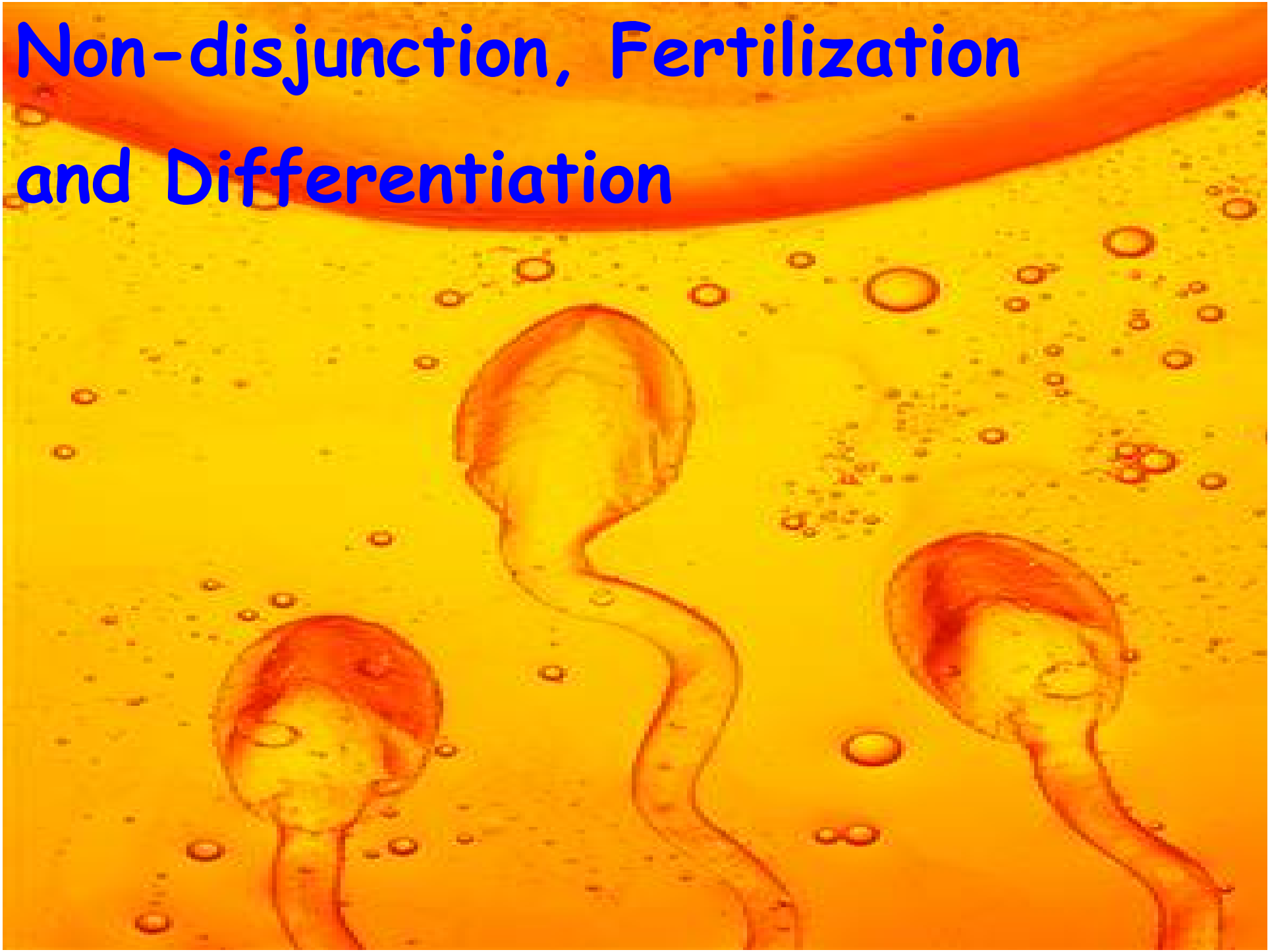
Non-disjunction, Fertilization and Differentiation



