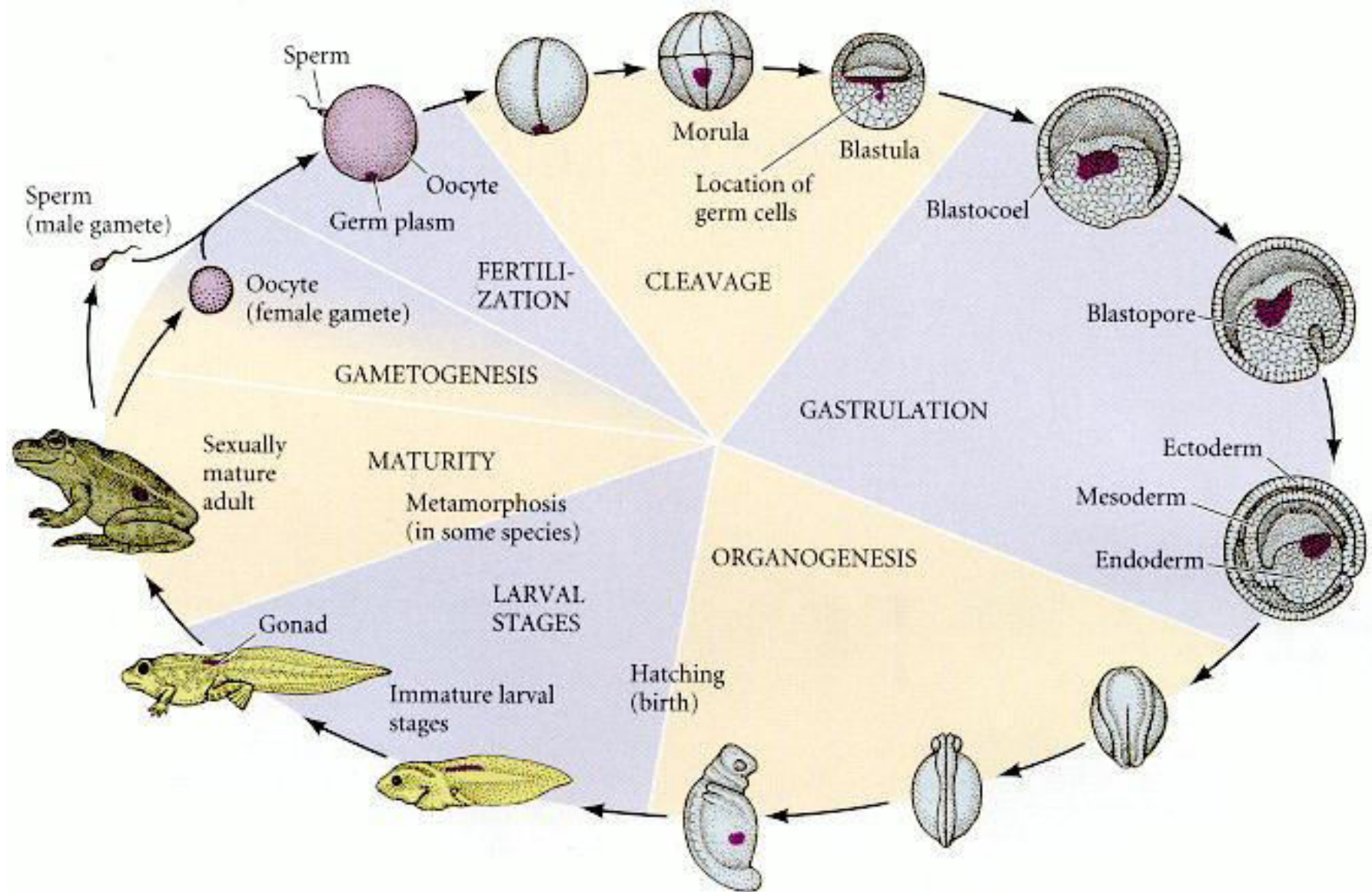
Recognition of Egg & Sperm

(A) SEA URCHIN

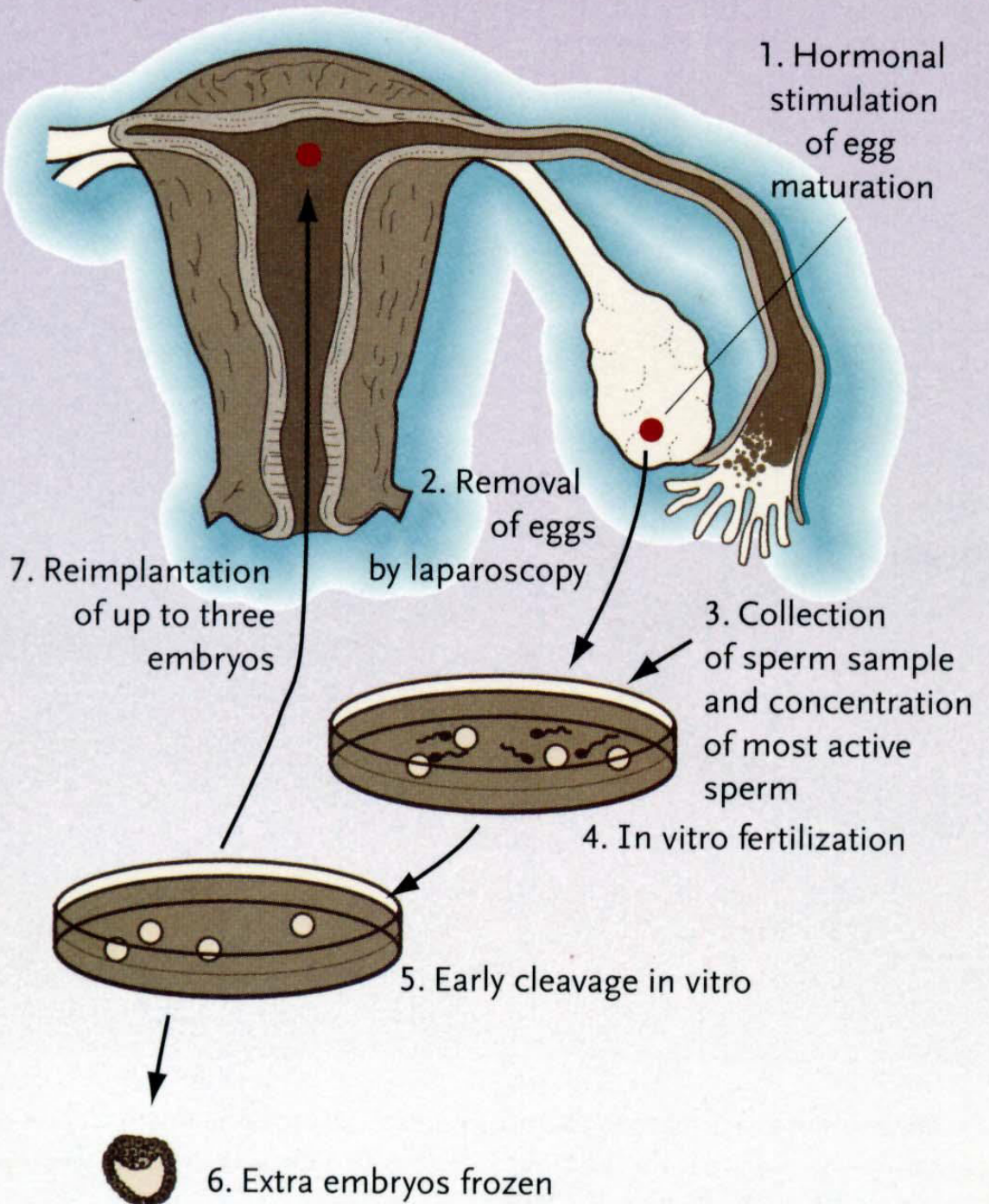


(B) MOUSE





IVF of Human Gametes



The usual accepted indications include the following:

- (a) Tubal obstruction or problems;
- (b) Endometriosis;
- (c) Poor semen quality;
- (d) Unexplained infertility.