AMERICAN UNIVERSITY OF BEIRUT

DIFFERENTIATING INSTRUCTION IN BIOLOGY FOR THE GENETICS UNIT IN SECONDARY CLASSES

by

MOHAMMED SALIM ESTAITEYEH

A project
submitted in partial fulfillment of the requirements
for the degree of Master of Arts
to the Department of Education
of the Faculty of Arts and Sciences
at the American University of Beirut

Beirut, Lebanon
February 2015

AMERICAN UNIVERSITY OF BEIRUT

DIFFERENTIATING INSTRUCTION IN BIOLOGY FOR THE GENETICS UNIT IN SECONDARY CLASSES

by

MOHAMMED SALIM ESTAITEYEH

Approved by:

Dr. Saouma B. BouJaoude, Professor
Department of Education — First Reader

Dr. Rola F. Khishfe, Associate Professor
Department of Education — Second Reader

Date of project presentation: February 3, 2015

AMERICAN UNIVERSITY OF BEIRUT

THESIS, DISSERTATION, PROJECT RELEASE FORM

Student Name: Estaiteyh Mohammed Salim
Last First Middle

○ Master's Thesis ✓ Master's Project ○ Doctoral Dissertation

☑ I authorize the American University of Beirut to: (a) reproduce hard or electronic copies of my thesis, dissertation, or project; (b) include such copies in the archives and digital repositories of the University; and (c) make freely available such copies to third parties for research or educational purposes.

☐ I authorize the American University of Beirut, **three years after the date of submitting my thesis, dissertation, or project,** to: (a) reproduce hard or electronic copies of it; (b) include such copies in the archives and digital repositories of the University; and (c) make freely available such copies to third parties for research or educational purposes.

Signature Date

Feb. 3, 2015

This form is signed when submitting the thesis, dissertation, or project to the University Libraries

AN ABSTRACT OF THE PROJECT OF

Mohammed Salim Estaiteyeh for Masters of Arts
Major: Science Education

Title: Differentiating instruction in biology for the genetics unit in secondary classes

Differentiated instruction is tailored instruction that incorporates a variety of strategies aimed at meeting the needs and interests of individual students. It aims at aligning the instructional strategies with students' needs, strengths, interests and learning styles. Research has shown the positive impact of differentiating instruction according to the students' learning styles. Given this positive effect of differentiated instruction on various aspects, this project aims at providing the biology teachers of grades 10 till 12 with the tools needed to differentiate instruction in their classes while teaching the genetics unit. This unit was specifically chosen since many students have misconceptions about genetics concepts and face difficulties understanding many of these concepts.

CONTENTS

TABLES

CHAPTER I

INTRODUCTION

This chapter provides a background on differentiated instruction and presents the purpose, rationale and significance of this project.

A. Background

Differentiated instruction is a constructivist-based teaching approach that aims to achieve learning for all students of diverse socio-cultural backgrounds, abilities and interests (Valiandes & Tarman, 2011). Studies revealed that when teaching methods are not aligned with students' learning styles, this negatively influences students' academic performance and commitment to attending classes (Felder & Henriques, 1995). Hence, effective instruction requires taking into account individual differences among students.

Differentiation of instruction promotes learning of all students by catering to their idiosyncratic needs (Tomlinson, 2001). This is achieved through modification of the existing curriculum, development of lessons and materials and implementation of teaching strategies that correspond to students' readiness, interests and learning profiles (Mitchell & Hobson, 2005; Tomlinson, 1999; Willis & Mann, 2000). Due to the complexity of the process of differentiating instruction, its implementation also requires ongoing teacher training (Valiandes, 2010).

There is no single formula for creating a differentiated classroom. However, the concepts, principles and skills of a particular subject area should be at the core of teacher instruction. According to Tomlinson (1999), differentiating instruction entails modifying one or more of the following: content, process or product. The content is

what students are expected to learn. The process describes the activities designed throughout the lesson. Products refer to how students demonstrate their learning by means of assessment tools since assessment cannot be separated from instruction (Tomlinson, 1999).

B. Purpose

Previous research has consistently shown that students encounter many difficulties in basic areas of genetics including, but not limited to, differences between genotype and phenotype, gene expression, and the meiotic model (e.g., Lewis & Kattmann, 2004; Lewis, Leach & Wood- Robinson, 2000a, 2000b). Studies have also indicated that teachers experience difficulties in genetics instruction (e.g., Bahar, Johnstone & Hansell, 1999). Therefore, given the positive effect of differentiated instruction on student learning, this project aims at providing Lebanese biology teachers of grades 10 till 12 with the tools needed to differentiate instruction in their classes while teaching the genetics unit. The project integrates Tomlinson's theoretical framework explained above by which the teacher should modify one or more of the three curricular elements: content, process, and product. This will be done for all the concepts in the genetics unit including: Chromosomes, Karyotyping, DNA Structure, DNA Replication, DNA Transcription, Translation, Mutations, Genetic Engineering, Dihybrid Crossing, and Pedigree Analysis.

C. Rationale

A large portion of the research dealing with differentiated instruction has been done in the context of language and reading (e.g., Felder & Henrique, 1995). However,

there is very minimal research on teachers' integration of differentiated instruction in science classrooms (Mastropieri et al., 2006) and the majority of these studies have been done with elementary students (Tobin & Tippet, 2014) or middle school students (Oliveira et al., 2013). Recent literature on secondary biology classrooms is non-existent (Brigham, Scruggs & Mastropieri, 2011) particularly in the area of genetics and in the Lebanese context. Therefore, this project aims to address a gap in the literature in regard to differentiating instruction in secondary biology classrooms.

D. Significance

This project has practical implications in terms of teacher professional development and positive student outcomes. On the one hand, secondary biology teachers will be equipped with the knowledge and skills of how to integrate differentiated instruction in their teaching practices, particularly in the teaching of genetics. On the other hand, by catering genetics instruction to students' needs and interests, teachers can help promote student engagement and motivation (Tomlinson, 2008) and, in turn, enhance student achievement (Tulbure, 2011).

CHAPTER II

LITERATURE REVIEW

This chapter presents an overview of differentiated instruction and provides a review of the literature on the characteristics of effective differentiation as well as the positive outcomes and challenges of differentiated instruction.

A. What is Differentiated Instruction?

Differentiated instruction is tailored instruction that incorporates a variety of strategies aimed at meeting the needs and interests of individual students (Watts-Taffe et al., 2012). The concept of differentiated instruction began with the No Child Left Behind and the Individuals with Disabilities Education Act (1997) in the USA which advocate that all students be included in a least restrictive learning environment by being taught using instructional approaches that align with their needs (De Jesus, 2012). This has increased teachers' accountability in providing quality education for all students (Brigham, Scruggs & Mastropieri, 2011). Moreover, general education classrooms in the USA have currently become ethnically and culturally diverse, which has necessitated that teachers cater to diverse populations (Tomlinson et al., 2003).In short, "differentiated instruction is a set of strategies that will help teachers meet each child where they are when they enter class and move them forward as far as possible on their educational path" (Levy, 2008, p. 162).

Differentiated instruction differs from individualized instruction. In individualized instruction, the teacher modifies instruction for every student while in differentiated instruction the teacher divides the whole class into smaller subsets based

on their common needs and preferences (Chamberlin & Powers, 2010). Moreover, differentiation is not merely the use of "different methods and different materials in everyday teaching", but it actually involves everything and anything teacher does or chooses not to do during the learning process in order to fulfill the needs of the students (Valiandes & Tarman, 2011, p. 171).It is also important to note that differentiating instruction does not occur in every single classroom session (Chamberlin & Powers, 2010).

Differentiation is a way of thinking that is grounded in the following six beliefs: 1) Every student is worth being respected and dignified; 2) Diversity in classrooms is unavoidable but has positive outcomes on learning; 3) Classrooms should reflect the kind of society that students will eventually participate in; 4) Most students have the potential to learn essential concepts and skills in particular subject areas; 5) Each student has the right to equal access of high-quality teaching and learning; and 6) The ultimate goal of teaching is to capitalize on the capabilities of each learner (Tomlinson & Imbeau, 2010).

Differentiated instruction focuses on the *content* students learn, the *process* and *product* of student learning and the *environment* in which students learn (Tomlinson, 2001). For the scope of this project, only content, process and product will be considered. However, it is important to mention that rather than being separate entities the four dimensions of differentiated instruction are reciprocally related and therefore influence one another (Watts-Taffe et al., 2012).

B. Characteristics of Effective Differentiated Instruction

Despite the fact that science teachers acknowledge the importance of differentiated instruction as a pedagogical approach, many struggle with translating this approach into their instructional practices (Whitworth, Maeng & Bell, 2013). There is no single formula or scripted method to apply differentiated instruction (Valiandes & Tarman, 2011). Nonetheless, according to the literature, several common elements of differentiated instruction serve as guidelines for effective implementation of such an approach at the level of content, process and product.

First, one of the major characteristics of differentiated instruction is to align instructional strategies with students' needs, strengths, interests and learning styles (De Jesus, 2012; Goodnough, 2010). This in turn requires teachers to have an in-depth understanding of their students (De Jesus, 2012; Levy, 2008; Watts-Taffe et al., 2012; Whitworth et al., 2013). According to Tomlinson (2008), teacher instruction should be based on students' readiness, interests and learning profiles. Readiness refers to a student's knowledge and skills of a particular subject matter area (Tomlinson, 2008). Learning profile refers to a student's gender, culture and learning style while interest refers to students' inclinations toward certain topics or activities (Tomlinson, 2008). Also, when planning instruction, teachers need to honor the cultural, socioeconomic, linguistic and intellectual diversity of their students (Chamberlin & Powers, 2010; Sondergeld & Schultz, 2008; Watts-Taffe et al., 2012) by allowing all students to have equal opportunities to be challenged and to grow (Chamberlin & Powers, 2010; De Jesus, 2012; Goodnough, 2010).

Second, an important aspect of differentiation is to align instructional strategies with learning goals (Chamberlin & Powers, 2010; De Jesus, 2012; Levy, 2008; Watts-

Taffe et al., 2012; Whitworth et al., 2013). Having clear learning goals helps link assessment to curriculum and instruction (Chamberlin & Powers, 2010). In terms of instructional strategies, they should include a balanced range of teacher-centered and student-centered activities and whole-group, small-group and individual activities (Chamberlin & Powers, 2010; Goodnough, 2010). Levy (2008) argues that students can be grouped based on ability, learning styles or interests or even heterogeneously depending on the need.

Ongoing and dynamic assessment that is responsive to student needs is a third essential characteristic of differentiated instruction (De Jesus, 2012; Levy, 2008; Watts-Taffe et al., 2012; Whitworth et al., 2013). Levy (2008) highlights the importance of three levels of assessment: pre-assessment in order to gauge student readiness, formative assessment which occurs in tandem with teaching and summative assessment to determine the extent of students' attainment of learning goals. Continuous and ongoing assessment allows the teacher to understand the diversity of students' learning styles and preferences, evaluate students' understanding of the material, modify instruction based on students' needs and determine how to progress with future instruction (Chamberlin & Powers, 2010; Goodnough, 2010; Whitworth et al., 2013).

Fourth, evidence-based practice in terms of instruction and assessment is essential for differentiated instruction (Chamberlin & Powers, 2010; Watts-Taffe et al., 2012). For instance, cooperative learning and problem-based learning (De Jesus, 2012) and peer-mediated instruction and hands-on activities (Brigham et al., 2011; Mastropieri et al., 2006) have been found to be effective strategies for differentiation. Another method is tiered instruction in which "the teacher provides students with

activities of different degrees of complexity or abstractness in order to challenge individual students at their point of readiness" (Whitworth et al., 2013, p. 14).

Finally, a key component of differentiated instruction is flexibility (Chamberlin & Powers, 2010; Goodnough, 2010; Sondergeld & Schultz, 2008; Watts-Taffe et al., 2012). Goodnough (2010) claimed that in differentiated instruction "effective teaching required teachers to be flexible and utilize a variety of instructional approaches in order to maximize the learning opportunities for all students" (p. 253). The issue of flexibility is actually tied to the issue of ongoing assessment discussed earlier. More specifically, teachers constantly need to modify instruction based on the feedback they receive from different types of assessments.

In sum, while there are core principles that guide the use of differentiated instruction, its implementation depends on the individual needs of students in a particular classroom (Chamberlin & Powers, 2010). Therefore, in order to effectively implement differentiated instruction teachers need to be informed decision-makers (Watts-Taffe et al., 2012).

C. Positive Student Outcomes of Differentiated Instruction

Previous research has shown that differentiated instruction enhances student achievement and motivation as well as fosters independent learning in both science and other fields. The effect of differentiated instruction on achievement, motivation and interest, and independent learning is elaborated in the following pages.

1. Achievement

Olivier et al. (2013) compared seven high-performing schools with three average-performing schools and found that the extent of integration of differentiated science instruction was greater in the higher-performing schools. According to Tulbure (2011), when teaching strategies align with students' learning styles and preferences, students show better learning outcomes. In fact, students claim that they learn better when content is related to their daily lives and their interests (Goodnough, 2010). In line with this, Tobin and Tippet (2014) found that the use multiple of representations (written, spoken, visual) to teach content in the classroom increases the likelihood of student achievement. Douglass and Kahle (1978) also found that in a grade 9 class, student achievement in Mendelian genetics increased when students used materials matching their unique cognitive styles.

Differentiated instruction has been found to improve achievement in low-performing students (McAdamis, 2001) and across a wide range of cultures and grade levels (Sabar & Kaplan, 1978; Tomlinson & McTighe, 2006). McAdamis (2001) reported on the five-year journey of a historically low performing K-12 school district in Missouri that decided to adopt a differentiated instruction approach to teaching. The teachers in this district underwent professional development training and workshops on differentiated instruction over the course of five years. Results revealed an overall significant improvement in state-wide standardized test scores across the students in the district. Sabar and Kaplan (1978) aimed to determine the effect of incorporating a new teaching-model in aquatic zoo ecology on the comprehension of science content. The teaching-model consisted of basic core material and enrichment-optional material

catered to a culturally and intellectually heterogeneous 7th grade class. Results showed an overall improvement in students' comprehension of the content.

Similar results have been found in inclusive classrooms that consist of students of varying abilities. In a review of the literature on effective instructional strategies for students with learning disabilities, Brigham et al. (2011) found that differentiated curriculum enhances the academic performance of both students with and without disabilities in inclusive science classes. A study conducted by Mastropieri et al. (2006) aimed to compare the effects of using differentiated hands-on and peer-mediated instruction with using traditional teacher-directed instruction in an inclusive grade 8 science classroom. Results indicated that students receiving differentiated instruction showed significantly better learning as evident from their scores on the post-tests and high-stakes tests.

The positive association between differentiated instruction and student achievement may be due to the increase in students' motivation and interest when experiencing this approach (see next section). It may also be due to the fact that ongoing assessment is an important feature of differentiation (Levy, 2008; Watts-Taffe et al., 2012) and that this approach encourages the use of higher order thinking skills (De Jesus, 2012; Sondergeld & Schultz, 2008). Furthermore, adapting instruction in accordance to students' readiness concurs with Vygotsky's (1978) zone of proximal development (ZPD) which is believed to maximize student learning (Chamberlin & Powers, 2010). ZPD is defined as "the distance between the actual development level and the level of potential development" (Vygotsky, 1978 as cited in Subban, 2006). Social interaction with more knowledgeable or capable adults and peers is necessary for students to attain their full potential (Blanton, 1998). Hence, teachers play a significant

role in helping students reach their ZPD by first recognizing what students already know and then providing scaffolding opportunities until students become independent and self-sufficient learners (Subban, 2006).

2. Motivation and Interest

Differentiated instruction results in higher student motivation (Chamberlin & Powers, 2010; Tomlinson, 2008). In fact, several studies have indicated that students receiving differentiated instruction tend to be more motivated and interested in learning than those receiving traditional instruction. The results of Sabar and Kaplan's (1978) study showed that differentiating instructional approaches in a 7th grade biology class that was intellectually and culturally diverse lead to more positive attitudes toward science. Similarly, in the study mentioned earlier by Mastropieri et al. (2006) it was found that students enjoyed using hands-on and peer-mediated instruction compared to traditional approaches. Teachers have reported that students are more involved in differentiated science activities and that they are more confident, enthusiastic, and engaged (Tobin & Tippet, 2014). Furthermore, students tend to show a willingness to accept challenges and persist in them (Tomlinson et al., 2003).

Students' increased interest in learning when receiving differentiated instruction is mainly due to the fact that this type of instruction relates content to students' daily lives, matches students' interests and learning styles, gives students more choice of activities and stimulates their creativity (De Jesus, 2012;Goodnough, 2010). In Sondergeld and Schultz's (2008) study, students argued that when they learned about simple machines using a differentiated approach, learning was more "fun" than learning the traditional way because this approach allowed them to work on their own.

Moreover, differentiating instruction in accordance with student readiness results in increased social interaction, cooperation, and self-worth (Tomlinsonet al., 2003; Tomlinson & McTighe, 2006).

