LAB 9 – DNA and Mitosis

Section 1 – DNA Introduced

[2] DNA, once suspected to be the powerful and mysterious force behind inheritance as well as a great prize at the end of the race for discovery of its structure, is a now a daily headline in news reports and a subject introduced as early as the elementary school level. Surprisingly, as common a topic as DNA is, few individuals comprehend how we arrived at our understanding of its heritable powers or how its structure was finally revealed. What a story! What a structure! What a remarkable subject to investigate! Let's start at the molecular level and get to know the structure of DNA!

[3] Deoxyribonucleic acid, or DNA, is the genetic material that an organism inherits from its parents. Does that mean it comes from a lawyer in the form of a will? No! When we say you inherit your DNA from your parents it is an inheritance you receive that enables you to come into

[11] Look at these two forms of chromosomes. Drag the word chromatin to DNA and proteins in their relaxed state**.** Now, drag the word chromosome to DNA and proteins in its coiled state. Record this information in your lab book.

[12] In sexually reproducing organisms, when the chromosomes of the haploid sperm cell fuse with the chromosomes of the haploid egg cell we call the resulting cell diploid. This fusion is called fertilization and it produces a zygote which is a fertilized egg. Record these important definitions in your lab book.

[13] Do you think only humans have DNA? Click on your answer.

[14] Did you realize that all known forms of life carry their hereditary information within their molecules of DNA? Humans have 46 chromosomes, but a dog has 78 chromosomes! A Koala has 16 chromosomes! The number of chromosomes in a eukaryotic cell depends on the species. Here you see a table listing the chromosome numbers of various species. Take a look at that now and answer the questions next to the table.

[15] Let's examine the components of the molecule of DNA more closely. Each molecule of DNA consists of a double-stranded helix. This is a common image you will see representing DNA.

[16] The "blue ribbon" backbone is actually made up of repeating molecules of sugar and phosphate. The letters in between the ribbons represent the hereditary instructions contained in the DNA molecule that produce organisms like you. Each letter (A, T, C and G) represents one of four nitrogenous (nitrogen-containing) bases. They are called *bases* because they act as a base and accept hydrogen ions. Record this information near the double-helix in your lab book.

[17] Let's take an even closer look at part of a molecule of DNA (because a molecule of DNA is MUCH longer than what you see here). This picture still shows the sugar phosphate

[22] A polymer is a larger unit consisting of many similar molecules *covalently* joined in a chain. Look at this longer sequence of DNA nucleotides. In DNA, the chain of covalently joined monomers of nucleotides is one strand of the double-stranded helix. Answer the questions

[30] Griffith reasoned that there must have been some factor from the pathogenic “S” bacteria, even after it had been heat-killed, that could transform or alter the nonpathogenic bacteria into a pathogenic form. Griffith called the event transformation. Copy this definition down in your lab book.

[31] We now understand transformation to be a change in the genes and physical characteristics of an organism by the incorporation of external DNA into a cell. Griffith did not discover the transforming factor, but laid the groundwork for other researchers. Summarize Griffith’s findings in your lab manual before you go on.

[32] For 14 years American bacteriologist Oswald Avery and his colleagues McCarty and MacLeod continued Griffith’s search by asking the question “what chemical component of the heat-killed ‘S’ cells could cause this transformation”?

[33] When Avery and colleagues destroyed the DNA of the heat-killed “S” strain bacteria, transformation did not occur and the “R” strain bacteria did not become pathogenic. The scientists announced that the transforming agent was DNA. Even so, biologists were still not convinced. Note this discovery in your lab book.

[34] In 1952, additional experiments were done by two scientists named Hershey and Chase that confirmed DNA as the genetic material. To accomplish this, they used bacteriophages. Bacteriophages are viruses that attack and infect bacteria. You can see the tiny space-ship shaped bacteriophages infecting the oval shaped bacteria. Label the bacteriophage and the bacterium in your lab book before you continue.

[35] Viruses consist of only DNA and protein. The viruses head and body are made of a protective protein coat that encloses the DNA in the head or top portion of the virus. Hershey and Chase took advantage of the fact that DNA contains the element phosp
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Section 4 - The Discovery of the Structure of DNA

[49] By the early 1950's it was a generally accepted fact that DNA was the cell's hereditary material and could be isolated as a clear, sticky substance. Though it was already

[58] The information presented by Franklin's x-ray diffraction provided further evidence for Watson and Crick that DNA was a double-stranded helix, and that the sugar-phosphate backbone was on the outside of the molecule. This did not answer every question. Watson and Crick did not know how the bases came together in the middle of the helix.

[59] The solution was found after further study of the x-ray data. Measurements of the width between the two strands of DNA were consistent with the pairing of a purine and a pyrimidine. This should help you answer the questions about Franklin's work

[67] The sequence or ordering of bases along the length of each strand of DNA is exclusive to each chromosome and unique to an organism. It is the sequence of DNA that provides the instructions for the development, characteristics and functioning of the organism.

[68] The sequence of each strand of DNA represents the genetic code – a code that was deciphered in the 1960's. You will learn to read the code in an upcoming lab.

[76] DNA replication begins with the original, “parental” double-strands of the DNA molecule.

[85] Mitosis is followed by cytokinesis. Cytokinesis is the division of the cytoplasm to form two separate daughter cells. Remember, the term “daughter” does not indicate gender, but represents new cells. Make note of this information before you go on.

[86] Cell division is essential for the growth of a multicellular organism, even those that reproduce sexually. Multicellular organisms begin development as a zygote which you remember is a fertilized egg. That includes you! You did not remain a single-celled organism and you have mitosis to thank! New cells for the growth of an organism are provided by cell divisions.

[87] You see here polar bears and stalked eyed flies. Both

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[102] The second stage of mitosis is called metaphase. The microtubules, now attached to the centromeres, move the chromosomes so that they are arranged along the equator of the cell. This position is often called “the metaphase plate”. You can see the chromosomes but will not be able to distinguish which chromatid belongs to which chromosome. It is not possible to see the centromeres, but each chromatid has its own.

[103] The third stage of mitosis is anaphase. The centromere of each attached sister chromatid are pulled to opposite poles of the cell. As the

representative cell in your lab book. You do not need to be an artist to produce scientific drawings. It should be an accurate representation of what you have seen, not a work of art!

[111] Have you completed your drawings? If so, locate one onion cell in your microscope in anaphase and put the pointer on that cell. Have the instructor initial your lab book, then you can move on to Section 11 and finish up lab 9. Remember the instructor is available to help you if you run into any problems.

Section 11 – Mitotic Stages in Animal Cells; Different than Plant Cells?

[112] You have investigated and drawn cell division in a plant cell, specifically an onion. Had you thought about onions having chromosomes? What about animal cells? Are they different?

[113] Let's see how animal mitosis might look in animal cells with this animation. Remember as we view the animation that whether these phases occur in a plant or animal cell, the goal of mitosis and cytokinesis remains the same - to produce genetically identical daughter cells. But, there are differences worth taking note of.

[114] Though you would not be able to see centrioles in animal cell slides in your microscope, you can see them in the still slides from the animation. Centrioles are present at the pole of each dividing animal cell. Centrioles physically anchor one end of each microtubule. Most plant cells anchor their microtubules, but not with centrioles.

[115] You may have already wondered…where is the cell wall? Animal cells do not have cell walls so do not get that question wrong on a quiz! In animal cells, cytokinesis is accomplished through a process called cleavage. The first sign that cleavage is occurring is seen here as a wrinkled indent at the metaphase plate of the cell. This is called the cleavage furrow. It looks as though someone is pulling the drawstrings of a trash bag