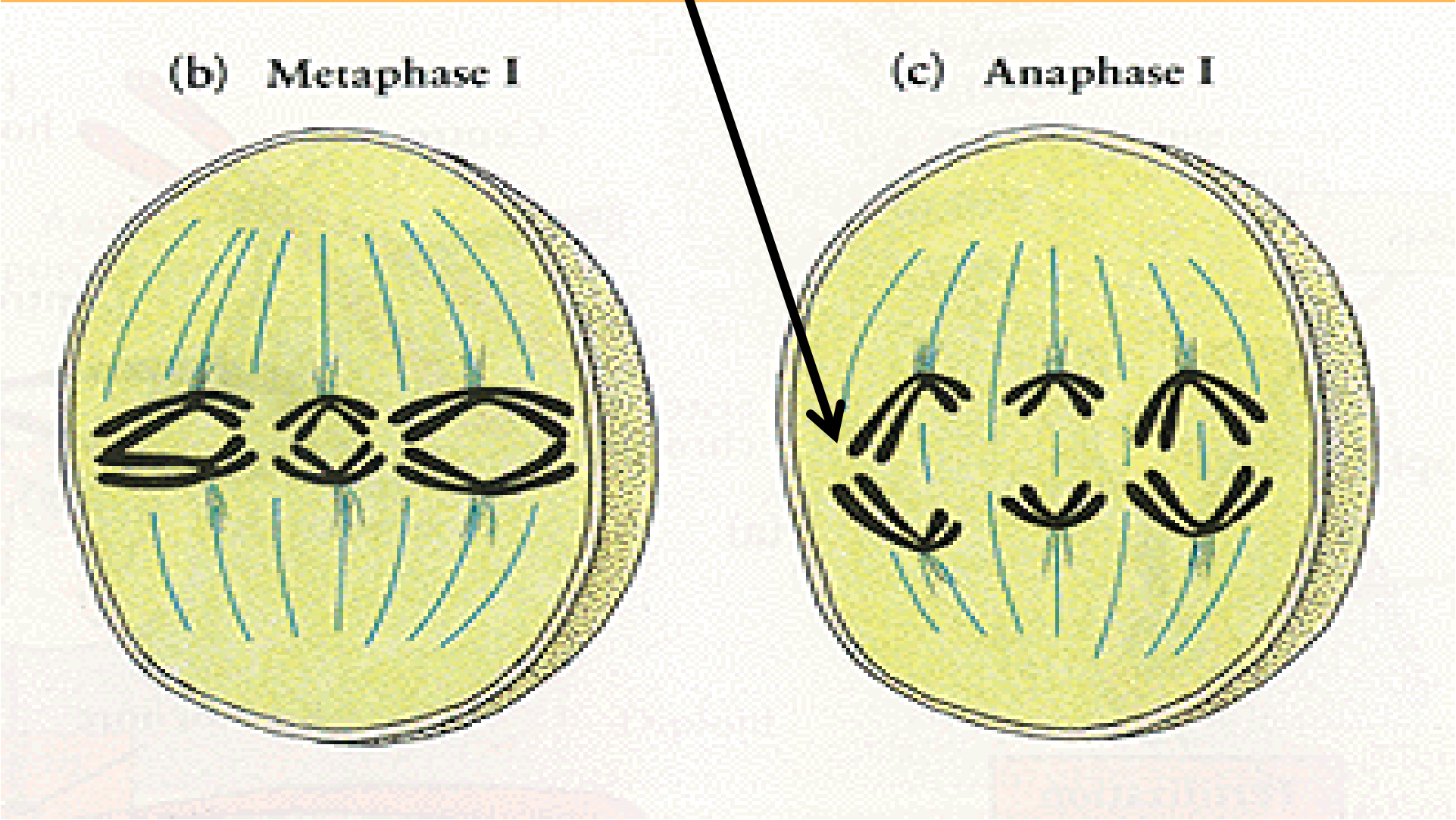
Disjunction

How do chromosome abnormalities occur?

- Seperation of Chromosomes in Anaphase I or II of Meiosis is called <u>Disjunction</u>.

  - Replication of DNA during "S"
  - Meiosis begins with formation of tetrads in Prophase I.
  - Normal Anaphase I or II results in disjunction (seperation of chromosomes)