3. Independent Learning

Differentiation ultimately leads to students being independent learners by maximizing their potential and encouraging them to voice their opinions and interests (Tomlinson, 2008). Also, giving students opportunities to learn in ways that match their learning styles and interests allows them to become more aware of and responsible for their own learning (Goodnough, 2010; Tomlinson, 2008). For instance, students learn how to capitalize on their strengths and weaknesses and how to assess their own understanding (Tomlinson, 2008). Also, in differentiated instruction teachers share decision-making with their students so that students have a shared responsibility in learning (Sondergeld & Schultz, 2008; Tobin & Tippet, 2014).

D. Challenges to Implementing Differentiated Instruction

In previous studies, teachers have reported several challenges and barriers of implementing differentiated instruction. In a study on in-service science teachers' perceptions of the barriers of implementing differentiation, Tobin and Tippet (2014) found that fear and insecurity of implementation, lack of time, curricular and assessment demands, and lack of resources were common teacher responses. Goodnough's (2010) study on pre-service science teachers showed similar challenges to those identified by Tobin and Tippet's (2014). Teachers claimed that differentiating instruction requires knowledge of the approach itself, extensive time and planning,

knowledge of students as well as the curriculum, availability of additional materials and resources and flexibility in terms of assessment and instruction (Goodnough, 2010). Sondergeld and Schultz (2008) also argued that teachers find the process of differentiating lessons difficult since it requires time for additional planning and preparation and since students need to adjust to the new approach.

CHAPTER III

DIFFERENTIATED INSTRUCTION MATERIAL FOR THE GENETICS UNIT

A. Introduction

The unit used in this project includes 15 concepts that cover the "Genetics" Unit for Grade 11.This unit was selected because many students face difficulties learning it, and many teachers face difficulties explaining it as well.

The material of the project is presented in the form of a table. The table includes four entries (columns) indicating the concept number and title, the session content (objectives), the session process (the methods of implementation,) and the products (assessment tools). The concept title indicates the concept being explained within the Genetics Unit. Every concept will theoretically take one 60-minute session. Yet, the teacher can give more sessions as per the need of the students, and depending on the pace of coverage of the concept. The objectives column summarizes the different learning goals/objectives of every concept. In general, all students are expected to acquire the same learning objectives. Yet, as part of the differentiation process, some students will be tackling the same concept in more depth. This will be shown in the table as extra learning outcomes for those students. The third column summarizes the teaching methods and strategies that will be implemented by the teacher to deliver the lessons. Sessions will start with an introduction by the teacher, followed by group work based on the different learning styles of students, and will end by a closure done by the students and the teacher. The methods of implementation will be differentiated

according to the four different learning styles of students. Hence, four different activities will be implemented for every concept: Linguistic Activity, Logical-Mathematical Activity, Kinesthetic Activity, and Audio-Visual Activity. It is important to note that some of the concepts will be explained by only 3 activities due to restrictions and particularities related to the specific concept. The last column will indicate the tools of assessment or the product. This will also be differentiated according to the learning styles of every group. Every group will present its product differently.

The differentiation will be achieved in the content, the process, and the product of every concept within the "Genetics" Unit. The details of this differentiation are listed in more details below. Moreover, the Appendices include the materials needed to teach the concepts including the handouts, the worksheets, the quizzes, the tests, and the activities that will be implemented.

B. The Unit Details

Grade Level: 11
Subject: Biology
Program Followed: Lebanese Curriculum
Unit Title: Genetics
Unit Objective: explain all the processes related to Genetics
Unit Concepts: Karyotyping, Mitosis, Meiosis, DNA Structure, DNA Replication, DNA Transcription, Protein Synthesis, Mutations, Biotechnology, Pedigree, Monohybrid Cross, and Dihybrid Cross

1. Content Differentiation

Since the content is usually set by the official Lebanese curriculum, the margin of flexibility is low. Yet, the differentiation can happen here by adding more challenging concepts that are not usually included in the program for the high-achieving students. In this way, we guarantee that all students attain the minimum requirements. Moreover, we give higher depth of the topics for students who are capable of grasping more concepts. In the table below, the red color is used to identify the additional session objectives that can be given to the Higher-level students.

2. Process Differentiation

A maximum of four simultaneous different activities will be implemented for four different learning styles of students. This framework was used by Bruce Campbell in his book: "Handbook of Differentiated Instruction Using the Multiple Intelligence, Lesson Plans & More". The book was published in 2008. The four activities are:

- Linguistic Activity
- Logical-Mathematical Activity
- Kinesthetic Activity
- Audio-Visual Activity

Lesson activities are presented in Appendix A.

3. Product Differentiation

As a logical consequence to the differentiation in the objectives and the teaching strategies, the assessment tools will also be different. Each category of students will be assessed based on a different product.

4. Assessment Tools

In addition to the product differentiation explained above, the assessment tools include the following: leveled worksheets, quizzes, and leveled tests.

- **Worksheets:**

Application Worksheets are provided to students for every concept. This will help students reinforce the concepts explained. Worksheets should be solved with the teacher in class before quizzes and tests. Worksheets are presented in Appendix B.

- **Quizzes:**

- The Quiz is a formative assessment tool
- It assesses students on one or two specific concepts
- This is done to check if students acquired a certain concept before moving to the next one
- The allocated duration of the Quizzes ranges between 10 to 20 minutes

Quizzes are presented in Appendix C.

- **Tests:**

- The Test is a summative assessment tool
- The allocated duration of the Tests ranges between 45 and 60 minutes

Tests are presented in Appendix D.

Leveled Sheets in Worksheets and Tests:

All worksheets and tests are to follow the system of Leveled Sheets. Students will have their application sheets and tests with different levels on different papers where the difficulty ascends from simple knowledge requirements to higher order thinking requirements. By this, the classification of

each level will enable identifying the areas of strength and weakness for each student, and allow the student to self-assess their work in relation. The levels are:

- Level I: Knowledge and Understanding: requiring students to recall information and reflect concept acquisition
- Level II: Application: requiring students to apply the acquired concepts in a familiar context
- Level III: Interpretation and Inference: requiring students to draw conclusions and links among acquired concepts
- Level IV: Critical Analysis: requiring students to manipulate the acquired concepts with higher order analysis
- Level V: Evaluation and Synthesis: requiring students to manipulate the concepts and skills into new scenarios and real life situations

Following this way, the application is differentiated according to students' abilities of achievement. All students are required to solve the first two levels. This will reflect the understanding of the concepts. As we go further with the levels, students will show higher orders of thinking. High achievers can answer challenging questions without getting bored in class. Average achievers will make sure they acquired the minimum requirements. Yet, they will still be asked about the higher levels to get trained on these levels and to help them improve their thinking and analytical strategies, and to make them dwell more on the concepts being explained. On tests, 75% of the grade will be given to levels 1 and 2. This will guarantee good grades for students who acquired the

concepts. The remaining 25% of the grade will be allocated for levels 3, 4, and 5. This will be a fair balance between these levels.

Table 1 summarizes the differentiation tools in the “Unit of Genetics” for grade 11 students. Instructions sheets will guide and support the activities of different groups. The class will always start by introductory statements from the teacher. Then, it will commence with group work activities, whereby different categories of students will be based on different abilities (intelligence/learning styles) of the students. Then, every group will present its findings followed by general concluding statements from students and the teacher.

Table 1: *Detailed Planning of the Unit of Genetics*

Concept Number & Title	Session Content (Session Objectives)	Processes (Methods of Implementation)	Products (Assessment Tools)
1. Karyotyping	1. Explain "chromosomal formula" 2. Define Karyotyping 3. Explain the process of Karyotyping 4. Analyze Karyotypes 5. Describe the most common chromosomal abnormalities	▪ **Introduction:** Class Discussion about the purpose of karyotyping and its importance ▪ **Logical-Mathematical Activity:** A group of students will calculate the chromosomal formulas in different cases (normal and abnormal) ▪ **Audio-Visual Activity:** A group of students will use a Computer simulation showing the steps of karyotyping ▪ **Kinesthetic Activity:** A group of students will construct the karyotypes of a normal male and a male with Trisomy 21 (cutting and pasting papers) ▪ **Linguistic Activity:** A group of students will summarize different case studies on different ways of dealing with people having chromosomal abnormalities. ▪ **Closure:** Summary and follow-up questions	▪ **Logical-Mathematical Activity:** Worksheet ▪ **Audio-Visual Activity:** Performing the Simulation ▪ **Kinesthetic Activity:** Constructing the karyotypes ▪ **Linguistic Activity:** Case Studies Reports
2. Mitosis	1. Explain the purpose of Mitosis and Interphase 2. Explain the steps of Mitosis and Interphase 3. Describe the link between mitosis	▪ **Introduction:** Class Discussion about the purpose of Mitosis and its importance ▪ **Logical-Mathematical Activity:** Calculating the	▪ **Logical-Mathematical Activity:** Worksheet ▪ **Audio-Visual Activity:** Making a power-point presentation summarizing the

	and cancer	Mitotic Index in normal cell division and in cancerous cells, and calculating the duration of the cell cycle ▪ **Audio-Visual Activity:** A group of students will watch videos to summarize the steps of Mitosis ▪ **Kinesthetic Activity:** A group of students will construct 2 models of cell division for plant and animal cells ▪ **Linguistic Activity:** A group of students will summarize different case studies on different ways of dealing with people having cancer ▪ **Closure:** Summary and follow-up questions	steps of Mitosis ▪ **Kinesthetic Activity:** Constructing the models ▪ **Linguistic Activity:** Case Studies Report and presentation
3. Meiosis	1. Explain the purpose of Meiosis 2. Explain the steps of Meiosis 3. Describe the link Meiosis to chromosomal abnormalities	▪ **Introduction:** Class Discussion about the purpose of Meiosis and its importance ▪ **Audio-Visual Activity:** A group of students will watch videos to summarize the steps of Meiosis ▪ **Kinesthetic Activity:** A group of students will construct 2 models of Anaphase of Mitosis vs. Meiosis ▪ **Closure:** Summary and follow-up questions	▪ **Audio-Visual Activity:** Making a power-point presentation summarizing the steps of Meiosis ▪ **Kinesthetic Activity:** Constructing the models
4. Meiosis-	1. Explain crossing over	▪ **Introduction:** Class Discussion	▪ **Audio-Visual Activity:**

Related Processes	2. Explain independent assortment 3. Explain the variety of children in reference to Meiosis	about the importance of variety within species ▪ **Audio-Visual Activity:** A group of students will watch videos and animations showing how crossing over and independent assortment happen ▪ **Kinesthetic Activity:** Class Activity: picking chromosomes from envelopes and combining them in different cases (Marshmallow Activity) to calculate different possibilities and combinations ▪ **Logical-Mathematical Activity:** Calculating the different possibilities and total number of gametes in different cases ▪ **Closure:** Summary and follow-up questions	Summarizing the simulations and animations ▪ **Kinesthetic Activity:** Activity Report and Questions ▪ **Logical-Mathematical Activity:** Calculations Worksheet
5. DNA Discovery	1. Explain the discovery of DNA	▪ **Introduction:** Recap on chromosomes structure, location, and function ▪ **Logical-Mathematical Activity:** Students will be provided with couple of experiments that had lead to the discovery of DNA. Students should analyze the experiments and derive the conclusions ▪ **Audio-Visual Activity:** Students will watch animations	▪ **Logical-Mathematical Activity:** Solving the worksheet of DNA Discovery (analysis and conclusion of the experiments) ▪ **Audio-Visual Activity:** Summarizing the animations ▪ **Linguistic Activity:** Summarizing the cases given

		summarizing these experiments ▪ **Linguistic Activity:** Students will be provided with the story of DNA Discovery ▪ **Closure:** The timeline of DNA Discovery will be plotted and explained by different groups	
6. DNA Structure	1. Explain the structure of DNA 2. Explain the characteristics of DNA (base pairing, anti-parallel…)	▪ **Introduction:** Recap on DNA location ▪ **Logical-Mathematical Activity:** analyzing the structure of DNA provided on pictures and in text, and calculating DNA size and compression/packaging extent ▪ **Kinesthetic Activity:** constructing the DNA model after reading about its structure ▪ **Audio-Visual Activity:** analyzing and summarizing animations explaining the DNA structure and performing a simulation about DNA extraction process ▪ **Closure:** Summary and follow-up questions	▪ **Logical-Mathematical Activity:** report describing DNA structure ▪ **Kinesthetic Activity:** DNA model ▪ **Audio-Visual Activity:** Summarizing the animations
7. DNA Replication	1. Explain the purpose of DNA Replication 2. Explain the basic steps of DNA Replication 3. Explain the detailed steps of DNA Semiconservative Replication	▪ **Introduction:** Recap on DNA structure and the need to DNA replication (link to Cell Cycle: interphase) ▪ **Logical-Mathematical Activity:** calculating the speed of DNA replication, and	▪ **Logical-Mathematical Activity:** report describing DNA replication steps ▪ **Audio-Visual Activity:** Summarizing the animations

		analyzing the steps of DNA Replication by ordering them and guessing what happens after giving some hints about the tools needed in replication ▪ **Audio-Visual Activity:** analyzing and summarizing animations explaining the DNA replication process ▪ **Closure:** Summary and follow-up questions	
8. DNA Transcription	1. Define Gene Expression 2. Explain the purpose of DNA Transcription 3. Explain the steps of DNA Transcription 4. Explain the post-transcription modifications	▪ **Introduction:** Introduction to gene expression ▪ **Logical-Mathematical Activity:** calculating the number of genes and codons, and analyzing the steps of DNA transcription by ordering them and guessing what happens after giving some hints about the tools needed in transcription ▪ **Audio-Visual Activity:** analyzing and summarizing animations explaining the DNA transcription process ▪ **Closure:** Summary and follow-up questions	▪ **Logical-Mathematical Activity:** report describing DNA transcription steps ▪ **Audio-Visual Activity:** Summarizing the animations
9. Translation & Protein Synthesis	1. Explain the purpose of Translation 2. Explain the basic steps of Translation 3. Explain the detailed steps of Translation and gene expression	▪ **Introduction:** reinforcegene expression and recap on DNA transcription ▪ **Logical-Mathematical Activity:** calculating the size of mRNA, peptides, number of	▪ **Logical-Mathematical Activity:** solving the worksheet calculation exercises ▪ **Audio-Visual Activity:** Summarizing the animations

	4. Differentiate between genes and alleles in terms of gene expression	amino acids, number of tRNA, number of codons and anticodons needed in a translation process, and calculate the number of possibilities of different genes for the same peptide in different cases ▪ **Audio-Visual Activity:** analyzing and summarizing animations explaining the translation process ▪ **Kinesthetic Activity:** constructing a model about translation steps ▪ **Linguistic Activity:** constructing an analogy about translation steps ▪ **Closure:** Summary and follow-up questions	▪ **Kinesthetic Activity:** model ▪ **Linguistic Activity:** analogy
10. Mutations	1. Define Mutations 2. Explain Mutations types 3. Explain the effects of Mutation	▪ **Introduction:** Recap on gene expression and translation steps ▪ **Logical-Mathematical Activity:** calculating the number of alleles possible for a certain gene, and proving the diversity of proteins by calculations ▪ **Audio-Visual Activity:** analyzing and summarizing animations explaining how mutations happen and their effects	▪ **Logical-Mathematical Activity:** solving the worksheet calculation exercises ▪ **Audio-Visual Activity:** Summarizing the animations ▪ **Linguistic Activity:** summarizing and generalizing from case studies ▪ **Kinesthetic Activity:** generalizing from the activity

