Understandings:

1. Outline the process of meiosis.
- The idea of meiosis is to make a diploid into four haploids.

First the nucleus replicates. Then the nucleus splits into two haploids. Then the haploids further splits into four haploids with only single chromatids.

Since we are halving the chromosome number, we call this a reduction division.

2. Explain how halving allows fusion of gametes.
- Since meiosis produces haploid cells, it enables fusing with other haploids for fertilization! So meiosis is essential for reproduction, and genetic variety.

Meiosis can happen anytime, but animals only undergo meiosis when gametes are needed.

3. State that replication happens before meiosis.
- This is simple mathematics. Let's take an example of humans with 46 chromosomes or 23 chromosome pairs. What we could do is that we just split it into two haploid cells with 23 chromosomes. However, this does not give much genetic variety, especially for species with less chromosome numbers.

So, in order to produce four, we replicate into 92 chromosomes. Then if we divide that into 4, we get that each haploid cells get 23 chromosomes.

Note that the replication happens in interphase!

4. Explain bivalents formation and crossing over.
- As explained above, we need to undertake replication before meiosis. However, at first we had 46 chromosomes, hence 23 pairs.

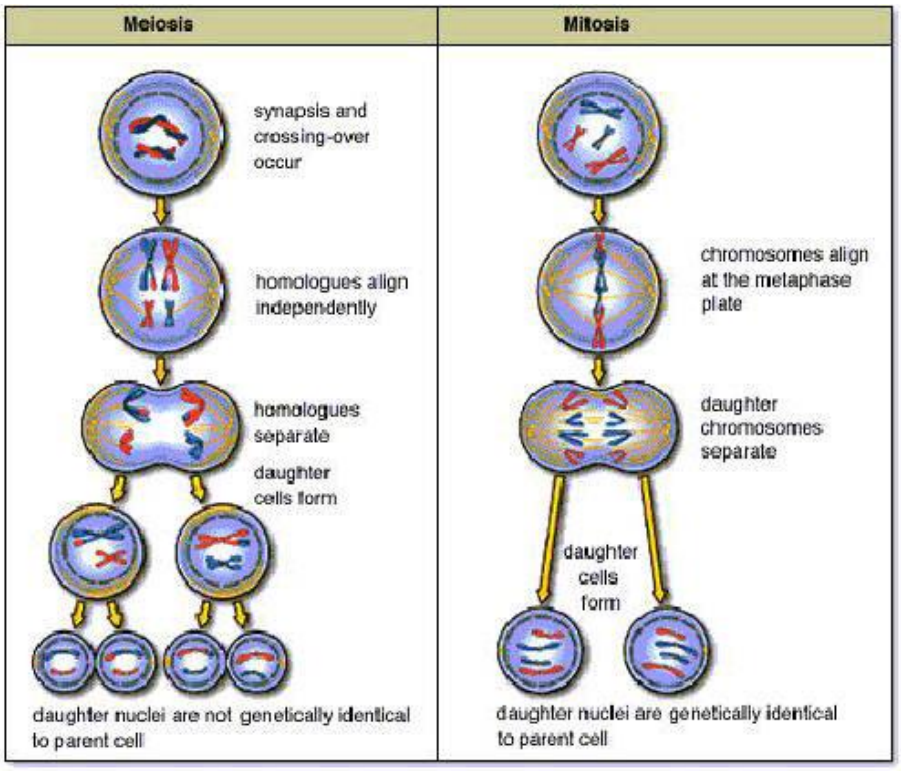
But if we replicate them, we will get 4 homologous structures in one "pair" which is technically not a pair anymore. We call it bivalent (two pairs) and the process where two pairs come together is called synapsis.

So what is then crossing over? This is a random process where the chromatids in the chromosome pairs overlap with its neighboring chromatid and exchange genes that might or might not be of the same allele.

Replication → synapsis into bivalents → crossing over. This whole process of chromosomes preparing can be called condensation.

5. State that the orientation of chromosomes in meiosis is random.

- In the first metaphase, the aligning of meiosis chromosomes is different from mitosis.