Disjunction: Chromosome Separation



Non-disjunction

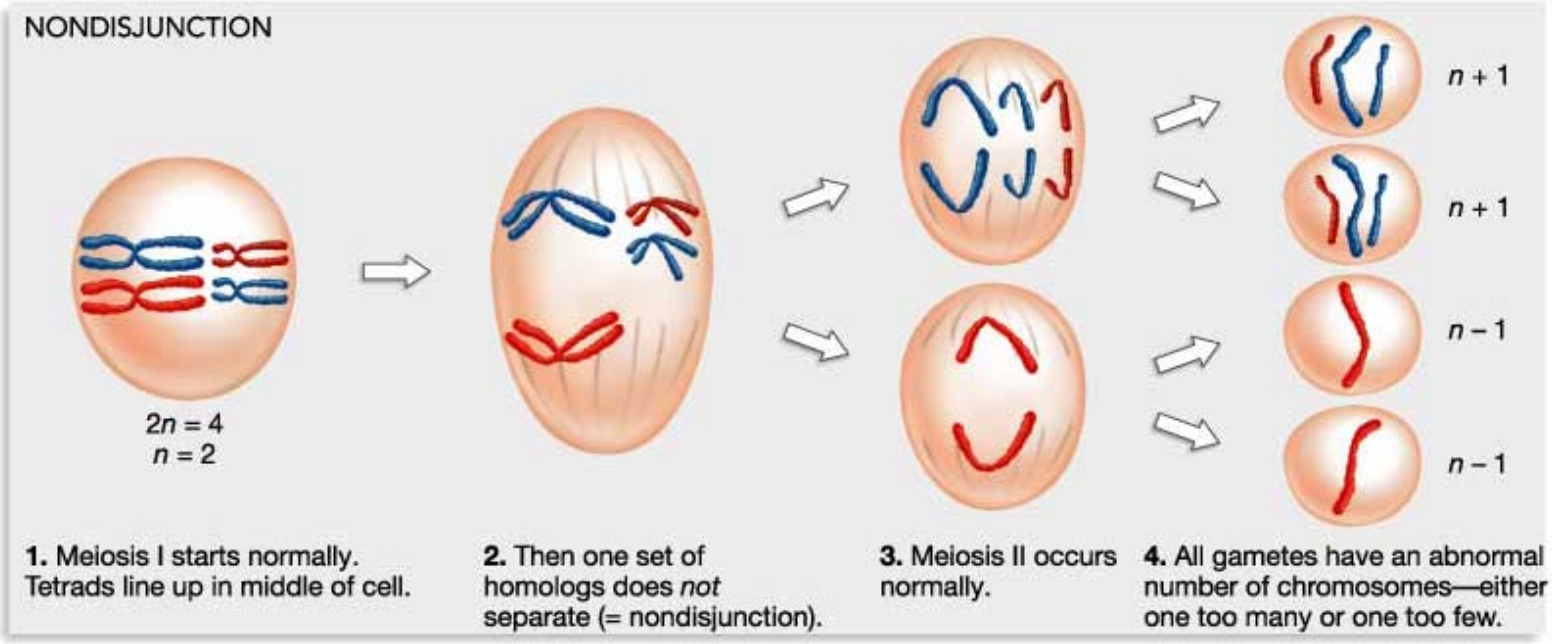
When chromosomes fail to separate during **Anaphase I or II** we call it <u>non-disjunction</u>.

- Chromosomes which should split end up moving to the same pole.
- This can happen in Meiosis I or Meiosis II.
- Result: Aneuploidy- gametes are produced with either one chromosome too many or one too few.

Non-disjunction

Non-disjunction results in Aneuploidy:

-All individuals with too few chromosomes (except for the sex chromosomes) will die.



Aneuploidy

-An individual with one X will survive and exhibit:

- "Turner Syndrome." "monosomy" (2n-1)

-Individuals with one too many chromosomes sometimes survive. These include: chromosome #13, 18, 21 and 23.

- Ex. Down Syndrome, Trisomy 21
- Ex. Kleinfelter's Syndrome, Trisomy 23 (XXY)