		▪ **Linguistic Activity:** reading case studies and stories about mutation cases ▪ **Kinesthetic Activity:** hands-on activity whereby students have to write different sentences composed of 3-letter words only, and suggesting changes to these sentences (1 point change). Students should generalize the different types of mutations based on this activity ▪ **Closure:** Summary and follow-up questions	
11. DNA Fingerprinting	1. Explain the function of Restriction Enzymes 2. Discuss DNA fingerprinting from scientific, medical, and ethical perspectives	▪ **Introduction:** Explain the purpose of DNA Fingerprinting ▪ **Logical-Mathematical Activity:** calculating the number of restriction sites, specifying the different possibilities of restriction sites ▪ **Kinesthetic Activity:** hands-on activity: constructing restriction maps ▪ **Audio-Visual Activity:** analyzing and summarizing animations explaining how restriction enzymes work and the steps of DNA fingerprinting ▪ **Linguistic Activity:** discussing DNA fingerprinting from ethical and legal perspectives ▪ **Closure:** Summary and follow-	▪ **Logical-Mathematical Activity:** calculation worksheet ▪ **Kinesthetic Activity:** constructing restriction maps ▪ **Audio-Visual Activity:** presenting a summary about the animations: process of DNA fingerprinting ▪ **Linguistic Activity:** debating the ethical and legal perspectives and presenting them in a report

		up questions	
12. Genetic Engineering	1. Discuss genetic engineering in agriculture & animal farming from scientific, agricultural, and ethical perspectives	▪ **Introduction:** Explain "Biotechnology" ▪ **Audio-Visual Activity:** analyzing and summarizing animations explaining how restriction enzymes work and the steps of genetic engineering ▪ **Linguistic Activity:** discussing genetic engineering from ethical, religious, consumer advocate, and legal perspectives • **Closure:** Summary and follow-up questions	▪ **Audio-Visual Activity:** presenting a summary about the animations: process of genetic engineering ▪ **Linguistic Activity:** debating the ethical, religious, consumer advocate, and legal perspectives of genetic engineering and presenting them in a report
13. Dihybrid Crossing: independent genes	1. Explain the results of dihybrid crossing: independent genes	▪ **Introduction:** Recap on monohybrid cross and introducing dihybrid crossing ▪ **Logical-Mathematical Activity:** calculating the number of possibilities of different gametes and different genotypic & phenotypic proportions in the case of independent genes ▪ **Kinesthetic Activity:** hands-on activity: independent genes activity: ▪ **Audio-Visual Activity:** Drosophila crossing online simulation: case of independent genes ▪ **Linguistic Activity:** analyzing	▪ **Logical-Mathematical Activity:** calculation worksheet ▪ **Kinesthetic Activity:** hands-on activity sheet • **Audio-Visual Activity:** online simulation exercises ▪ **Linguistic Activity:** generalizing and concluding from Mendel's work

		the historical case studies of Mendel ▪ **Closure:** Summary and follow-up questions	
14. Dihybrid Crossing: linked genes	1. Explain the results of dihybrid crossing: linked genes	▪ **Introduction:** Recap on dihybrid crossing: independent genes ▪ **Logical-Mathematical Activity:** calculating the number of possibilities of different gametes and different genotypic & phenotypic proportions in the case of linked genes ▪ **Kinesthetic Activity:** hands-on activity: modeling crossing over • **Audio-Visual Activity:** Drosophila crossing online simulation: case of linked genes • **Closure:** Summary and follow-up questions	▪ **Logical-Mathematical Activity:** calculation worksheet ▪ **Kinesthetic Activity:** model • **Audio-Visual Activity:** online simulation exercises
15. Pedigrees	1. Explain the structure of pedigrees 2. Explain the transmission of autosomal and sex-linked genes 3. Calculate the probability of getting certain diseases	▪ **Introduction:** Introducing Pedigrees: definition, symbols, and how to deduce the mode of transmission and localization of diseases ▪ **Logical-Mathematical Activity:** documents analysis tocalculate the risk of getting a certain disease ▪ **Kinesthetic Activity:** hands-on activity: Construct your family	▪ **Logical-Mathematical Activity:** solving calculation exercises ▪ **Kinesthetic Activity:** building the family pedigree and answering the questions ▪ **Linguistic Activity:** analyzing and summarizing the case studies

		pedigree and deduce the mode of transmission and localization of a certain trait ▪ **Linguistic Activity:** analyzing case studies about certain diseases: Huntington, Cystic Fibrosis, and Sickle Cell Anemia ▪ **Closure:** Summary and follow-up questions	

REFERENCES

Bahar, M., Johnstone, A.H. &Hansell, M.H. (1999). Revisiting learning difficulties in biology. *Journal of Biological Education, 33*, 84–86.

Brigham, F.J., Scruggs, T.E. &Mastropieri, M.A. (2011). Science education and students with learning disabilities.*Learning Disabilities Research and Practice*, *26*(4), 223–232.

Chamberlin, M. & Powers, R. (2010).The promise of differentiated instruction for enhancing the mathematical understandings of college students. *Teaching Mathematics and Its Applications*, *29*, 113-139.

Douglass, C.B. &Kahle, J.B. (1978). The effects of instructional sequence and cognitive style on the achievement of high school biology students.*Journal of Research in Science Teaching, 15*(5), 407-412.

De Jesus, O.N. (2012). Differentiated instruction: Can differentiated instruction provide success for all learners? *National Teacher Education Journal, 5*(3), 5-11.

Felder, R.M. &Henriques, E.R. (1995). Learning and teaching styles in foreign and second language education.*Foreign Language Annals*, *28*(1), 21-31.

Goodnough, K. (2010). Investigating pre-service science teachers' developing professional knowledge through the lens of differentiated instruction. *Research in Science Education, 40*(2), 239–265.

Individuals with Disability Education Act Amendments of 1997 [IDEA]. (1997). Retrieved from http://thomas.loc.gov/home/thomas.php

Lewis, J. &Kattmann, U. (2004). Traits, genes, particle and information: Re-visiting students' understandings of genetics. *International Journal of Science Education, 26*(2), 195-206.

Lewis, J., Leach, J. & Wood-Robinson, C. (2000a). All in the genes?—Young people's understanding of the nature of genes. *Journal of Biological Education, 34*, 74–79.

Lewis, J., Leach, J. & Wood-Robinson, C. (2000b). What's in a cell? Young people's understanding of the genetic relationship between cells, within an individual.*Journal of Biological Education, 34*(3), 129-132.

Levy, H.M. (2008). Meeting the needs of all students through differentiated instruction: Helping every child reach and exceed standards. *The Clearing House, 81*(4), 161-164.

Mastropieri, M.A., Scruggs, T.E., Norland, J.J., Berkeley, S., McDuffie, K., Tornquist, E.H. et al. (2006). Differentiated curriculum enhancement in inclusive middle school science: Effects on classroom and high-stakes tests. *Journal of Special Education, 40*, 130–137.

McAdamis, S. (2001). Teachers tailor their instruction to meet a variety of student needs. *Journal of Staff Development, 22*(2), 1–5.

Mitchell, L. & Hobson, B. (2005).*One size does not fit all: Differentiation in the elementary grades.* Paper presented at the Beaverton School District Summer Institute, Beaverton, OR.

Oliveira, A.W., Wilcox, K.C., Angelis, J., Applebee, A.N., Amodeo, V. & Snyder, M.A. (2013). Best practice in middle-school science. *Journal of Science Teacher Education, 24*, 297-322.

Sabar, N. & Kaplan, E.H. (1978). The effect of a new seventh-grade biology curriculum on the achievements and attitudes of intellectually and culturally heterogeneous classes.*Journal of Research in Science Teaching, 15*(4), 271-276.

Sondergeld, T.A. & Schultz, R.A. (2008). Science, standards and differentiation: It really can be fun! *Gifted Child Today, 31*(1), 34-40.

Subban, P. (2006). Differentiated instruction: A research basis. *International Education Journal, 7*(7), 935-947.

Tobin, R. &Tippett, C.D. (2014). Possibilities and potential barriers: Learning to plan for differentiated instruction in elementary science. *International Journal of Science and Mathematics Education, 12*, 423-443.

Tomlinson, C.A. (2008). The goals of differentiation.*Educational Leadership, 66*(3), 26-30.

Tomlinson, C.A. (2001). The differentiated classroom: Responding to the needs of all learners. Alexandria, VA: ASCD.

Tomlinson, C.A. (1999). How to differentiate instruction in mixed-ability classrooms. Alexandria, VA: ASCD.

Tomlinson, C.A., Brighton, C., Hertberg, H., Callahan, C.M., Moon, T.R., Brimijoin, K., Conover, L.A. & Reynolds, T. (2003). Differentiating instruction in response to student readiness, interest, and learning profile in academically diverse classrooms: A review of literature. *Journal for the Educationally Gifted, 27*, 119–145.

Tomlinson, C.A. &Imbeau, M.B. (2010).*Leading and managing a differentiated classroom*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C.A. &McTighe, J. (2006). *Integrating Differentiated Instruction and Understanding by Design*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tulbure, C. (2011). Do different learning styles require differentiated teaching strategies? *Procedia Social and Behavioral Sciences,11,* 155–159.

Valiandes, A.S. (2010). Application and evaluation of differentiated instruction in mixed ability classrooms. Doctoral Dissertation University of Cyprus (In Greek).

Valiande, S. &Tarman, B. (2011). Differentiated teaching and constructive learning approach by the implementation of ICT in mixed ability classrooms. *AhiEvran University Journal of Education Faculty*, *12*(1), 169-184.

Vygotsky, L. (1978). *Interaction between learning and development.*Cambridge, MA: Harvard University Press.

Watts-Taffe, S., Laster, B.P., Broach, L., Marinak, B., Connor, C.M. &Walker-Dalhouse, D. (2012). Differentiated instruction: Making informed teacher decisions. *The Reading Teacher*, *66*(4), 303–314.

Whitworth, B.A., Maeng, J.L. & Bell, R.L. (2013). Differentiating inquiry. *Science Scope*, *37*(2), 10-17.

Willis, S. & Mann, L. (2000). Differentiating instruction: Finding manageable ways to meet individual needs. Curriculum Update. Alexandria, VA: Association for Supervision and Curriculum Development.

Appendix A: Lesson Activities

LESSON 1: KARYOTYPING

Grade: 11
Subject: Biology
Title: Karyotyping Online Activity
Name: ……
Date: ……

*** Instructions:**

- Visit the website http://bluehawk.monmouth.edu/~bio/karyotypes.htm

- Check the finished karyotypes for the reference.

- Enter the unknowns requested from you and finish their karyotypes.

- You are asked to do only the designated unknowns.

- When you finish constructing the karyotypes, print screen the page and save it as a picture. Save the picture and name it as NameKaryotype1 & NameKaryotype2 for example.

- 3 files will be collected from you: the 2 pictures you saved, and this worksheet filled (check page 2)

Student	Unknowns
1	G & O
2	I & X
3	L & P
4	E & M
5	J & F

6	H & N
7	G & M
8	I & F
9	L & N
10	H & F

*** Tasks:**

I- You are asked to construct the karyotypes of the individuals listed in the table found on page 2. (7 points each)

II- After you construct the karyotypes, answer the questions below.

1- Write the chromosomal formula of each individual. (2 points)

……

……

2- What is the gender of each individual? Justify your answer. (2 points)

……

……

3- What is/are the abnormality/ies that each individual has (if any)? Justify your answer. (2 points)

……

……

Source:
German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

LESSON 3: MEIOSIS

MarshmallowMeiosis

ThisactivitywastakenfromPattiSoderbergfromanarticlein*TheScienceTeacher*and adaptedto Mrs.Iacuone'sneeds.

Rebopsaremagicalcreaturesthathavedeveloped.Somepeoplebelievetheyhave comefromanotherplanetandothersbelievetheyhaveevolvedfromapreviouscreature hereon Earth.OtherssaythatGodcreatedthemtoshowloveandaffection,likeTribbles. You,as ascientist,areinterestedintheirreproductioncapabilities.Todeterminewhat theirpotentialoffspringwouldlooklikeyouwillneedtoreproduce2additionalRebops.

Thingsyouknow:

Theyarefriendly;theydonotbite.

Theywillstickyouwiththeirpointyantennaorclawsifyouarenotcareful. Theyhaveadiploidnumberof14.

Theyaremulticellularorganisms.

Theyundergocellularrespiration.

Theircellcycletakesabout24hourstocomplete.

Purpose:Toexplainhowmeiosisisresponsibleforthetremendousvariation,withina speciesbycreatingartificialRebopchildren.

Hypothesis:

Experiment Materials:

Large White Marshmallows Colored Marshmallows Nails / Tacks

Colored Push Pins

Pipe Cleaners

Toothpicks

Construction Paper (2 Colors) Envelopes

Methods:

1. Observe the Rebop parents. Describe their physical characteristics.

2. Decide who will be the mother and who will be the father Rebop. Mom will have the envelope with labeled female and dad will have the envelope labeled male.

3. Donotlookatthechromosomes,pleasedraw7outof theenvelopeandplacethem facedownon thedesk.Arrangethemfromtallesttoshortestandmakesurethatno twoofonecolorarethesamesize.Iftheyare,putthembackintotheenvelopeand drawagainuntil youhave7piecesofpaper,allof differentsizesfromeach envelope.

4. UsingtheDataConversionTable,pleasewritedownyourtraitsonobservations.

5. CreatethebabyRebopusingthematerialsprovidedandthekeyfromthedata conversiontable.

6. Repeat3-5againfor thesecondRebop.

DataConversionTable

Feature	Genotype	Phenotype	Partsused
Antenna	AA	1 antenna	Toothpicks
	Aa	2 antenna	
	aa	no antenna	
Humps	MM	1greenhump	Small Marshmallows
	Mm	2greenhumps	
	mm	3greenhumps	
Nose	QQ	rednose	Small Marshmallows
	Qq	orangenose	
	qq	yellownose	
Tail	TT orTt	curlytail	WhitePipeStem
	tt	straighttail	
Eyes	EEorEe	2eyes	SilverTacks
	ee	3eyes	
Legs	LLorLl	bluelegs	PushPins
	ll	redlegs	
BodySegments	DDorDd	3 bodysegments	LargeWhite
	dd	2 bodysegments	

Observations:

Rebop#1

Chromosome	Alleles	Genotype	Phenotype
1			
2			
3			
4			
5			
6			
7			

Rebop#2

Chromosome	Alleles	Genotype	Phenotype
1			
2			
3			
4			
5			
6			
7			

QuestionstoAnswer:

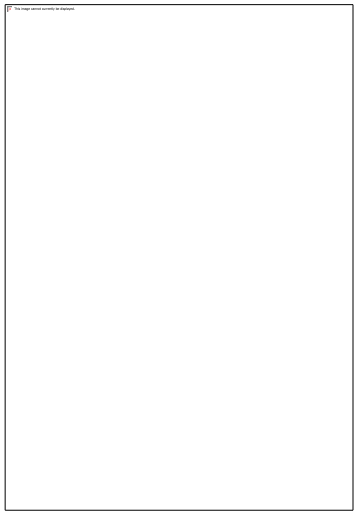
1. How many pairs of homologous chromosomes does each parent have?
2. Why does each Rebop have two alleles for each trait?
3. What is the diploid number of the Rebop?
4. What is the haploid number of the Rebop?
5. Is the sperm diploid or haploid?
6. Is the egg diploid or haploid?
7. What type of cell division creates skin cells?
8. What type of cell division creates stomach cells?
9. What type of cell division creates egg cells?
10. Is the zygote haploid or diploid?
11. How many chromosomes does your baby Rebop have?
12. What happened to the zygote for the Rebop baby to develop?

Discussion:

Conclusion:

LESSON 4: MEIOSIS RELATED PROCESSES

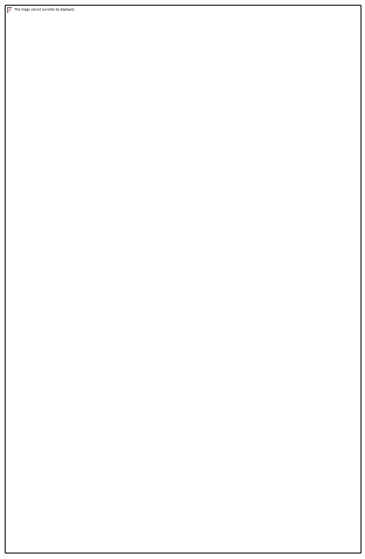
Background Information



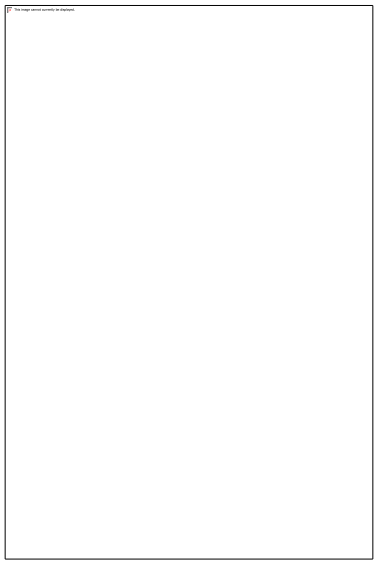
Cri du chat is a rare syndrome (1 in 50,000 live births) caused by a deletion on the short arm of chromosome 5. The name of this syndrome is French for "cry of the cat," referring to the distinctive cry of children with this disorder. The cry is caused by abnormal larynx development, which becomes normal within a few weeks of birth. Infants with cri du chat have low birth weight and may have respiratory problems. Some people with this disorder have a shortened lifespan, but most have a normal life expectancy.

Where does the abnormal chromosome 5 come from? In 80 percent of the cases, the chromosome carrying the deletion comes from the father's sperm.

Williams Syndrome is caused by a very small chromosomal deletion on the long arm of chromosome 7. The deleted region includes the elastin gene (see figures A and B below), which encodes a protein that gives blood vessels the stretchiness and strength required to withstand a lifetime of use. The elastin protein is made only during embryo development and childhood, when blood vessels are formed. Because they lack the elastin protein, people with Williams Syndrome have disorders of the circulatory system, also known as vascular disorders.