The second step is metaphase, where the chromosomes align and microtubules attach.

In meiosis, one chromosome pair is a bivalent structure, meaning that we have two pairs in one chromosome pair! (Sounds crazy)

The <u>orientation is random</u> and neither affects the other.

Mitosis is a chromosome pair (this time with two strands of DNA or chromatids).

6. Explain how the first stage of halving chromosome is different in meiosis and mitosis.

- This is mentioned above with pictures.

Right after the metaphase and the anaphase where the chromosomes in bivalents are split, they contain two chromosomes with two identical chromatids each. Even though they technically have 4 DNA molecules like in the start, they are in the same copy, hence haploids.

Remember that the process where the bivalents split is called <u>disjunction</u>.

7. Explain how meiosis provides genetic variation.

- Genetic variation occurs through randomness, so if we can identify the process in meiosis where randomness occurs, we might be able to answer how meiosis provides genetic variation.

1. The <u>alignment of bivalents is random</u>. During the metaphase 1, bivalents can be facing either pole, and in either alignment order.

2. <u>Crossing over in the prophase 1 is random</u>. These might not or might happen. Also, the amount of crossing over and the location of crossing over are also random. Probability is basically infinite…

8. Explain how fertilization results in genetic variation.

- Since we have variation in gametes due to meiosis, fertilization will also have genetic variation since this is the fusion of two individuals. The chances that the alleles are same is extremely low, thus that is why we all animals are unique.

This is also very important for natural selection.

Applications and skills:

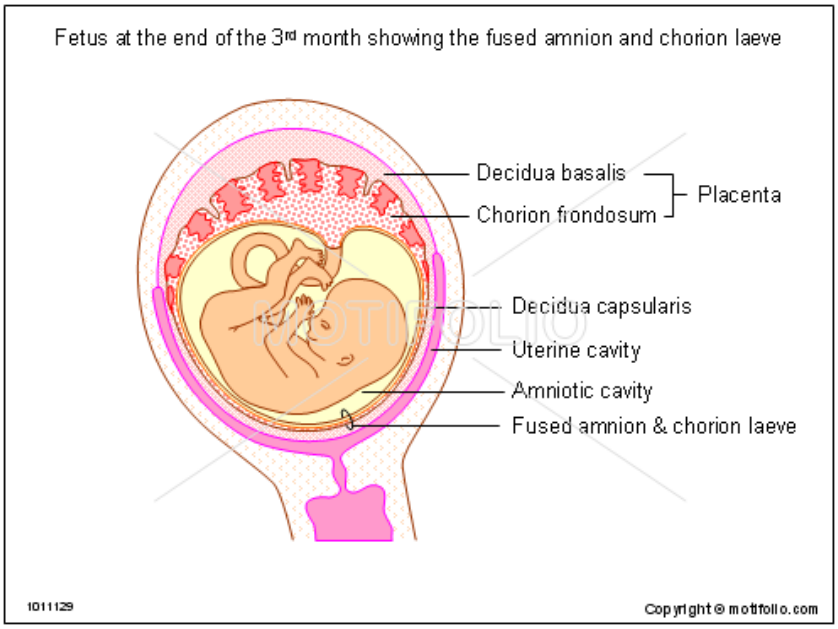
1. Outline ways of obtaining cells of a fetus to see its karyotype.

- This basically asks for the process of karyotyping for fetus (pre-natal or before birth) to check abnormalities, and it is quite simple.

First of all, we need to know what the heck chorionic villus sampling and an amniocentesis are.

These are two separate methods for karyotyping, both sucking up a sample of fetal cells.

Note that since amniotic sac, amniotic fluid, chorion (extra embryonic membrane) and embryonic membrane all are formed from embryo and hence will become a fetus; the amniotic fluid will have same genetic information as the fetus.



Now it is only the matter of how to extract the fluid.

