Biology summary 12. 12. 2020

diffusion & osmosis

All molecule move at a temperature greater than 0K. If it is a solid, it only jiggles but still moves. That movement is random. Movement will mostly go from a region with high concentration to a region with low concentration. Therefore, molecules will spread everywhere. That's called diffusion and its speed depends on temperature.

The same can happen trough a selective permeable membrane. In that case we call it osmosis. We call a solution isotonic if its concentration is the same as in the cell. We call a solution Hypertonic if its concentraition is higher than in the cell. We call a solution Hypotonic if its concentraition is lower than in the cell.

meiosis/recombination/non-disjunction

The goal of meiosis is to create haploid cells out of diploid cells (for reproduction).

Mytosis (as reminder):

Interphase Interphase is the normal working phase. It grows. If the cell plans on dividing, the DNA duplicates. (consists of g1, s, g2)

Prophase

- Chromosomes condense. (get shorter and thicker)
- Nuclear envelopes break down.
- Spindles grow out of centrosomes which are located on opposite poles.

Metaphase

- Chromosomes align at equator.
- Spindles are fully grown and attach to each sister chromatid.

Anaphase

- The centromere (which holds sister chromatids together) divides. And the spindles pull the sister chromatids apart.

Telophase

- The chromatids reach opposite ends of cell. 2 new nuclear envelopes form and chromosomes decondense. Spindles disappear.

Meiosis:

0. Interphase
1. Prophase I –> one diploid cell with double-chromatid chromosomes. (Here sister chromatids can exchange parts)
2. Metaphase I –> Spindles connect to homologous pairs.
3. Anaphase I –> Seperate homologous pairs
4. Telophase I (& cell division) –> cell division (now we have two diploid cells)
5. Metaphase II –> Spindles connect to centromeres.
6. Anaphase II –> seperate sister chromatids.
7. Telophase II (& cell division) –> cell division (now we have four haploid cells (different from mother cell))

Recombination

Because the distribution of the homologue pairs is random, there are many possible outcomes for the daughter cells in meiosis. During prophase 1 the sister chromatids lie very close to each other. They can exchange parts, which makes more variation possible.

non-disjunction

During Meiosis mistakes can happen at Anaphase I/II. It can happen, that not exactly half of the chromosones are in the two resulting cells. That results in aneuploidy (trisomy or monosomy (mostly lethal)). The older the mother is, the higher is the chance of such a mistake, because the sisterchromatids lie together longer.

Aneuploidy of sex chromosomes is oftern viable, because only one X chromosone is required. If there are more, it doesn't matter. If there are some Y that also doesn't matter. Following syndromes exist:

Turner	Poly-X	Klinefelter	Diplo-Y
X0	XXX	XXY	XYY

spermatogenesis

There is one primordial germ cell. If sperm cells are produced, this cell gets divided. Then, it goes through Meiosis and at the end forms a sperm cell.

oogenesis

The eggs do cell division in the embrio. At birth, all the egg cells are there. (Diploid / double chromatid-chromosomes) From Puberty on, the egg cells will end meiosis I (from prophase I) and start with meiosis II. All the material will stay at one of the daughter cell. The other one just becomes a polar body. Meiosis II only finishes (from metaphase II), if the egg gets Fertilized.

egg cell & sperm cell

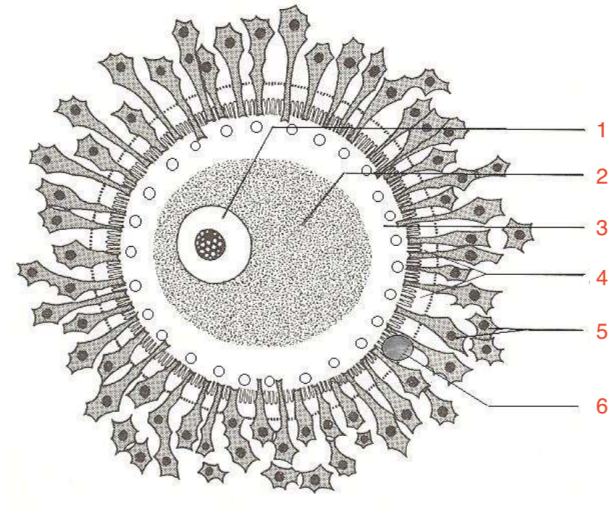

diagram of an egg cell (oocyte II)