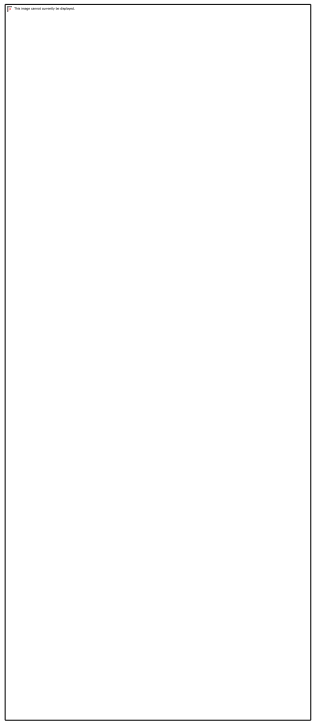
The chromosomal deletion that causes Williams Syndrome is so small that it cannot be seen in a karyotype. However, the deletion can be observed using a special technique called fluorescent in situ hybridization, or FISH. This technique allows DNA sequences to be labeled with a fluorescent chemical (called a probe) that lights up when exposed to ultraviolet (UV) light. The Williams Syndrome deletion can be detected by labeling the elastin gene with a fluorescent probe. The gene will light up under a UV light only if it is present; a lack of signal indicates a deletion.



Down Syndrome is a genetic disorder caused by extra genetic material. It affects over 350,000 people in the United States alone and is the most common (1 in 800 live births) imbalance in the number of autosomes in people. The effects of Down Syndrome vary greatly from person to person but can include mental retardation, eyes that slant upward, and heart defects.

People with Down Syndrome have 3 copies of chromosome 21. For this reason, Down Syndrome is also called "Trisomy 21".

Where does the extra chromosome come from? In 90% of Trisomy 21 cases, the additional chromosome comes from the mother's egg.

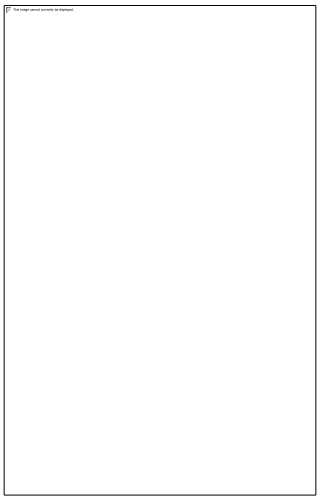


Turner Syndrome affects 60,000 girls and women in the United States. This disorder occurs in 1 in 2000 to 1 in 2500 live births, with about 800 new cases diagnosed each year. Symptoms include short stature and lack of ovarian development. Other features, such as webbed neck, arms that turn out slightly at the elbow, and a low hairline in the back of the head are sometimes seen.

Women and girls with Turner Syndrome have only one X chromosome. This is an example of monosomy.

See the box below to learn more about how the sex of an individual is determined.

Where does the single X chromosome come from? In 75 to 80 percent of cases, the single X chromosome comes from the mother's egg because the father's sperm that fertilizes the egg is missing a sex chromosome.



Klinefelter Syndrome occurs in 1 in 500 to 1 in 1000 live births. People with this disorder develop as males with subtle characteristics that become apparent during puberty. They are often tall and usually do not develop secondary sex characteristics such as facial hair, or underarm and pubic hair.

Men and boys with Klinefelter Syndrome have a Y chromosome and 2 X chromosomes. This is an example of trisomy.

Where does the extra chromosome come from? In about half of Kleinfelter cases, the extra X chromosome is from the mother's egg, while in the other half of cases the extra chromosome is from the father's sperm.

Source:

http://www.biology.arizona.edu/human_bio/activities/karyotyping/karyotyping.html

LESSON 5: DNA DISCOVERY

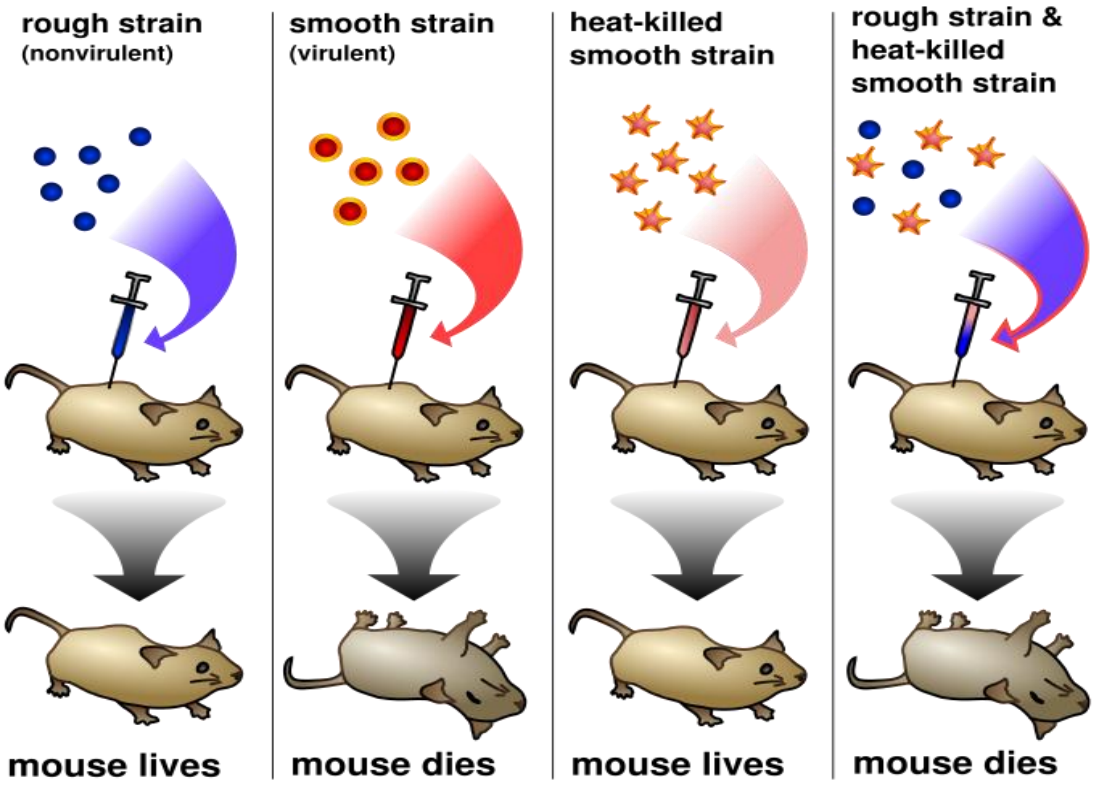
Grade: 11
Subject: Biology
DNA Discovery
Date: …….
Name: ……

Below are series of experiments done by different scientists. Your task is to:

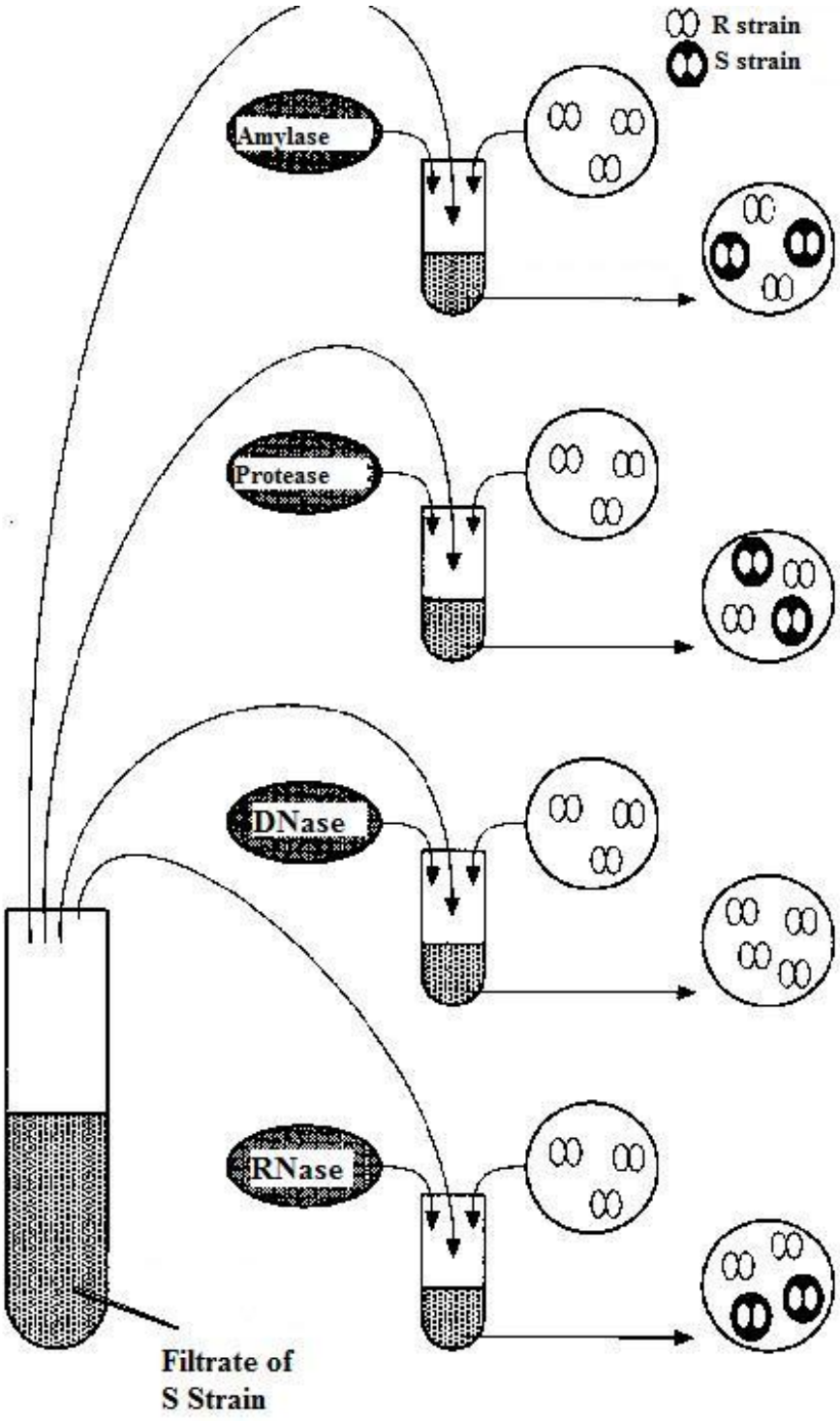
1- Interpret each experiment.

2- Comment on the importance of these discoveries and their contribution to the Biology field.

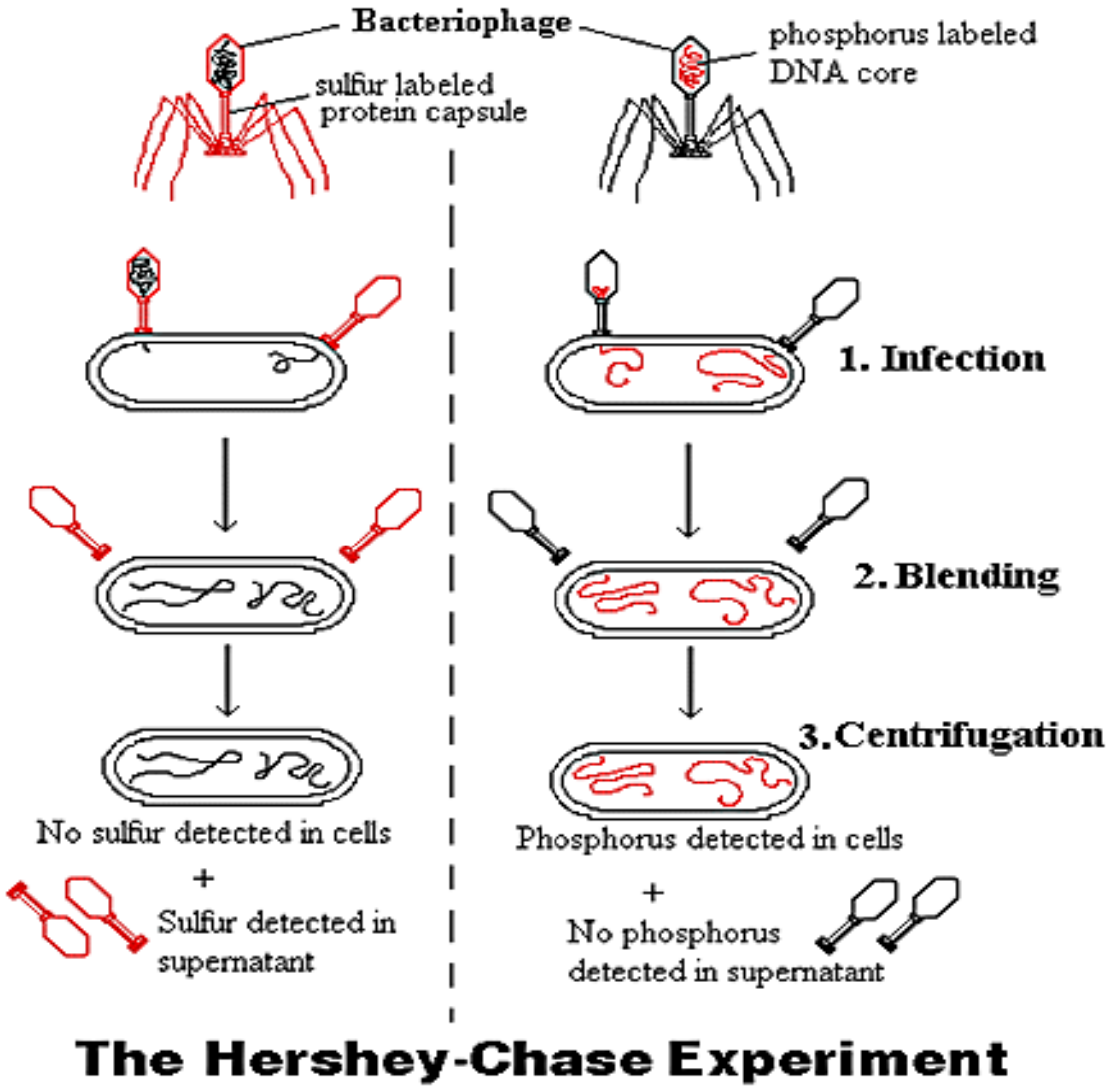
I- Experiment 1: By Fred Griffith (1928):



II- Experiment 2: By Oswald Avery (1944):



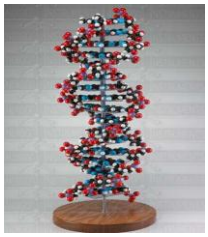
III- Experiment 3: By Martha Chase & Alfred Hershey (1952):



Source:

German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

LESSON 6: DNA STRUCTURE



Grade 11

Subject: Biology

DNA Model Project

Your assignment is to research and build a Double Helix DNA Model. The maximum grade you can obtain is **20!** You will have over a week to work on it. So, do a great job and **don't** put it off until the last minute! I would suggest using wire or pipe cleaners as a framework, and using beads, buttons, or some other item that you can support on the framework to represent **sugars**, **phosphate groups, hydrogen bond**, and the **four nitrogenous bases**. That means you need seven different colors or shapes, and a way to hold them together and support them. Also, the model must show the helical shape of DNA. Finally, a **key** must accompany your model. (The key must include your name and a representation of each different part of your model that identifies which structural part it represents.

I do **not** expect this to be an expensive project, so use what you have. You can make great models using pasta (uncooked), toothpicks, pipe cleaners and a variety of beads. So be creative with this model! **Do not use anything that will spoil (food/candy) or create a mess.** Do not make it too big. Remember, you have to get it to school in one piece. It should have a minimum of **ten** base pairs represented. If you have an idea that doesn't fit this description, please check with me first to make sure it will work and you will get maximum points. **Have fun!!**

GRADING RUBRIC

Expectations	**Possible Points**	***Earned Points***
3-D DNA Model		
❑ Deoxyribose Sugar	1	
❑ Phosphate	1	
❑ Hydrogen Bond	1	
❑ Nitrogenous Bases Pairing	1	

❑ Helical shape	1	
❑ Free standing or hanging	1	
❑ Base Pairs (10 Rungs)	1	
Key		
❑ Your Name	1	
❑ Deoxyribose Sugars	1	
❑ Phosphate	1	
❑ Hydrogen Bond	1	
❑ Adenine	1	
❑ Thymine	1	
❑ Cytosine	1	
❑ Guanine	1	
Neatness	2	
Creativity	3	

Grade: _____

Source: http://www.humbleisd.net

Grade: 11

Subject: Biology

How to extract DNA? **Source:** http://learn.genetics.utah.edu/units/activities/extraction/

Step I Blender Insanity

Put in a blender:

- 1/2 cup of split peas (100ml)
- 1/8 teaspoon table salt (less than 1ml)
- 1 cup cold water (200ml)

Blend on high for 15 seconds.

Step II Soapy Peas

Pour your thin pea-cell soup through a strainer into another container.
Add 2 tablespoons liquid detergent (about 30ml) and swirl to mix.
Let the mixture sit for 5-10 minutes.
Pour the mixture into test tubes or other small glass containers, each about 1/3 full.

Step III Enzyme Power

Add a pinch of enzymes to each test tube and stir gently. Be careful! If you stir too hard, you'll break up the DNA, making it harder to see. Use meat tenderizer for enzymes. If you can't find tenderizer, try using pineapple juice or contact lens cleaning solution.