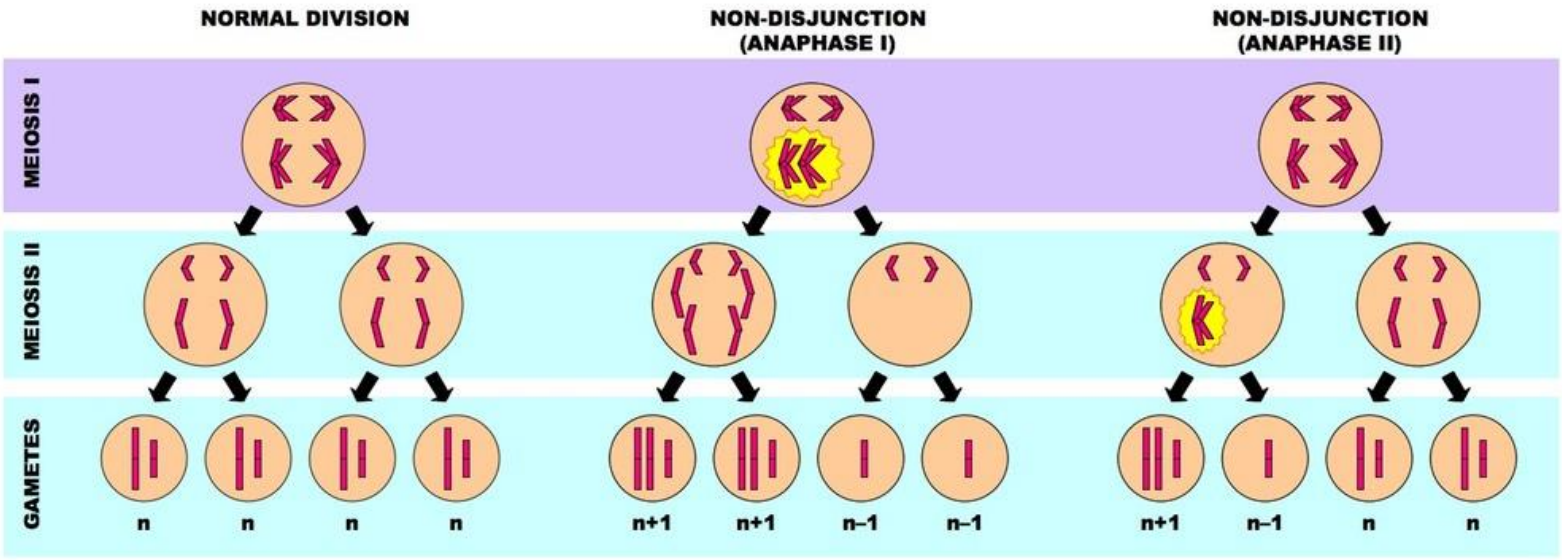
Chorionic villus sampling	Amniocentesis
A small tube is inserted to collect a small piece of chorionic villi (a part in placenta).	Inserts a needle through the abdominal wall to collect the amniotic fluid.
Risk of miscarriage ~ 1%	Risk of miscarriage ~0.5%
Uses ultrasound to identify position of fetus and minimize risk.	Uses ultrasound to identify position of fetus and minimize risk.

2. Explain the relationship between parental age and abnormalities in chromosomes.
- The later a mother gives birth to its child, the higher probability it seems that the child undergoes non-disjunction.

What might be the reason? What is it that elders don't have? Is it hormones, sex drive, humor?

3. Explain how non-disjunction can cause Down syndrome.
- Non-disjunction (non-separating) is when there is a split unbalance during anaphase1 or anaphase2 due to errors in microtubules. I.e. instead of having equal number of chromosomes in each pole, on pole has got an extra chromosome.

When a non-disjoint gamete with two copies of chromosome no.21 fertilizes with another normal gamete, it will result in three no.21 chromosome, aka trisomy 21. This is Down syndrome.



4. Be able to draw the stages of meiosis!
- Well…I think it would better of you to draw this on your own.

TOK:

1. In 1922 the number of chromosomes counted in a human cell was 48. This remained the established number for 30 years, even though a review of photographic evidence from the time clearly showed that there were 46. For what reasons do existing beliefs carry certain inertia?