Aneuploidy

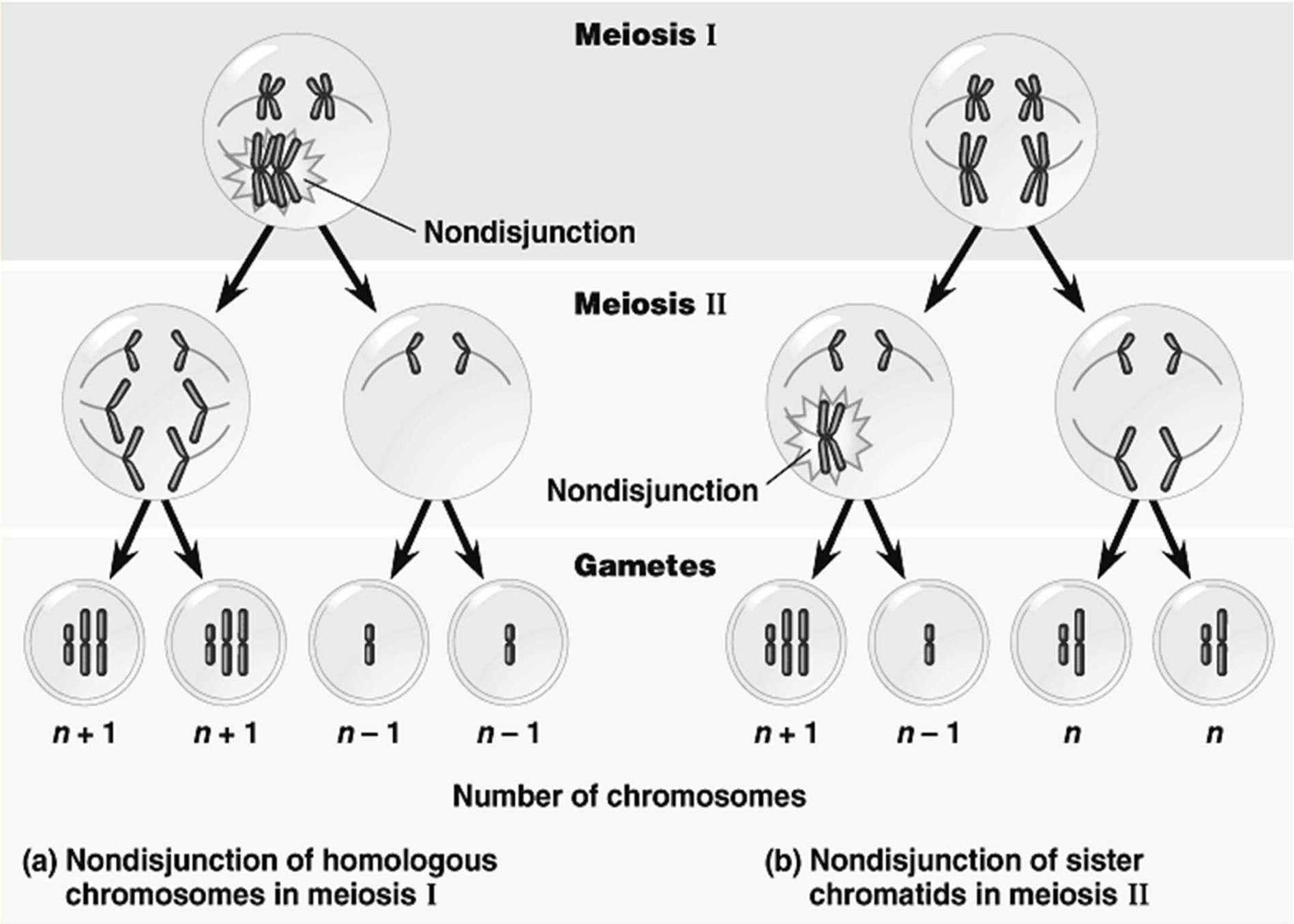
- Non-disjunction results in abnormal gametes and an aneuploid fertilized egg.

- The (2n+1) or (2n-1) condition will be passed on to all cells by mitosis.

Normal Gametes:

If normal Meiosis occurs, normal gametes will be produced.

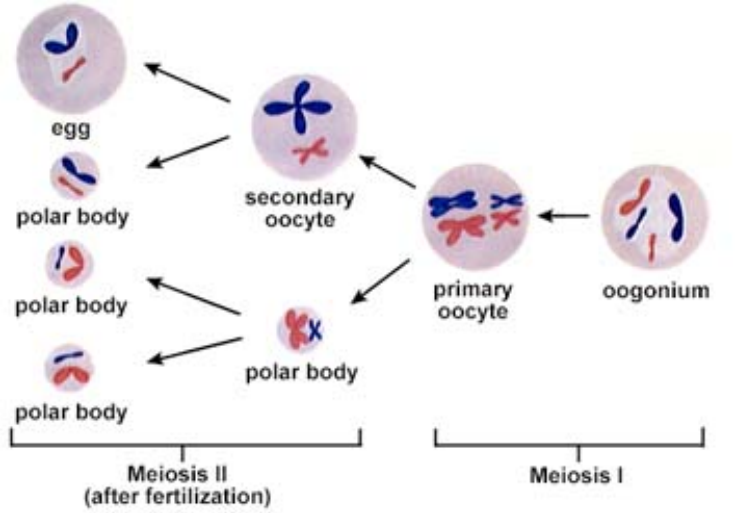
- The fertilized egg will have 46 chromosomes.
- Mitosis will ensure that all the cells of the baby will have 46 chromosomes.