Step IV Alcohol Separation

Tilt your test tube and slowly pour rubbing alcohol (70-95% isopropyl or ethyl alcohol) into the tube down the side so that it forms a layer on top of the pea mixture. Pour until you have about the same amount of alcohol in the tube as pea mixture.

DNA will rise into the alcohol layer from the pea layer. You can use a wooden stick or other hook to draw the DNA into the alcohol. Alcohol is less dense than water, so it floats on top. Since two separate layers are formed, the protein and grease parts find the bottom, watery layer the most comfortable place, while the DNA prefers the top, alcohol layer.
DNA is a long, stringy molecule that likes to clump together

***** Experiment with other DNA sources. Which source gives you the most DNA? How can you compare them?

* Experiment with different soaps and detergents. Do powdered soaps work as well as liquid detergents?

LESSON 7: DNA REPLICATION

DNA Replication Video Sheet

Here are some notes summarising all you need to know about DNA replication. Unfortunately, they are in the wrong order… After watching the video, arrange them in order.

… nucleotides in a 5' → 3' direction (In the ….

… is needed for building up a complementary strand for this template.

To this primer, DNA polymerase III adds nucleotides in a 5' → 3' direction, moving…

… sealed up by DNA ligase which makes a sugar-phosphate bond between adjacent DNA fragments.

The DNA double helix is uncoiled and the two strands are…

… DNA polymerase III can follow along behind it, adding nucleotides in one continuous strand., however…

… a short length of RNA to the template strand of DNA, which acts as a prime.

… away from the replication fork as it does so. In this way…

… replication fork will be opening up in the 3' → 5' direction: another method, therefore,…

… short lengths of DNA – called *Okazaki fragments* - are formed between RNA primers.

… separated by the enzyme *Helicase*, producing a *replication fork.*

… reproduce or 'replicate' a double helix with anti-parallel strands.)

… the RNA primer and replaces it with DNA. A nick is left where…

…because the template strands are anti-parallel, for the other template strand, the…

At regular intervals along the 3' → 5' strand, RNA primase adds …

Behind the replication fork, the enzyme DNA polymerase III adds…

Next, DNA polymerase I removes…

… two nucleotides are still left unconnected – this nick is…

… opposite direction to the direction of the bases in the template strand, so as to…

As DNA helicase moves along *one* of the anti-parallel template strands in a 5'→ 3' direction…

Source: IB Online Curriculum Center, Teacher Resource Exchange:

http://occ.ibo.org/ibis/occ/guest/home.cfm

LESSONS 8&9: DNA TRANSCRIPTIONAND TRANSLATION

DNA to Proteins

Answer this after watching the video

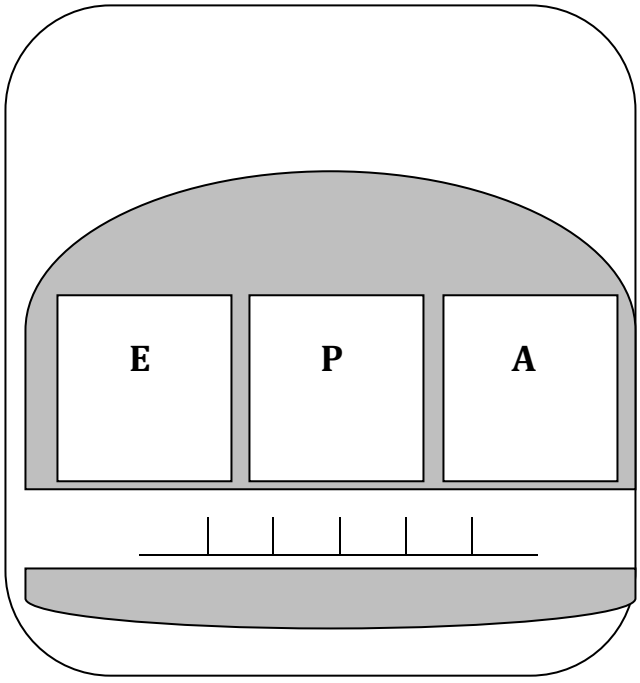
DNA

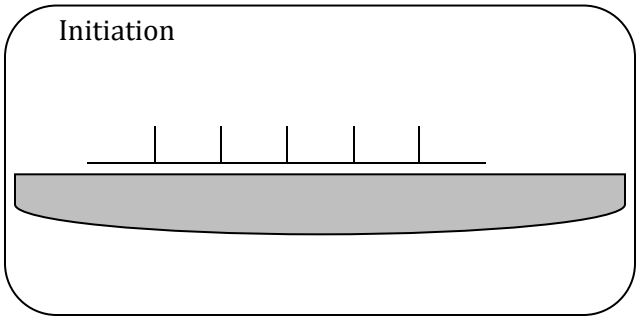
Anti sense strand (or _____ strand)

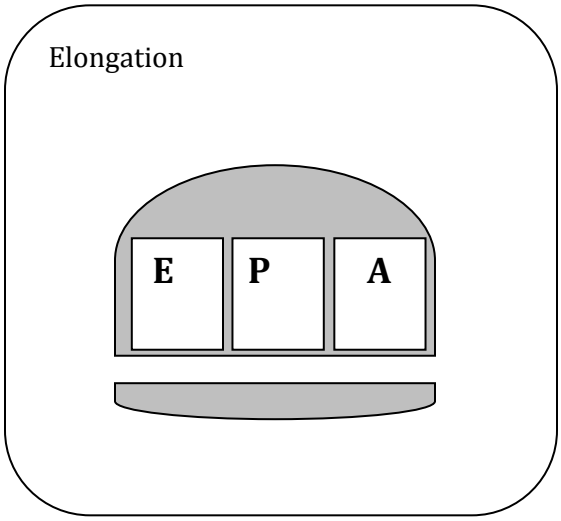
T	A	C	T	C	C	T	G	A	T	C	G	C	T	A	T	C	A	T	T

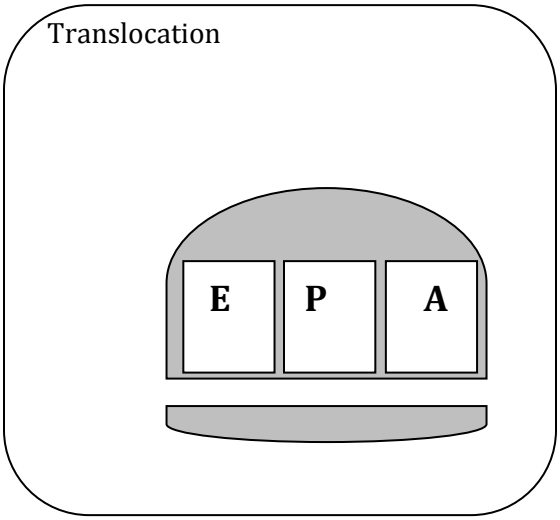
Sense Strand (or _____ strand)

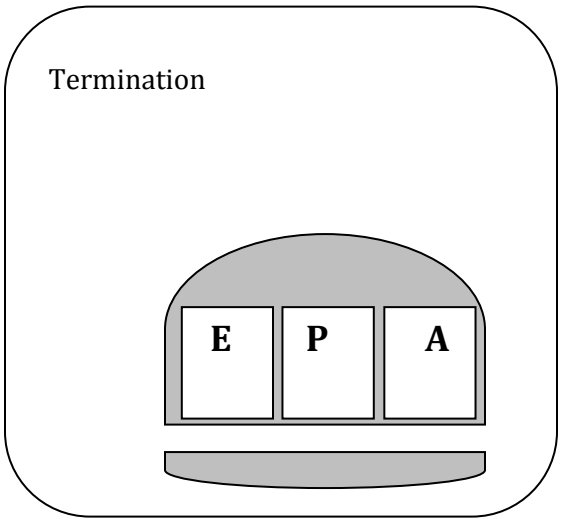
mRNA strand











Source:
IB Online Curriculum Center, Teacher Resource Exchange:
http://occ.ibo.org/ibis/occ/guest/home.cfm

LESSON 11: DNA FINGERPRINTING

DNA Fingerprint lab

Mr. McMurtry

Here is the original sequence of DNA, make it your own and personal DNA by making unique changes to the base sequence following the instructions below.

AGCTACGAGAATTCGGATCCTCGAAGCTTACTGAGAATTCCTAGCTACGATCGATCG
ACTGACTAGCTACGAAGCTAGCAAAGCTTTCGATCGAGAATTCGGATCCCTAGCTAG
CATCGATCGACTAGCAAGCTTATCGATCGATGAATTCCGACTGACTACGAGGATCCT
CGATCGACTAGCTACGATCGACTAAGCTTGACTAGCTACGATCGAATTCGACCACTC
GCATACCGAGAGTGGATCAAGGGATCCAATTCGAAGGGCCTTCGATCGCCTGCAAA
GCCTTCGATCCCTTCCTAGCTAGCTAGC

1. STARTING FROM THE BOTTOM and working towards the top, type your individual changes to the DNA sequence.

2. Type (your name) ORIGINAL SEQUENCE at the top of the sequence. Use **BOLD** to indicate **SUBSTITUTIONS**, use *Italics* to indicate *ADDITIONS*; use <u>UNDERLINE</u> OF EACH BASE ON EITHER SIDE OF <u>DELETIONS</u>: Save your document as DNA sequence lab

3. Select the whole sequence and copy and paste so you will have a new copy of your individual DNA.

4. Using only the second copy of your DNA, use the REPLACE command under EDIT

(or use Strg H) to find GAATTC and replace with G[use 5 spaces] AATTC, label this second sequence as"Ecor1 cuts DNA of (your name)at GAATTC" Save your document as DNA sequence lab

5. Repeat step 3 so that you will have a third copy.

6. Using only the third copy of your DNA, use the REPLACE command under EDIT

(orStrg H) to find GGATCC and replace with G[use 5 spaces] GATCC; label this third sequence as

"BamH1 cuts DNA of (your name) at GGATCC". Save your document as DNA sequence lab

7. Repeat step 3 so that you will have a fourth copy of your DNA.

8. Using only the fourth sequence of your DNA, use the REPLACE command under EDIT

(orStrg H) to find AAGCTT and replace with A[use 5 spaces] AGCTT, label this fourth sequence as

"HindIII cuts DNA of (your name) at AAGCTT". Save your document as DNA sequence lab

9. Now find each cut for each restriction enzyme and put a return at the end so that each fragment is on its own line. Be aware that some fragments will be longer than one line so don't cut artificially.

10. Print out your DNA

11. Count the number of bases in each fragment, record in a table

Fragment #	Ecor1	BamH1	HindIII
1			
2			
3			
4			
5			
6			
7			

12. Check around with other classmates,

Do you have the same number of fragments?

Are your fragments the same size?

Suggest reasons why this could be.

13. How have your individual changes caused the DNA to be cut differently? Examine the restriction enzyme cutting sites in the orginal DNA to see how your changes affected the cutting process.

Source:

http://teachers.yourhomework.com/marshallc/public/IB%20Bio%20Part%201/DNA%20fingerprint%20lab.doc.

LESSON 12: GENETIC ENGINEERING

Subject: Biology
Title: Biotechnology Tasks Sheet
Grade: 11
Name: ……
Date: ……
Source:

IB Online Curriculum Center, Teacher Resource Exchange:

http://occ.ibo.org/ibis/occ/guest/home.cfm

Task 1: Cloning & Stem Cell Research

"The technology exists to treat Parkinson's disease using neurons created from human stem cells generated from early stage human embryos."

This is an extremely controversial situation which the Commonwealth Minister for Health and Aged Care must consider. To do this, he must have advice from people who are experts in this area. He puts together a committee consisting of a doctor, an ethicist, a scientist, and a minister of religion.

Your task as a group will be to become familiar with the issues surrounding the use of human embryos for the development of cells which can then be used to treat patients with incurable Parkinson's disease. You will take on the roles of the experts and will make recommendations based upon your research. These recommendations must answer the following question:

The Big Question :What recommendations should the committee make to the Minister regarding the use of human embryos for the creation of stem cells to be used in the treatment of Parkinson's disease?

Roles:1- Scientist 2- Minister of religion 3- Doctor 4- Ethicist

Summary of the Task:

- Goal: Treating Parkinson Disease by the use of human embryos for the creation of stem cells.

- Role: 4 students: Each student will be 1 of the following: a doctor, a scientist, an ethicist, or a minister of religion.

- Audience: Commonwealth Minister for Health and Aged Care.

- Context: Convince the minister with your opinion.

- Performance: A report composed of a set of recommendations for the minister.

Remember that the main idea is that you need to decide what advice you will present to the Minister regarding issues surrounding the use of embryonic stem cells for gene therapy in patients with Parkinson's disease.

1- Scientist:

As the scientist, your role is to investigate issues involved with the process of creating neurons from human stem cells from early stage human embryos. Some of the questions you will need to consider are:

- What is the process involved in the creation of these neurons?
- Is this a beneficial process?
- How would you as a scientist counter claim that the process involves the destruction of human life?

2- Minister of Religion:

As the minister of religion, your role is to investigate religious concerns or issues surrounding the use of human embryos for the creation of the neurons necessary for the treatment of Parkinson's disease. Some of the questions you will need to consider are:

- What are the religious issues surrounding this situation?
- Does this process fit in with the teachings of religious teachings (take 2 religions)?
- Where do the major rejections stand on the issue of the use of human embryos?

3- Doctor:

As the doctor, your role is to investigate issues involved with the medical issues involved with gene therapy and Parkinson's disease. Some of the questions to consider are:

- What is the likely outcome for the patient if no therapy becomes available?
- What hope does the possibility of gene therapy offer?
- Describe the process and effects of Parkinson's Disease to the committee

4- Ethicist:

As the ethicist, your role is to investigate issues involved with the ethical issues involved with gene therapy and Parkinson's disease. Some of the questions you will need to consider are:

- What are the ethical issues which surround this therapy?
- Who are the groups who will have ethical objections to make against this therapy?
- What are these objections?

Task 2: DNA Profiling

Introduction

"This is the most advanced and effective crime-fighting tool ever provided to police" (Sydney Morning Herald 5/4/00)

The Big Issue

"When a person is arrested in Queensland under suspicion of committing a crime, that person shall submit a blood sample for the purpose of creating a DNA profile. This profile will be kept on file in a central database and may be used for the purposes of identifying suspects in any crime situation either future or past."

This is the central issue of a bill to be presented to the next sitting of Queensland Parliament. The Minister of Police, Thomas Barton, has formed a committee of experts to investigate this question and make recommendations as to whether he should support it. This committee will consist of a police officer, a civil libertarian, a lawyer and a scientist.

Your task as a group will be to become familiar with the issues surrounding DNA profiling. You will take on the roles of the committee members and will make recommendations based upon your research. These recommendations must answer the following question:

The Big Question

Should the Minister for Police argue for or against the bill as presented, or should he suggest modifications to it?

*** Summary of the Task:**

- Goal: Using DNA Fingerprinting (Profiling) for forensic science (crime analysis).

- Role: 4 students: Each student will be 1 of the following: a scientist, a civil libertarian, a lawyer, or a police officer.

- Audience: Minister for Police, and then the Parliament in Queensland.

- Context: Convince the minister with your opinion.

- Performance: A report composed of a set of recommendations for the minister.

1- Lawyer:

As a lawyer, your role is to research the legal aspects of DNA profiling. You may also need to look at cases involving DNA Profiling. You should attempt to find examples of legislation pertaining to DNA Profiling.

Consider the following questions:

- What are the advantages of DNA Profiling?
- What are the disadvantages of DNA Profiling?
- What are the problems which could be encountered in the use of DNA profiles as evidence in court?
- What are the implications of DNA profiling for those convicted of a crime but who still profess their innocence?

2- Civil Libertarian:

As a Civil Libertarian, you will need to consider the following questions and any others which need answering during your research:

- What are the advantages of DNA Profiling?
- What are the disadvantages?
- How does DNA Profiling fit in with the philosophies of human rights?
- What are the implications of DNA Profiling upon the right to privacy?

- What safeguards/processes would need to be put in place for you to be comfortable with DNA Profiling?

3- Police Officer:

As a Police Officer your role is to consider the impact DNA Profiling would be likely to have on your profession. You will need to consider the following questions and any others which need answering during your research:

- What are the advantages of DNA Profiling? What are the disadvantages?
- What safeguards would have to be put into place?
- What recommendations would you make about the process of taking the sample and passing it onto the appropriate place for screening?
- What are the implications in terms of time and labor?

4- Scientist:

As the scientist, your role is to investigate issues involved with the process of DNA Profiling. Some of the questions you will need to consider are:

- What is the process involved in DNA Profiling?
- Is the privacy of the individual tested being upheld?
- Are there steps in the process which are inaccurate or open to abuse or negligence?
- Is it an accurate process?