In the centre of the egg theres the **nucleus (1)** sourrounded by **cytosol and cell organelles (2).** On the periphery of the egg cell there are so called **cortical granules (3),** which play an important role during insemination/fertilisation. (see. 5.4) The egg membrane separates the cytosol from the so called **zona pellucida (4)** which is a protective layer of glycoproteins secreted. It is secreted by the **granulosa cells (5)** that surround the egg cell forming the so called zona radiate.
The **polar bodies** ("rest cells" of meiosis) **(6)** that are formed during the oogenesis (see 5.4) sit between egg membrane and zona pellucida.

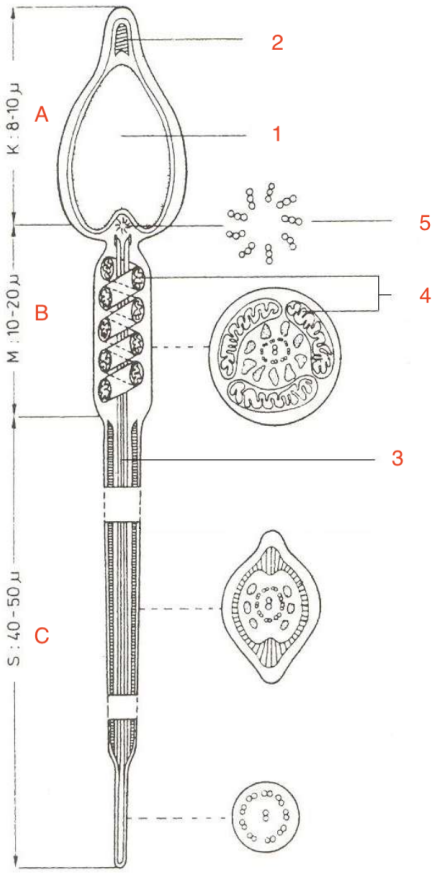

diagram of a sperm cell (on the right: cross sections through different regions)

A fully formed sperm looks very different from any other type of cell found in the human body. The **nucleus (1)** is contained within the **head (A),** and there is only a thin layer of cytoplasm between the nucleus and the cell surface membrane. Right at the tip of the head is the **acrosome (2),** which is a membrane-bound compartment formed from the Golgi apparatus that contains hydrolytic enzymes.
The **tail (C)** of a sperm contains **microtubules (3)** running along its entire length. These microtubules are responsible for the swimming movements of the sperm. They obtain ATP for this activity from many **mitochondria (4)** which are packed closely in a region called the **middle piece (B)** just behind the head of the sperm.
Just at the base of the head there are **two centrioles (5)** which will form the spindle apparats for the first division of the zygote.

Fully formed sperm move from the lumen of the seminiferous tubules to the epididymis, carried in fluid secreted by the Sertoli cells. At this stage, they do not swim, but they gradually become able to do so after a day or so in the epididymis. However, they do not make use of their swimming ability until they are ejaculated; it seems that proteins secreted by cells in the epididymis inhibit their activity. Once released, a healthy sperm can swim at up to 4 mm per minute.

fertilisation

0. The sperm cells are around the egg cell.
1. The sperm cells come in contact with the zona pellucida.
2. The acrosome in the head of the sperm cell gets released.
3. The released acrosome digests the zona pellucida.
4. The sperm cell can enter the perivitelline space.
5. The sperm cell fuses with the cell membrane of the egg.
6. Two processes are started to block other sperm cells from getting in the cell:
    - Fast block: Eggs cell membrane depolarizes
    - Slow block: cortical granules release their content
7. The nucleus of the sperm cell goes through the eggs membrane
8. Egg cell finishes meiosis II
9. Nucleus of egg and sperm fuse and create the zygote.