Oogenesis

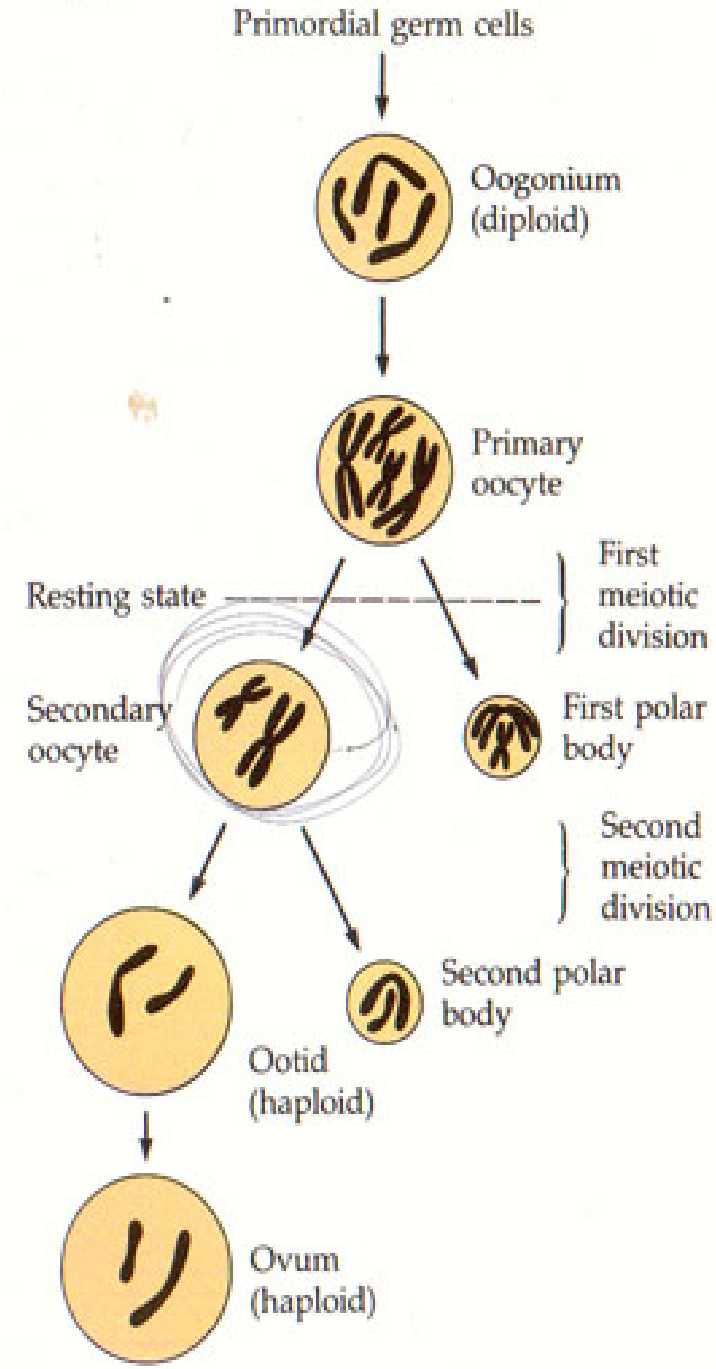
Production of the Egg

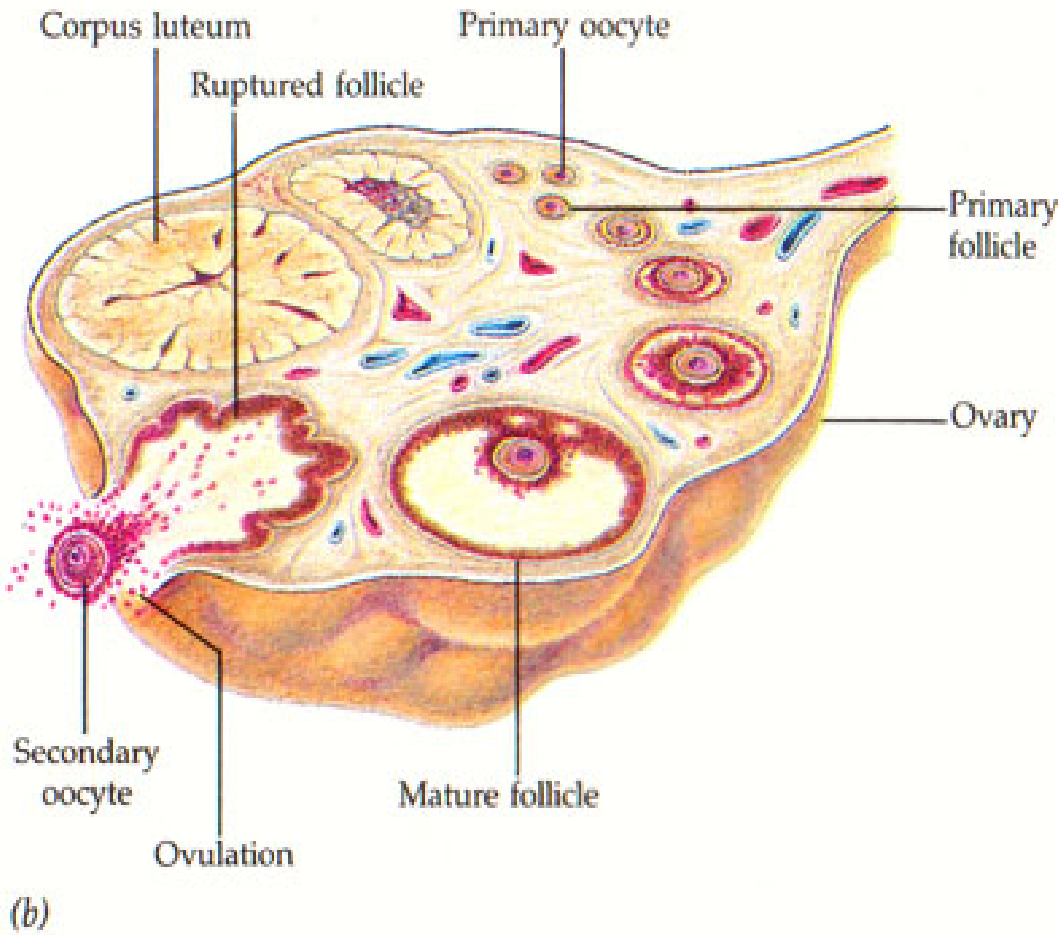
- Specialized cells in the female's ovaries will produce eggs.
- Meiosis occurs with **nonequal** cytokinesis during telophase 1.
  - A non-functional "polar body" is produced.
  - The larger cell continues into Meiosis II.