Task 3: Genetic Engineering in Agriculture

Imagine this...an orange that contains all the nutrients in a multivitamin, a tomato with more flavor as well as cancer fighting substances, sweeter strawberries, a potato that produces healthier French fries, allergen-free peanuts, rice high in beta-carotene as well as bananas that deliver needed vaccines.

Is this science fiction or real science?

It's real science and it is happening in laboratories today as genetically engineered foods. To many scientists this is a very exciting time to enter a new frontier called food biotechnology.

But now, what about fruits and vegetables that contain a gene from a bacterium that makes these crops more insect resistant? Would you want to eat these foods? What if these crops found their way into our food supply right now? This actually happened in September 2000!

Many people are afraid of this new technology and are calling these new genetically modified foods 'Frankenstein' foods. Should we be concerned? Are these foods safe to eat? How would these new crops affect the environment? Are these genetically modified foods everything they promise to be by their proponents? Or are they something to fear according to several advocacy groups?

Are you ready for the new foods of the 21st century? Are you ready to explore the risks and benefits of genetically engineered foods? Should we consider food biotechnology a friend or a foe?

The Quest

What are genetically engineered foods and are they dangerous to our health and to the environment?

Here is some background information everyone:

Use the Internet information to explore the basic questions on the topic:
1.) What is food biotechnology?

2.) What are genetically engineered foods?

3.) What are the potential benefits of genetically engineered foods overall?

4.) What are the potential risks of genetically engineered foods overall?

Here are the roles you need to play:

Environmentalist:

You are a world-renowned environmentalist from a major advocacy group. You have been asked to assess the risks and benefits of food biotechnology from an environmentalist point of view for an upcoming conference.

Your main concern is that crops developed from genetic engineering may overcome or destroy the balance of nature. You are also concerned with the need to feed the world's population while balancing the needs for the environment.

Your task is to collect and analyze information from multiple viewpoints and then formulate a statement to present at the World Food Conference on Food Biotechnology.

Your topic at the conference is: "Are genetically engineered foods destroying our environment?"

1.) What are the potential benefits of food biotechnology to the environment and to the issue of world hunger?

2.) What are the potential risks of food biotechnology to the environment and to the issue of world hunger?

3.) Are the benefits worth the risks and why?

Scientist:

You are a world-renowned scientist from a major university. You have been asked to assess the risks and benefits of food biotechnology from a scientist's point of view for an upcoming conference.

Your main belief is that food biotechnology if used in a responsible way can solve a multitude of world food issues. Your task is to collect and analyze information from multiple viewpoints and then formulate a statement to present at the World Food Conference on Food Biotechnology. Your topic at the conference is:
"Are genetically engineered foods the cure for world food issues?"

You, as the scientist will develop this statement based on informed decision making skills.

1.) What are the benefits of genetically engineered foods?

2.) What are the risks of genetically engineered foods?

3.) Do the benefits outweigh the risks and why?

Consumer Advocate

You are a concerned consumer who wants to know more about genetically engineered foods and how these foods may affect the health of your family. As a concerned citizen you have posted a web page on the internet to inform other families about genetically modified foods and the potential health issues associated with these foods. You have been asked to assess the risks and benefits of food biotechnology from a consumer's point of view for an upcoming conference.

Your task is to collect and analyze information from multiple viewpoints and then formulate a statement to present at the World Food Conference on Food Biotechnology.

Your topic at the conference is: "What the consumer needs to know about genetically engineered foods?"

1.) What should the consumer know about genetically engineered foods?

2.) What are the benefits of genetically engineered foods from the consumer's perspective?

3.) What are the risks of genetically engineered foods from the consumer's perspective?

4.) Do these benefits outweigh the risks and why?

5.) Should genetically engineered foods be labeled?

Legislator:

You are a very powerful legislator on the Food and Agriculture Committee in Washington, D.C. Your constituents have asked you to sponsor a bill that would require the labeling of genetically modified foods. You have been asked to describe labeling requirements as outlined in your bill at an upcoming conference.

Your task is to collect and analyze information from multiple viewpoints and then formulate a statement to present at the World Food Conference on Food Biotechnology.

Your topic at the conference is: "Should genetically engineered food be labeled and why?"

1.) Should genetically engineered food be labeled and why?

2.) What are the benefits of labeling genetically engineered foods?

3.) What are the risks for labeling genetically engineered foods?

4.) Is there a need to label genetically engineered foods from the consumer's point of view?

Task 4: Gene Therapy

"With summer Olympic 2008 in Beijing in full swing, the athletes are breaking records like never before. New records are set with more than 50% improvement. The tests for performance enhancing drugs (testosterone and anabolic steroids) are negative but still something different about them: they are genetically enhanced athletes; their genes have been altered to increase strength and endurance that is undetectable by any test so far."

Your task is to understand the issues, gather and analyze the current information provided to you, try to reach on a consensus with your teammates on the questions, write your recommendations and let the world know about it."

1- Scientist:

How can this be done? Other applications, especially in animal farming?

2- Religious and Ethical:

Do they have the right to do so? Isn't this how God created us? Is it fair to play like this? And would it be nice to have genetically modified people playing!? Isn't this the same as having machines playing?!

3- Athletes:

Don't we have the right to perform better?! Do you prefer performing as you were born i.e. real potential

4- Director of the Sport Union:

Is it fair or not? Do you agree on such actions?

5- Everyone:

Is the superman possible?!! Can we use such methods to make/create a human being with the traits we want?!?

Task 5: Genetic Engineering in Medicine

Can genetic engineering be used to treat diseases by making medicines?

1- Scientist:

How can this be done? Give examples.

2- Doctor:

What are the consequences of this? Will this defeat every single disease?

3- Customers' Advocates:

Will such medicines be very expensive? Will this be fair?

4- Pharmaceutical Companies:

How will this affect these companies? Give examples of companies producing such medicines. Comment on their profits lately.

Assessment Rubric

- Standards for Success: Rubric Below: (Same Rubric for all tasks)

	Novice (1 point)	**Apprentice (2 points)**	**Proficient (3 points)**
Teamwork	Only one person presented.	Some, not all presented parts of the presentation.	All presented parts of the presentation.
Presentation Skills	Read all from notes.	Read some from notes.	Presented statement without reading from notes
Content of Statement for Presentation and for Written Statement	Poor to Fair research & answers none to only one question required by the role & task.	Good research & answers some of the questions required by the role & task.	Well researched & answers all the questions required by the role & task.
Content of Statement continued	States an opinion with only 1 statement to support that opinion.	States an opinion and provides 2 to 3 statements to support that opinion.	States an opinion and provides 4 to 5 statements to support that opinion.
Visuals	No visuals OR Sloppy and no visuals labeled appropriately.	Somewhat neat and some visuals labeled appropriately.	Very neat and all visuals are labeled appropriately.
Visuals continued	Visuals do not support the statement.	Visuals somewhat support the statement.	Visuals are well thought out and support the statement.
Written	A written essay	A written essay with	A written essay, with

Statement	without proper sentence structure and/ or many grammatical or spelling errors.	some proper sentence structure and/ or some grammatical or spelling errors.	proper sentence structure, and no grammatical or spelling errors.
Submission of Written Assignments	Did not submit any part of written assignment for this project on time.	Did submit a partially completed written assignment on time.	Did submit a complete written assignment on time.

LESSONS 13 & 14: CROSSING

DrosophiLab: Usingfruit flies as a model for genetic relationships (Teacher)

Fruit flies (*Drosophilamelanogaster*),areamodelspeciesforobservinggeneticrelationships.They breed quickly, andhaveclearlyobservable traits.By observingspecifictraitsandselectingparents, wecandeducegenotypes fromphenotypesandanalyse ourdata usingtheChi-squared (X^2) test.

Completethetutorial first,using*Example_Male*and *Example_Female*(monohybridcross)andthe presentationhere: http://wp.me/P7lr1-B6.**Thislinkincludes**:.*fly files*, aclass presentation, protocol

sheetsfor HLandSLandaChi-

squared calculator inExcel.

Teachernotes: This worksbestif installedonschool computersor student laptops with*student access restricted*–followtheinstructions inthe‘settings’menutolearn howtodo this.If youwantstudentsto deducethegenotypesandusethemicroscopeforphenotyping, theycannothaveaccess toresults tablesor thechromosomemap(oreditor). Switchthese off onstudentcomputers.

Youshould workthroughthecrossesbeforeyougivethemtostudents, toseewheretheymight encounter difficulties.

Studentswillneedaccess to these.flyfilesandthefirsttimetheyusethe programmeneed todirectthe flyloadertothe correctfolder(tryitandsee).

Answerkeyforfiles(.flyfiles)available at: http://wp.me/P7lr1-B6

.flyfiles	Males	Females
SL_Male1 SL_Female1	CyCy(homozygousforthe dominant,	$Cy^{+}CY^{+}$(homozygous recessivefor normal-
	All F1willhavecurledwings.Normalwings reappear inF2.	
SL_Male2 SL_ Female2	w^{+}forredeyes (X-linked)	wwontheXchromosomes(whiteeyes)
	All F1males havewhiteeyes.	
HL_Male1 HL_Female1	$sr^{+}srvg^{+}$vg(normalwings,no thorax	$sr^{+}srvg^{+}$vg(normalwings,no thorax
	Dihybridcross,vggeneonchr.2, srgeneonchr.3.9:3:3:1ratioexpected.	
HL_Male2 HL_Female2		
	Thechallengewiththis cross istodeducethatthegenesarelinked. If studentssucceed this far, unlockaccess to theresultstablesandletthemproducegenerationsof5000 offspring –they shouldseeasmall number ofrecombinants.	

Source:

http://www.drosophilab.com

StephenTaylor BandungInternationalSchool
http://sciencevideos.wordpress.com

Grade: 11
Subject: Biology
Title: Dihybrid Crosses: Testing predicted versus obtained ratios
Name: ……
Date: ……

Source:

IB Online Curriculum Center, Teacher Resource Exchange:

http://occ.ibo.org/ibis/occ/guest/home.cfm

You and your partner will design an experiment to model random mating of the F1 generation of a dihybrid cross. The goal of this experiment is to compare the phenotypic ratios obtained from actual random "mating" versus the predicted Mendelian ratios for a dihybrid cross.

Make sure to design your experiment so that each of your "matings" will be truly random. Make sure as well that you account for all possible gametes produced by the F1 generation before beginning your "matings".

Decide with your partner what you will call each of the traits, and what the dominant and recessive forms of each trait will be.

Some suggestions: seed color , seed shape, petal color, petal shape

You can make up whatever names you like for the traits, even "nonsense" names--just remember for each you need to keep track of what the trait specifies, and the version of the trait determined by the dominant and recessive alleles, respectively.

Write them below:

Trait 1, dominant allele	*Trait 1, recessive allele*
Ball color:_____	_____
Name of trait_____	_____
_____	_____
Dominant phenotype of allele:	
_____	_____
Allele designation (letter)	
_____	_____

Trait 2, dominant allele	Trait 2, recessive allele
Ball color:_____	_____
name of trait:_____	_____
_____	_____
dominant phenotype of allele:	
_____	_____
allele designation:_____	_____

What would be the forms of the two true-breeding parental individuals of the P generation?

_____ x _____

Give the phenotype for each:

_____ _____

_____ _____

What would be the genotype and phenotype of the F1 generation?

genotype:_____

phenotype:_____

Give the predicted phenotypic ratios expected for a cross of two F1 individuals.

Use the Punnett Grid below to determine your results:

What are the predicted phenotypic ratios for your F2 offspring?

Phenotype	# of individuals

Using the paper bags supplied with the Balls, count enough alleles for all possible gamete types for 32 random-mating crosses of male and females from the F1 generation of your "offspring". Assume 1 offspring/mating.

Using the supplies given above, carry out 32 random "matings" of your F1 individuals (using the Balls to represent the possible gamete combinations) and record the results for each "mating" on the following table.

Male gamete	female gamete	offspring genotype	offspring phenotype

Count up the phenotypes and determine whether the predicted phenotypic ratio was yielded in the 32 random "matings?

Predicted phenotypic ratio	Actual phenotypic ratio

Give a brief summary of your experimental design:

_____

_____

_____

_____

What measures did your team take to ensure that each individual "mating" event was random with respect to the possible gametes involved?

How does this type of experiment, if done properly, more accurately model the natural randomness of mating than the perfect ratios predicted by Mendel's methods?

Appendix B: Practice Worksheets

Biology Worksheet
Title: Biotechnology
Grade: 11
Name: ……
Date: …….

I- Define the following:

1- Deletion

2- Genetic Engineering

3- Human Genome Project

II- State 1 difference and 1 similarity between mutations and genetic engineering methods.

III- The mutation causing lung cancer in a mother doesn't affect her children.

1- What causes lung cancer?

2- Why isn't this mutation transmitted to children?

IV- State if each of the following statements is true or false. Correct the false sentences.

1- Mutations produce several alleles from the same gene. ……
2- A mutation might not always give a different protein. ……
3- An unpredictable modification in the transfer RNA molecules is the basis of mutation. ……
4- Mutations are transmitted to the offspring when they occur in somatic cells. ……
5- A mutation by deletion causes a frame shift. ……
6- A mutation by insertion can be silent. ……
7- The time at which mutations might happen cannot be specified even by good scientists. ……
8- A mutation might be favorable or harmful. ……
9- High exposure to sunlight might cause mutations and hence skin cancer. ……
10- Genetic polymorphism is due to mutations. ……

V- "Duchenne Myopathy" is a disease due to muscles weakness. Diseased people can't synthesize a protein called "dystrophine".

A part of the messenger RNA strand that is used to synthesize "dystrophine", is as follows: GAUUUGGGUUUGAAUAUA

1- Using the genetic code (in your books), give the peptide sequence resulting from the translation of the given mRNA.

2- Define silent mutations. Suggest a point silent mutation for the above mRNA.

3- Suggest a point mutation resulting in a non-sense peptide. Justify your answer.

4- Suggest a point mutation resulting in a mis-sense peptide. Justify your answer.

5- Suggest 2 different mutations leading to frame-shifts in the given mRNA.

VI- The document below shows the DNA sequences for 4 different types of hemoglobin:

Normal hemoglobin (HbA): … TGA-GGT-CTC-CTC-TTC

Sickle Cell Anemia Hemoglobin: …TGA-GGT-CAC-CTC-TTC

ß-Thalassemia Hemoglobin: …TGA-GGT-CCC-TCT-TC

Chinese ß-Thalassemia Hemoglobin: TGA-GGG-TCT-CCT-CTT-C

1- Compare the DNA sequences of the 4 types of hemoglobin.

2- What do you think is the cause of each of the following diseases? Note that you should explain what happened and give the corresponding scientific term in every case:

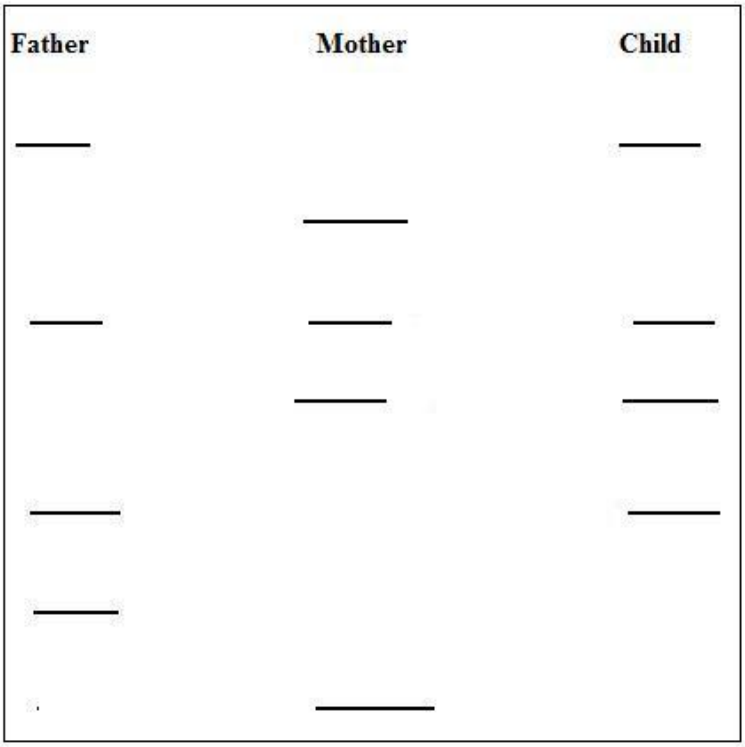
   a- Sickle Cell Anemia:

   b- ß-Thalassemia:

c- Chinese ß-Thalassemia:

VII- DNA Finger Printing:

A mother thinks that her child was exchanged for another at birth in the hospital. The document below represents a DNA finger-print performed to find out the truth.



1- Usually, what is the origin of any child's genes?
2- In the case above, has the child been really exchanged for another? Justify the answer.

VIII- By the action of restriction enzymes, we obtained several DNA pieces from 3 different individuals: A, B, and C.

