

## Homework 4: DNA/RNA, Mitosis/Meiosis & Protein Synthesis

1. What is the basic difference between a molecule of DNA and RNA?

While both are nucleic acids that are polymers of nucleotides, DNA differs from RNA in that it is double stranded vs single stranded, has deoxyribose vs ribose for its sugar, and has the pyrimidine Uracil instead of Thymine.

2. Why is DNA replication described as semi-conservative? What phenomenon allows each strand to function as a template against which a new strand can be fabricated?

DNA replication is called semi-conservative because each duplicate molecule of DNA produced consists of one strand of the original molecule and one newly synthesized strand. The phenomenon that allows each original strand to act as a template for the synthesis of a new complementary strand is the process of complementary base pairing (G-C, A-T) that ensures accuracy.

3. Describe (not list) the phases of the cell cycle (ie briefly state what occurs during each stage).

G1 – Gap 1 where the cell grows larger and acquires more resources. The DNA is unduplicated at this stage and in chromatin form

S – Synthesis where DNA is duplicated. The DNA is still in chromatin format, begins this phase as a single copy, and ends this phase in duplicate format

G2 – Gap 2 phase where the cell grows but this time in preparation for cell division. This includes that there are sufficient reserves to provide for each of the future daughter cells.

The DNA is in duplicate and chromatin form in this phase

M – Mitosis or Meiosis where nuclear division forms followed usually by cytokinesis.

The DNA starts in duplicate chromatin form, condenses to chromosome form and finishes this phase as single copy and chromatin.

4. What are sister chromatids? How do they differ from non-sister chromatids?

Sister Chromatids are duplicate copies of the same strand of DNA that are joined at the centromere prior to their separation in either mitosis or meiosis 2. Non sister chromatids are the chromatids of homologous chromosome pairs. They have the same genes associated with them but they may or may not be the same alleles for those genes. Non-sister chromatids do not interact during mitosis or meiosis 2 but do interact during meiosis 1.

5. What do you start with and wind up with in the process of 1) mitosis and 2) meiosis?

What do cells use these two processes for?

Mitosis: start with one parent cell and wind up with two daughter cells that are genetically identical to both themselves and the original parent cell.

Meiosis: start with 1 diploid parent cell and wind up with four haploid daughter cells (ie with half the genetic material of the parent cell).

Mitosis is used by cells for somatic growth and/or asexual reproduction while meiosis is used exclusively for sexual reproduction.

6. What is meant by diploid? How about haploid?

Diploid refers to the genetic state of a cell where there are both of the homologous chromosomes present for each pair in the nucleus.

Haploid refers to the genetic state where there is only one of each homologous chromosome pair is present in the nucleus

7. What are two ways that generate genetic variability during the process of meiosis? Why don't these occur during mitosis?

1 – Crossing over where pieces on non sister chromatids exchange when duplicate homologous chromosomes combine to form tetrads (synapsis) during meiosis 1.

2 – Independent assortment where paternal and maternal chromosomes for each homologous pair are randomly shuffled and separated during metaphase of meiosis 1. Neither of these occur during mitosis because homologous chromosome pairs don't undergo synapsis and aren't separated in this process.

8. Which stage of meiosis is most similar to mitosis and why?

Meiosis 2 most resembles mitosis because essentially all it does is separate sister chromatids and distribute one copy to each daughter cell.

9. Where does transcription occur and what does it produce? How about translation?

Transcription occurs in the nucleus and you produce RNA using one strand of a DNA molecule as a template. Specifically mRNA, tRNA, and rRNA are produced.

Translation occurs in the cytoplasm and the instructions for the sequence of amino acids of a polypeptide are decoded from a mRNA and used as a guide to assemble those amino acids into a polypeptide.

10. Briefly explain the role of mRNA, tRNA, and rRNA in the process of translation.

mRNA is the instruction for the polypeptide and consists of a long sequence of codons each identifying a specific amino acid

tRNA – seeks a specific amino acid in the cytoplasm and then brings it to the ribosome to where its anti-codon complementary base pairs to the corresponding codon on mRNA in order to allow adjacent amino acids to form a peptide bond

rRNA – is the building material from which the large and small subunit of the ribosome are fabricated.