- Unequal cytokinesis occurs again in telophase 2.
- Another non-functional "polar body" is produced.
- The end result is a **single**, functional, haploid **egg cell**.
- The first polar body may also divide.
- Now there are 3 polar bodies.

Oogenesis (Figure 42.14)

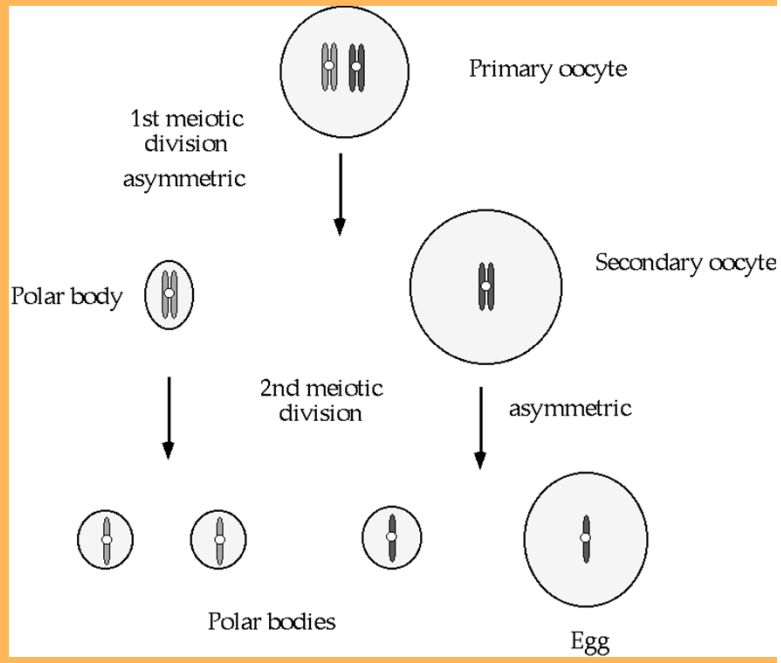




- Primary Oocytes (2n) are formed in the embryo.
- They are frozen at Prophase I until puberty.
- A female is born with 2 million oocytes, but only about 400,000 survive till puberty.
- A woman will release on average around 580 eggs in her lifetime (one per month!).
- When a Primary oocyte (2n) is released it undergoes Meiosis 1 and becomes a Secondary oocyte (1n)!

Oogenesis

- 4 products, but only 1 is useful.



- In plants the egg is called an "ovule" and is the precursor to a seed.