The sizes of the pieces (in base pairs "bp") are indicated in the table below:

C	B	A
200	**200**	**300**
500	**1500**	**600**
1500	**700**	**650**
1200	**100**	**50**
600	**300**	**1200**
	1200	**500**
		700

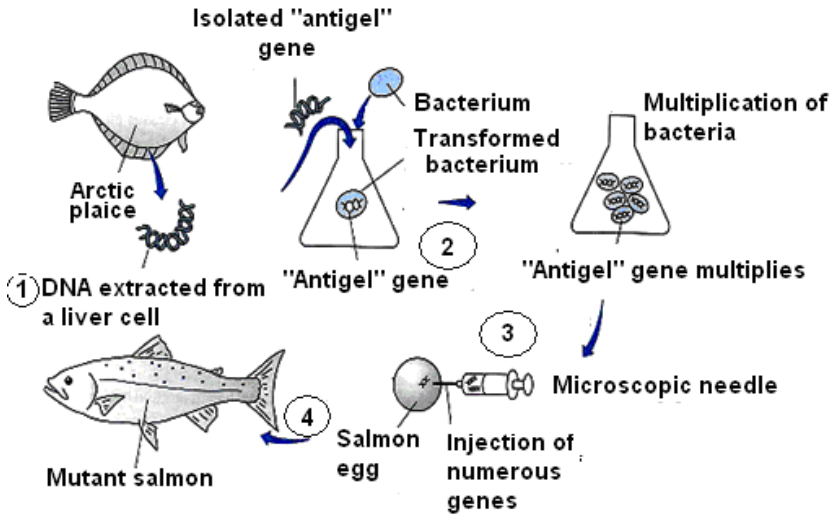
1- Construct the DNA fingerprint of the 3 individuals.

2- Knowing that one of those individuals is the real son of the other two. Who are the father, the mother, and the son? Justify your answer.

3- Knowing that the 3 individuals have blood type O. What is the size of this allele? Justify your answer.

IX- A fish species, called the arctic plaice, is equipped with a valuable gene (antigel gene), which is responsible for the synthesis of an antifreeze protein that enables them to resist very low temperatures. On the other hand, salmons die when the temperature decreases below 0°C. For that, researchers wanted to equip salmons with the savior antifreeze gene.

The document below shows how a "mutant salmon" is produced in the laboratory.



1- Write a short text describing the done experiment.

2- The term "mutant" used to describe the obtained salmon is not proper in this case. Propose another term that better describes that salmon. Justify the choice.

3- What new characteristic will the "mutant salmon" acquire?

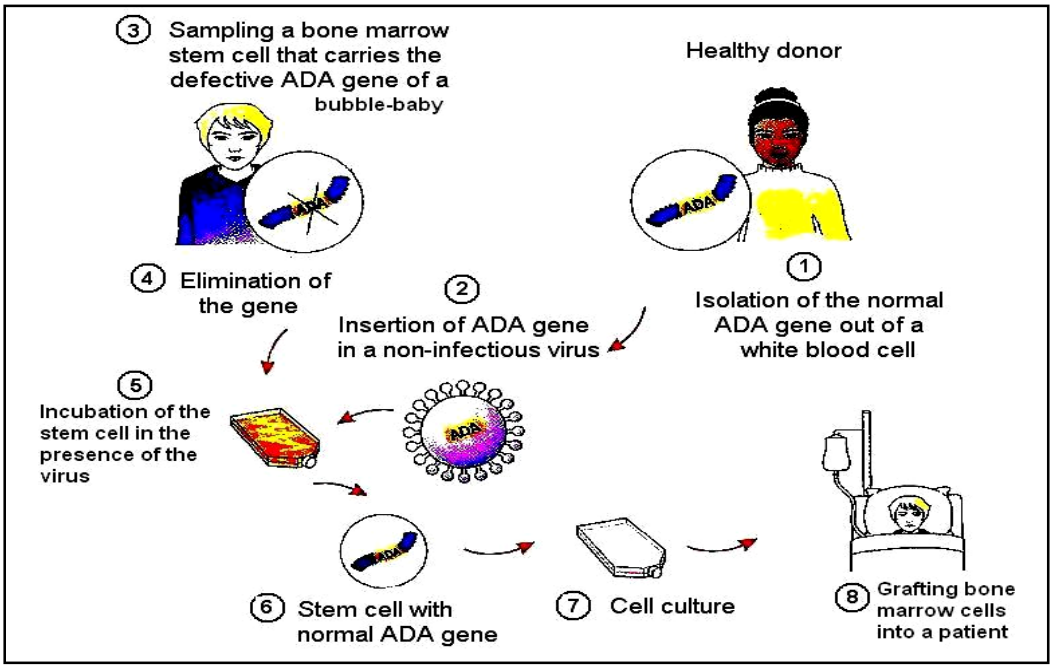
X- Studies were carried out in order to obtain tomatoes that ripe and rot slower than ordinary tomatoes. The document below reveals the results obtained.

Scientists obtained, by chance, a variety of super-tomatoes. In fact, they sought to produce fruits which can remain consumable for a time longer than in ordinary tomatoes. For that, they introduced a gene extracted from a bacterium into a tomato cell. This gene codes for the production of an enzyme that prevents cellular death. However, this manipulation had an unexpected effect at increasing the concentration of lycopene (*), known years ago, for its anti-oxidant properties. In fact, lycopene prevents certain components from attacking the cells. On the other hand, it is known that this attack favors the appearance of cancers or cardiovascular diseases within our body.

(*) ***Lycopene = pigment that gives the tomato its red color.***

1- Pose the problem at the origin of the studies performed.
2- Pick up, from the document, the origin of the extracted gene and the information it carries.
3- Are the obtained results consistent with the sought objective for producing these tomatoes? Justify the answer.
4- Justify the qualifications "transgenic" and "anti-cancer" attributed to this variety of tomato.

XI- Gene therapy is a method used to correct the defective cells of the organism. The next document reveals a gene treatment for babies affected with a rare disease: the absence of adenosine deaminase enzyme (ADA), leading to a deficiency of the immune system. These babies, called "bubble-babies", spend generally their brief life in a sterile bubble chamber in order to prevent infection.



1- Write a short text describing the gene treatment performed.
2- Name the biotechnology method used in this therapy. Justify the answer.
3- Specify the advantages acquired by the "bubble-baby" following this therapy.
4- Name two applications of this method in the domains of health and food technology.

XII- Given the picture below and the following quotes:

"Xenografting gives animals human DNA and vice versa. If an animal has human DNA is it still an animal? Would you want to eat a chicken with human DNA?"

"Humans have long since possessed the tools for crafting a better world. Where love, compassion, altruism and justice have failed, genetic manipulation will not succeed."

"I don't know what all the fuss is about!"

1- Comment on both: the quote and the picture. State your opinion concerning the social and ethical aspects of biotechnology.
2- In your opinion, what are the limitations that must guide this work?
3- Link the current and expected achievements in this field to what you learned before on the history of DNA discovery. Comment on such transition, explaining how previous discoveries lead to such huge advance.

Hope you enjoyed ☺

Source:

German School Beirut Archive

Done by the teacher: Mohammed Estaiteyeh

Biology Worksheet
Title: Crossing and Pedigree
Grade: 11
Name: ……
Date: …….

Source:
IB Online Curriculum Center, Teacher Resource Exchange:
http://occ.ibo.org/ibis/occ/guest/home.cfm

Sex-Linked Inheritance Problem Set

Problem 1: Test cross of a red-eyed female fly

Tutorial to help answer the question

A female Drosophila of unknown genotype was crossed with a white-eyed male fly, of genotype $X^{w}Y$(w = white eye allele is recessive, w+= red-eye allele is dominant.) Half of the male and half of the female offspring were red-eyed, and half of the male and half of the female offspring were white-eyed. What was the genotype of the female fly?

Sex-Linked Inheritance Problem Set

Problem 2: Predicting the offspring of a homozygous red-eyed female fly

Tutorial to help answer the question

In a cross between a pure bred, red-eyed female fruit fly and a white-eyed male, what percent of the male offspring will have white eyes? (white eyes are **X**-linked, recessive)

Problem 3: Predicting genotype when phenotype is known

What is the genotype of a red-eyed, yellow-bodied female fruit fly who is homozygous for the eye color allele?
Red eyes (w+) and tan bodies (y+) are the dominant alleles. (Both traits are **X** chromosome linked).

Dihybrid Inheritance Problem Set

For example: For wing size and body colour in *Drosophila* (fruit flies).

Let vg^+ = normal wing (dominant allele) b^+ = black body (dominant allele)
vg = vestigial wing (recessive allele) b = grey body (recessive allele)

Parents:

genotypes (2n): $vg^+vg^+b^+b^+$ x vgvgbb

phenotypes: _____ _____

M E I O S I S

Gametes (n): 100% __ ◯ 100% __ ◯

R A N D O M F E R T I L I S A T I O N

F_1 generation (2n):

genotypes: _____

phenotypes: 100% heterozygous for both characters = _____

An F_1 cross can then be performed – crossing one of the F_1 individuals with another:

Parents:

F_1 genotypes (2n): _____ x _____

F_1 phenotypes:_____ _____

M E I O S I S

Gametes (n): __ __ __ __ ◯ __ __ __ __ ◯

R A N D O M F E R T I L I S A T I O N

F_2 generation (2n):

Complete the Punnetsquare below:

As can be seen, this is a __:__:__:__ ratio.

The possible genotypes for each of the following phenotypes are:

1) Normal wing, black body:

_____ _____

_____ _____

2) Normal wing, grey body:

_____ _____

3) Vestigial wing, black body:

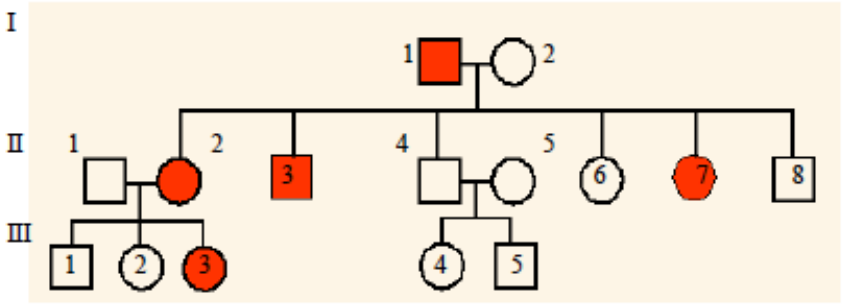
_____ _____

4) Vestigial wing, grey body:

_____ _____

Pedigree Problem Set

Pedigree Problem Set 1



= Huntington's Disease

1. Which members of the family above are afflicted with Huntington's Disease? _____

2. There are no carriers for Huntington's Disease- you either have it or you don't.
With this in mind, is Huntington's disease caused by a dominant or recessive trait? _____

3. How many children did individuals I-1 and I-2 have? _____

4. How many girls did II-1 and II-2 have? _____ How many have Huntington's Disease? _____

5. How is individual III-2 and II-4 related? _____ I-2 and III-5? _____

---

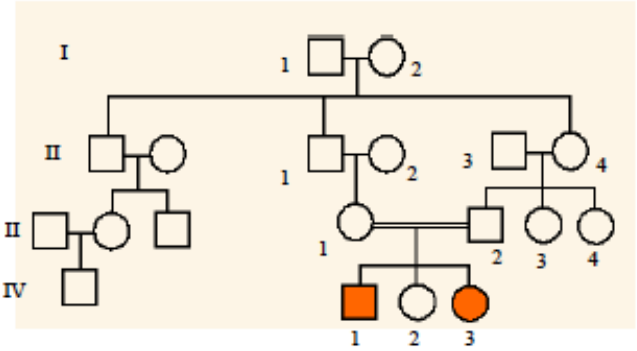
6. The pedigree to the right shows the passing on of Hitchhiker's Thumb in a family. Is this trait dominant or recessive? _____

7. How do you know? _____

8. How are individuals III-1 and III-2 related? _____

9. Name 2 individuals that have hitchhiker's thumb. _____

10. Name 2 individuals that were carriers of hitchhiker's thumb. _____



11. Is it possible for individual IV-2 to be a carrier? _____ Why? _____

---

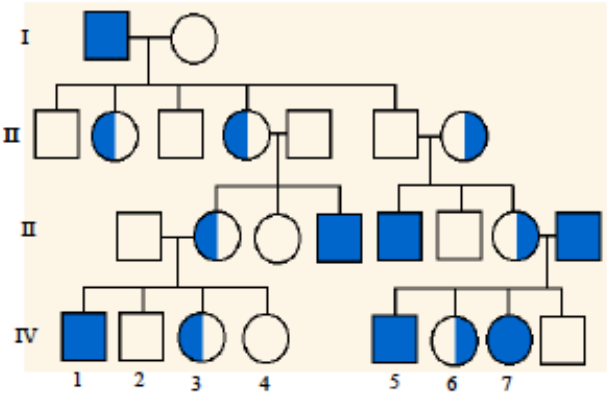
12. The pedigree to the right shows the passing on of colorblindness. What sex can ONLY be carriers of colorblindness? _____

13. With this in mind, what kind of non-mendelian trait is colorblindness? _____

14. Why does individual IV-7 have colorblindness? _____

15. Why do all the daughters in generation II carry the colorblind gene? _____

16. Name 2 IV generation colorblind males. _____



Biology Worksheet
Title: Crossing
Grade: 11
Name: ……
Date: …….

I. In a certain farm, we noticed the following facts:

- **Black sheep crossed among each other give always black sheep.**
- **Gray sheep crossed among each give gray and black descendents. We also notice a certain number of spontaneous abortions of sheep with black hair.**
- **The partially hairy sheep (having wool that contains both long and short hair) when crossed among each other gave descendents of 3 types: long hair, short hair, and partially hairy**

1- Determine for each of the mentioned genes (color and shape of wool) the dominant and the recessive alleles. Justify your answer.

2- Designate symbols for these alleles.

3- Give a hypothesis that permits the explanation of the spontaneous abortions occurring.

4- Perform the factorial analysis to explain the appearance of partially hairy sheep.

II. Given the 2 genes for the color of eyes and color blindness disease. The following 4 alleles are possible:

N: Normal sight
n: Color Blindness
G: Green eyes
b: Black eyes

Ziad, a grade 11 student, has a normal sight insured by his nice greenish eyes.

1- Write Ziad's all possible genotypes.

2- What is the name of the cross to be done to know his genotype? How is it done?

3- We were just informed that Ziad is homozyogous for both alleles. He also married a girl having exactly the same genotype. Should he feel worried about giving birth to color blind children? Justify your answer.

III. Albinism is a hereditary disease that is due to the absence of dark pigment, melanin, from hair and skin. A normal male and a normal female married. They were surprised to have an albino child.

1- Is the albinism allele dominant or recessive? Justify your answer.

2- Designate by symbols the 2 alleles.

3- Knowing that the albinism allele is situated on the X chromosome, determine the genotype of:

a- An albino male: ……..

b- An albino female: ……..

c- A normal male: ……..

d- A normal female: …… Or ……

4- Perform the factorial analysis to explain the appearance of the albino child from that normal couple.

IV. We crossed male drosophilae having long antennae and black bodies with female drosophilae having short antennae and grey bodies. All drosophilae of F1 had long antennae and grey bodies.

A second cross between females F1 and males F1 gave the following results:
- 1117 drosophilae with long antennae and grey bodies,
- 373 drosophilae with long antennae and black bodies,
- 374 drosophilae with short antennae and grey bodies,
- And 125 drosophilae with short antennae and black bodies.

1- Indicate the genotypes of the parents and individuals obtained in F1.

2- Calculate the proportions of the results. What can you conclude about the relative position of the 2 genes?

3- Schematize the results (with percentages) of meiosis of a drosophilae from F1.

4- Perform the factorial analysis to explain the results obtained from the second cross.

5- Using a logical analysis, and without constructing the table of cross, what will the results be if:

a- the test cross was made for F1.

b- F1 is crossed with drosophilae homozygous for short antennae and grey body.

6- What would be the results of all crosses done above if the considered genes are of different relative positions than the one you figured out in question 2?

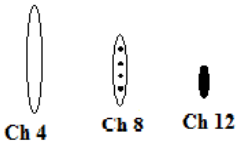
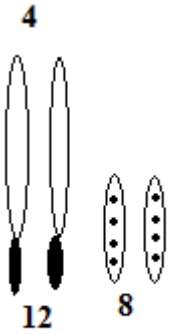
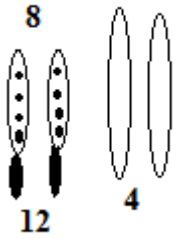
V. We propose to study certain particularities of sexual reproduction in mice. We measure the quantity of DNA present in different cells. The results are indicated in the table below:

Cells of the mouse	Liver	Pancreas	Spermatogonium	Sperm Cell
DNA Quantity (pg)	6.199	6.2	6.2	3.1

a- Compare the obtained results.

b- Name the biological phenomenon that caused the observed difference.

