3. Genetics – 3..3 Meiosis Name:

**Understandings, Applications and Skills** (This is what you maybe assessed on)

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|  | **Statement** | **Guidance** |
| 3.3.U1 | One diploid nucleus divides by meiosis to produce four haploid cells. |  |
| 3.3.U2 | The halving of the chromosome number allows a sexual life cycle with fusion of gametes. |  |
| 3.3.U3 | DNA is replicated before meiosis so that all chromosomes consist of two sister chromatids. |  |
| 3.3.U4 | The early stages of meiosis involve pairing of homologous chromosomes and crossing over followed by condensation. |  |
| 3.3.U5 | Orientation of pairs of homologous chromosomes prior to separation is random. |  |
| 3.3.U6 | Separation of pairs of homologous chromosomes in the first division of meiosis halves the chromosome number. |  |
| 3.3.U7 | Crossing over and random orientation promotes genetic variation. |  |
| 3.3.U8 | Fusion of gametes from different parents promotes genetic variation. |  |
| 3.1.A1 | Non-disjunction can cause Down Syndrome and other chromosome abnormalities. Studies showing age of parents influences chances of non-disjunction. |  |
| 3.2.A2 | Methods used to obtain cells for karyotype analysis e.g. chorionic villus sampling and amniocentesis and the associated risks. |  |
| 3.1.S1 | Drawing diagrams two show the stages of meiosis resulting in the formation of four haploid cells. |  |

**Recommended resources:**

<http://bioknowledgy.weebly.com/29-photosynthesis.html>

Allott, Andrew. *Biology: Course Companion.* S.l.: Oxford UP, 2014. Print.

3.3 U1 One diploid nucleus divides by meiosis to produce four haploid nuclei.

1. Cells divide \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   1. Result: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ daughter cells, each with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as many chromosomes as parent cell

3.3 U.2 The halving of the chromosome number allows a sexual life cycle with fusion of gametes.

1. Meiosis: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ # of chromosomes creating \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (n)
2. Fertilization: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gametes (sperm + egg) creating a fertilized egg or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3.3 U.3 DNA is replicated before meiosis so that all chromosomes consist of two sister chromatids.

1. Duplication of chromosomes during \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ stage of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_:
   1. Single chromosome (called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ during Interphase)
   2. Two identical sister chromatids joined by a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3.3 U.4 The early stages of meiosis involve pairing of homologous chromosomes and crossing over followed by condensation. [The process of chiasmata formation need not be explained.]

1. Crossover (Prophase I):
   1. Red and Blue chromosomes are a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   2. They have replicated during the interphase and each copy is held together by the centromere (black dot)
   3. The chromosomes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of DNA.
   4. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are the points at which the red and blue chromosomes overlap.
   5. At a molecular level the exchange has to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ avoiding loss of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   6. Such an error would have profound effect on the genes.
2. At \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the homologous pairs are separated.
   1. Notice that sections of DNA have been \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   2. These will mean that the alleles on these section have also been exchanged

3.3 U.5 Orientation of pairs of homologous chromosomes prior to separation is random.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of chromosomes:
   1. Meiosis introduces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in several ways.
   2. Gametes of offspring do not have same \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of genes as gametes from parents

3.3 U.6 Separation of pairs of homologous chromosomes in the first division of meiosis halves the chromosome number.

1. Each individual has a pair of chromosomes (both chromosomes of a pair carry “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” genes)
2. Control \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ inherited characters \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = same information
3. To create \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the number of chromosomes must be reduced for
   1. Humans from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ chromosomes → to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3.3 S.1 Drawing diagrams to show the stages of meiosis resulting in the formation of four haploid cells.

1. Meiosis 1
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Meiosis 2
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ division of meiosis separates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1n → 1n) \* just like mitosis \*
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ division of meiosis separates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (2n → 1n) “reduction division”
5. Meiosis: Generates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   1. Reduces the number of chromosomes by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   2. Also produces genetic variability, each gamete is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, ensuring that two offspring from the same parents are never \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ divisions: Meiosis I and meiosis II.
6. Meiosis I: Separation of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Chromosomes
   1. Prophase I:
      1. Chromatin \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into chromosomes.
      2. Nuclear membrane \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
      3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ move to opposite poles of cell and microtubules attach to chromatids.
      4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Homologous chromosomes pair up and form a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of 4 sister chromatids.
   2. Prophase I:
      1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between Homologous Chromosomes
7. Meiosis II: Separation of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Meiosis II is very similar to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   * 1. Prophase II: Very brief, chromosomes reform.
     2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ crossing over or synapsis.
     3. Spindle forms and starts to move chromosomes towards center of the cell.
9. Metaphase II:
   1. Very brief, individual chromosomes line up in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the cell.
   2. Anaphase II: Chromatids \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and move towards opposite ends of the cell.
10. Telophase II:
    1. Nuclei form at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ends of the cell.
    2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ occurs.
    3. Product of meiosis: Four (4) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gametes, each genetically different from the other.
11. Independent assortment of chromosomes – meiosis introduces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – gametes of offspring do not have same combination of genes as gametes from parents

3.3 U.7 Crossing over and random orientation promotes genetic variation.

1. Fertilization Sources of Genetic Variation – Human Sperm + Human Egg come together to produce 8 million X 8 million = 64 trillion combinations!

3.3 U8 Fusion of gametes from different parents promotes genetic variation.

1. Sperm + Egg = ? – any 2 parents will produce a zygote with over 70 trillion (223 x 223) possible diploid combinations
2. Sexual reproduction allows us to maintain both genetic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3.3 A.1 Non-disjunction can cause Down syndrome and other chromosome abnormalities.

1. Accidents During Meiosis Can Cause Chromosomal Abnormalities –
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Chromosomes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to separate. – Gametes (and zygotes) will have an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ chromosome, others will be missing a chromosome.
   2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Individuals with one extra chromosome, three instead of pair.
   3. Have 47 chromosomes in cells.
   4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Missing a chromosome, one instead of pair. Have 45 chromosomes in cells.

3.3 A.2 Studies showing age of parents influences chances of non-disjunction.

1. Weakening of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ties holding together chromosomes in sex cells may contribute to maternal age- related errors.
2. The loss of cohesion may contribute to incorrect \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ during meiotic divisions

3.3 A.3 Description of methods used to obtain cells for karyotype analysis e.g. chorionic villus sampling and amniocentesis and the associated risks.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ medical procedure used in prenatal diagnosis of chromosomal abnormalities and also used for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ determination.
2. A small amount of amniotic fluid, which contains \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, is sampled from the amniotic sac surrounding a developing fetus, and the fetal DNA is examined for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.