Spermatogenesis

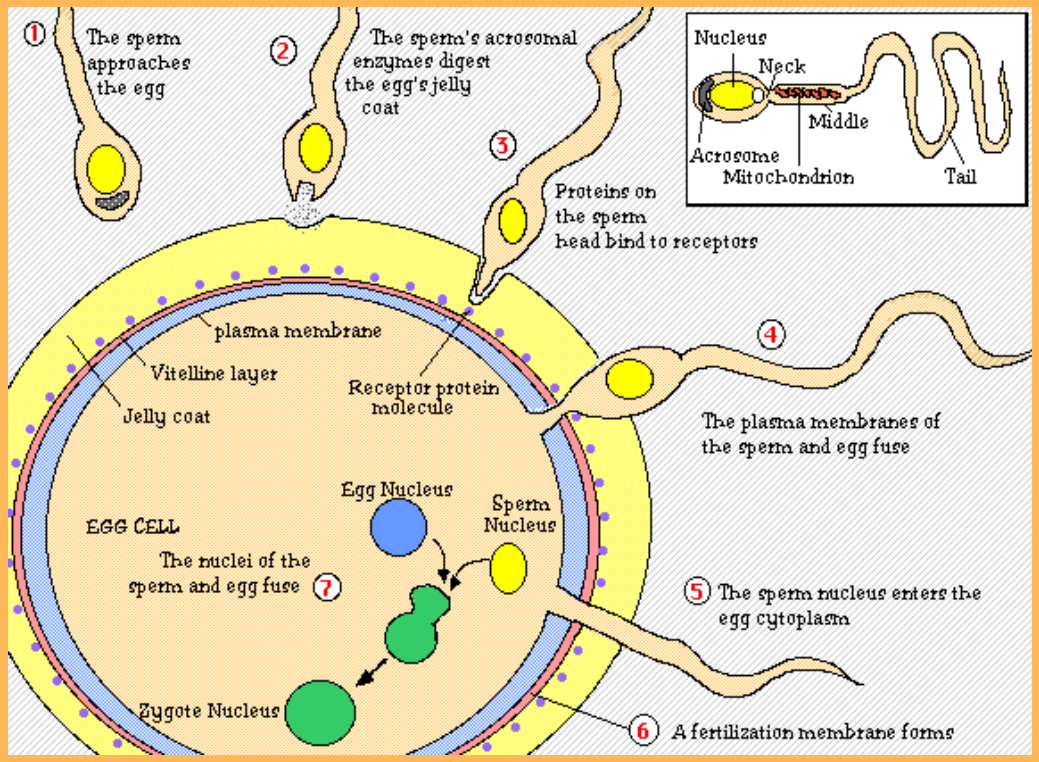
Production of sperm

- Specialized cells in the male testes will produce sperm.
- Meiosis proceeds normally, producing four haploid cells.

- The four cells then are modified to become sperm cells.
- In plants, the sperm are called "pollen".

Fertilization

Is when two haploid gametes (egg and sperm) join with each other to produce a diploid zygote.



- Only 1 sperm can enter the egg.
- In plants the fertilized ovul is called a "seed".
- In animals the fertilized egg is called a zygote.

Zygote

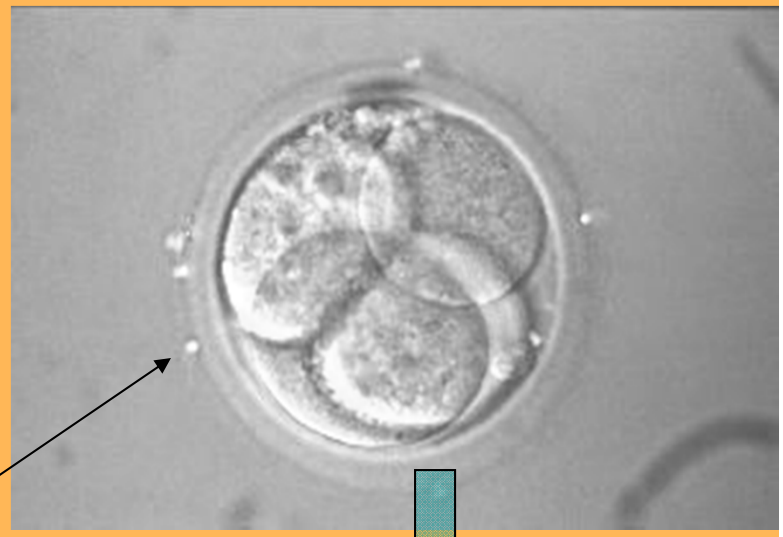
The zygote is the diploid fertilized egg.

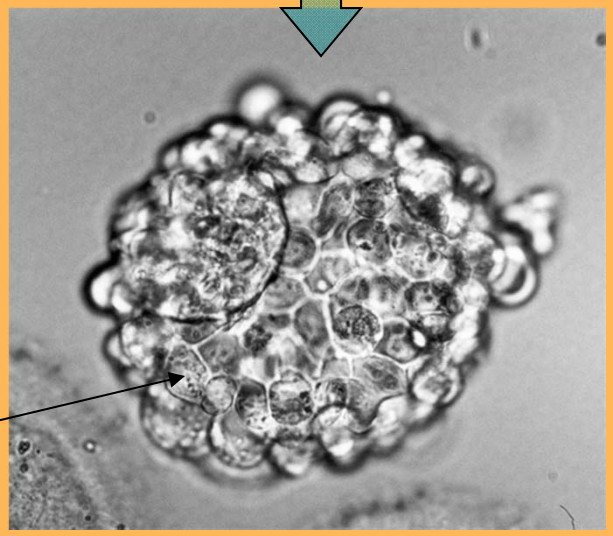
- In this photo you can see the two nuclei that are about to fuse.

- The egg nucleus has 23 chromosomes from Mom.
- The other nucleus from the sperm, has the 23 chromosomes from Dad.
- The result will be 2N, for a total of 46 chromosomes.

Embryo

- The embryo is the new, developing diploid individual.
- 1 cell develops into 2, both 2n.
- Here the embryo has undergone **mitosis** again and is now in the 4 cell stage.
- All 4 cells are identical, 2n.



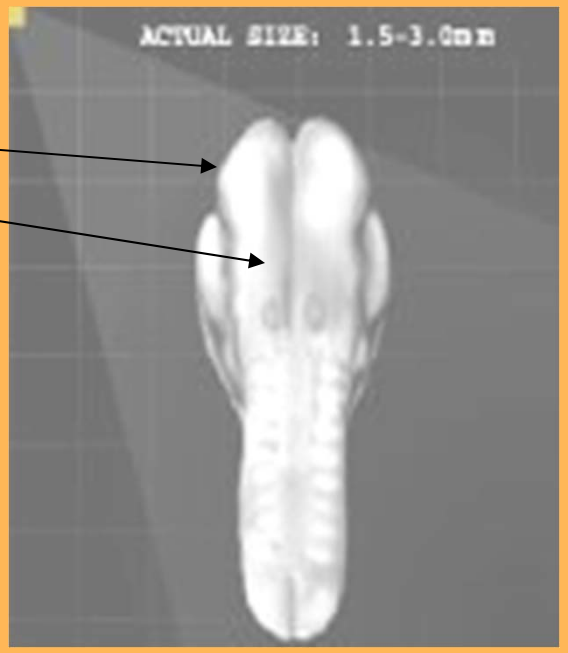


After day five: 70-100 cells (Blastocyst)

Differentiation

The process by which cells are directed to specialize into various different tissues.

- Differentiation allows organisms to reach their adult form and function.
- Here the developing spinal cord and brain are visible in the embryo.
- Cells become more specialized in their structure and function to be more efficient.
- Each cell has the same genetic information.
- The cell uses only the genetic information it needs to follow its specific pathway of development.
- (All cells have the same genes, because they have the same chromosomes. Genes can be "turned on" or "turned off" to make each type of cell specific for its function.)
- This is called Gene Expression!

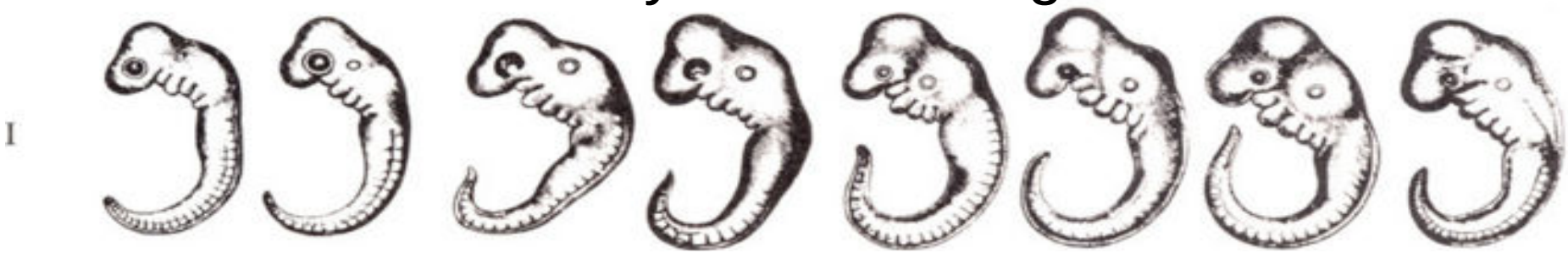


Fetus

When the individual has developed all the major organs and structures of an adult, we call it a **fetus.**

For humans this is the start of the 9th week after fertilization till birth.

Embryonic Homologies



Which one will develop into a fish? A human?