B) Two mice A and B have two pairs of attached chromosomes as shown below:

Legend	Mouse A	Mouse B
		

c- Upon crossing A with B, we obtain a hybrid AB having a normal phenotype.

i- Draw the cell of AB taking only these 3 chromosomes into consideration.

ii- How can you explain the normal phenotype of AB?

d- i- Draw all possible gametes of AB.

ii- Indicate the normal gamete. Justify your answer.

e- If one of the gametes of AB is crossed with a normal gamete:

i- Which gamete will result in Trisomy 4? Show how this will happen.

ii- Which gamete will result in Monosomy 4? Show how this will happen.

VI. We cross couple of rabbits of smooth and white coat with others of rough and black coat. In F1, we obtain the rabbits having smooth and gray coats.

Knowing that the 2 genes are independent, answer the following questions:

a- What can you conclude from the cross performed. Justify your answer.

b- Give a symbol for each allele indicated above.

c- What are the genotypes of each of the parents and the children in the cross above?

d- Schematize the gametes resulting from the meiosis of F1.

e- Perform the factorial analysis of F1xF1. (No need for chromosomic illustration).

f- What would the results of F1xF1 be if the rough allele is lethal?

VII. The cross between drosophilae of yellow body and long wings with others of green body and short wings gave drosophilae having green body and long wings only in F1.

The cross between F1 and drosophilae having yellow body and short wings gave the following results:

460 drosophilae having yellow body and long wings
460 drosophilae having green body and short wings
40 drosophilae having yellow body and short wings
40 drosophilae having green body and long wings

a- What can you conclude from the first cross?

b- What is the name of this recombination? Justify your answer.

c- i- What is the reason behind the results of the second cross?

ii- Schematize what happened.

iii- What are the advantages of such phenomenon?

d- Calculate the distance between the 2 genes. Show your work.

e- Perform the factorial analysis of F1xF1. Use the chromosomal illustration.

Source:
German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

Biology Worksheet
Title: DNA
Grade: 11
Name: ……
Date: …….

I- Answer the following questions:

1- Describe the shape of the DNA molecule, stating the names of its components.

2- Three different bonds are present in the DNA molecule. What are they? And between what substances are they formed?

3- What are the 4 DNA nitrogenous bases?

4- What are the 4 DNA nucleotides?

5- What's meant by the anti-parallel nature of DNA?

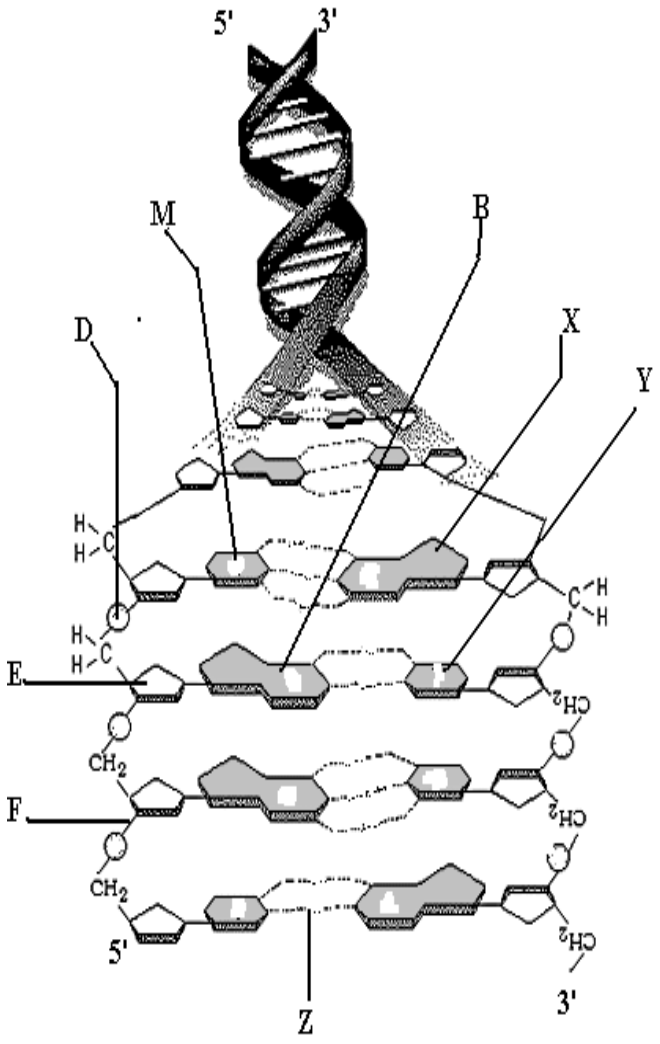
II- The reading of one of the strands of a DNA segment gives the following sequence: …ATGCCAAGCCATGCCCCCATTTGATGTA…

1- How many nucleotides are there in this DNA strand?

2- How many nucleotides are there in this DNA segment?

3- Write this segment as double stranded.

III- Fill the empty spaces with the correct names. Note that "B" is different from "X", and that "M" is different from "Y" too.



X: ……

Y: ……

Z: ……

B: ……

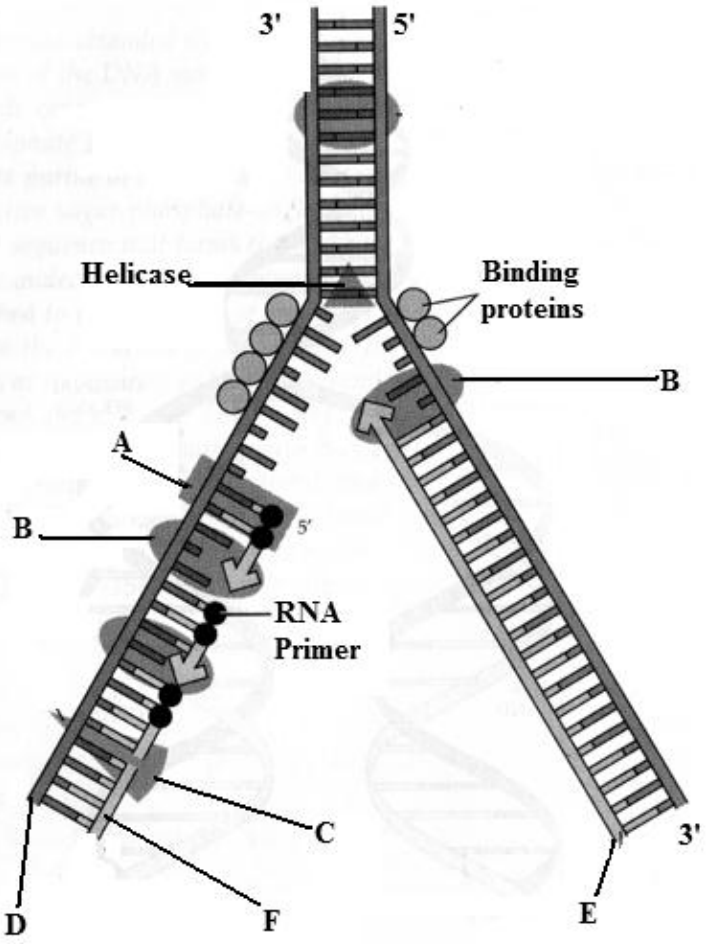
F: ……

M: ……

D: ……

E: ……

IV- DNA Replication: The figure below shows the process of DNA replication:



1- Fill in the blanks: (on your C.B. too)

a- "D" is called the ..... strand, while "E" is called the ..... strand.

b- "C" is called …… It joins the ……

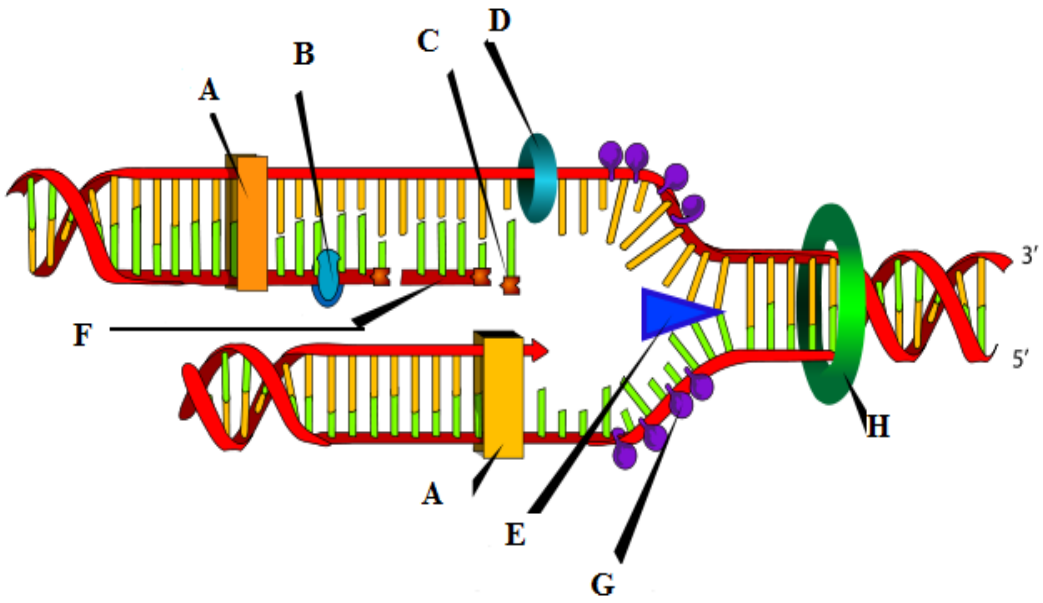
c- Helicase and binding proteins cooperate to ……..

d- "B" is very important. It is called …….....

e- DNA replication is semi conservative. Explain this phrase.

2- On the figure above, label the following: replication fork, primase, and Okazaki fragments.

V- Given the figure below:



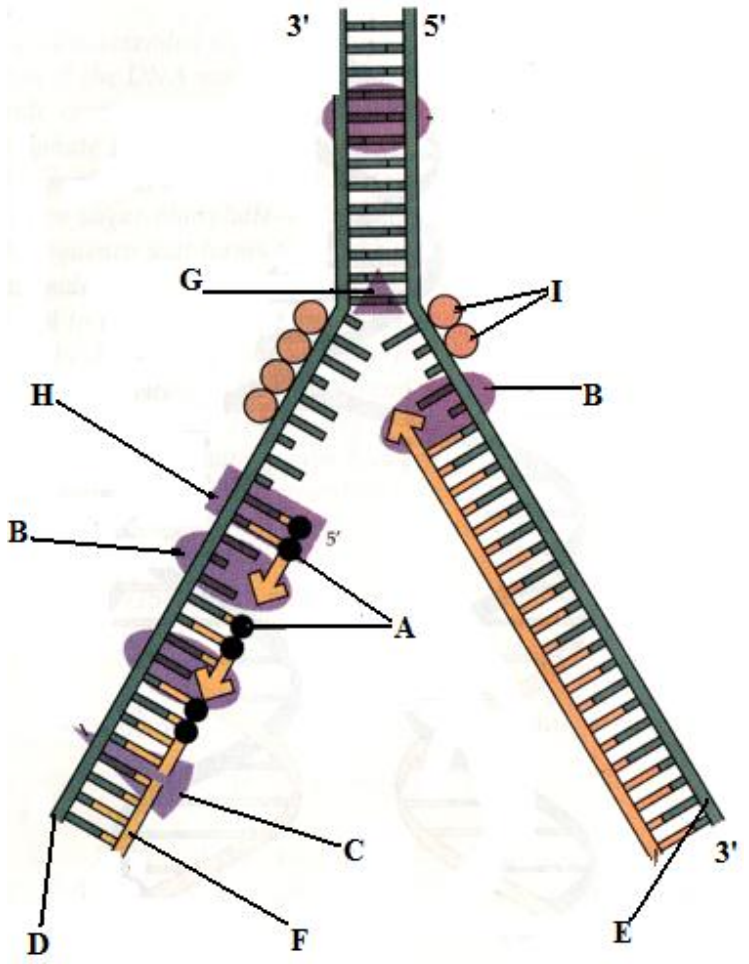
1- Give a title for this picture.

2- Label the structures from A to H.

3- Why is this process called semi-conservative?

4- On the figure above, show that DNA possesses an anti-parallel nature.

VI- The figure below shows the process of DNA replication:



1- "G" is an enzyme, while "I" is not. Theycooperate in separating the DNA double strands. G is …….; I is ……...

2- The above DNA moleculeis made of 2 strands. "……" thatiscalled the ……., and "……" thatiscalled the …….

3- "B" isvery important in replication. It iscalled …….

4- Although "B" is the most important enzyme in DNA replication, itcan'tworkunless "H" whichis ……..comes first. The role of "H" is to ……. that are symbolized by "…….." in the above figure.

5- "F" is a/an …… Many of these are joined by "……" thatsymbolizes ……..

6- Addingnucleotidesproceedsalways in the …… direction.

7- Mistakesalwayshappen. To decrease the number of mistakeswhilereplication, the enzyme responsible for replicationpossesses an impressive abilitythatiscalled …….

VII- The reading of the template strand of a DNA segment gives the following sequence: …ATTAGCCATG…

a- What is the sequence of the coding sequence of this DNA segment?

b- What is the sequence of the mRNA that results from the transcription of this segment?

VIII- The reading of a certain mRNA sequence gave:

AUGAGACUGCGAAACAAACACUAGAAA

a- Give the DNA double strand from which this mRNA is derived.

b- Using the genetic code table attached (appendix), what is the peptide sequence that will result from the translation of this mRNA?

c- If the G in the 4th codon of the mRNA is replaced with an A:

i) What will be the resulting amino acid sequence?

ii) What can you deduce?

IX- A peptide sequence is given:

Met- Lys- His- Gly- Ser

a) How many nucleotide sequences are possible for this peptide? Show your work.

b) Give 3 of these possible nucleotide sequences.

c) What does this prove regarding the degenerate genetic code?

X- The reading of the coding strand of a DNA segment gives the following sequence: …ATGCCAAGCCATGCCATTTGATGTA…

a- How many nucleotides are there in this DNA segment? Show your work.

b- Write this DNA segment as a double stranded one.

c- What is the mRNA that results from the transcription of this segment?

d- Making use of the genetic code given (appendix), what is the peptide sequence that will result from the translation of this mRNA?

e- How many tRNA molecules were used to give this peptide? Draw 2 of them.

f- If the "C" nucleotide in the 2nd triplet is substituted by a "G", what will happen?

g- How do such changes (questions f) affect the diversity of proteins?

h- Do you think there is any relation between such changes and genetic diseases? Justify your answer.

i- How many nucleotide possibilities are there for the same peptide sequence above? Show your work.

j- If "Methionine" is radio-labeled before translation starts. Where do you expect the radio-labeled uracil to appear:

*** At the beginning of the experiment? Justify your answer.**

*** And after some time? Justify your answer.**

First Position	Second Position: U				Second Position: C				Second Position: A				Second Position: G				Third Position
	code	Amio Acid	code	Amio Acid	code	Amio Acid	code	Amio Acid	code	Amio Acid	code	Amio Acid					
U	UUU	phe	UCU	ser	UAU	tyr	UGU	cys					U				
	UUC		UCC		UAC		UGC						C				
	UUA	leu	UCA		UAA	STOP	UGA	STOP					A				
	UUG		UCG		UAG	STOP	UGG	trp					G				
C	CUU	leu	CCU	pro	CAU	his	CGU	arg					U				
	CUC		CCC		CAC		CGC						C				
	CUA		CCA		CAA	gln	CGA						A				
	CUG		CCG		CAG		CGG						G				
A	AUU	ile	ACU	thr	AAU	asn	AGU	ser					U				
	AUC		ACC		AAC		AGC						C				
	AUA		ACA		AAA	lys	AGA	arg					A				
	AUG	met	ACG		AAG		AGG						G				
G	GUU	val	GCU	ala	GAU	asp	GGU	gly					U				
	GUC		GCC		GAC		GGC						C				
	GUA		GCA		GAA	glu	GGA						A				
	GUG		GCG		GAG		GGG						G				

XI- Given the % composition of the nitrogenous bases of the DNA extracted from a human cell and an ox cell.

Base	A	G	C	T
Cells of the cat	28.1	21.3	21.0	27.9
Cells of Human Liver	27.9	22.7	20.8	27.3

1- Compare the results. (2)

2- What can you deduce about the properties of DNA? (4) (Hint: 2 properties)

XII- In humans, there exists a serious, rare, and hereditary disease called Lesch-Nyhan syndrome. This disease is characterized by the excessive (high) secretion of Uric Acid. In healthy individuals, nucleotides are degraded according to the following reaction:

Nucleotide→ Nitrogenous base→ Hypoxanthine→ Uric Acid

Moreover, Hypoxanthine is usually removed to produce nucleotides, with the help of an enzyme named E, according to this reaction:

Hypoxanthine→ Nitrogenous base→ Nucleotide

1- What are the 4 nitrogenous bases & the 4 nucleotides of DNA? (2)

2- Represent in 1 scheme, the reactions described above. (1)

3- The absence of enzyme E leads to this disease. Justify this statement. (2)

We obtained cells from a normal person and cells from a diseased individual. We added hypoxanthine to each of these cells. Cells removed from the healthy individual multiplied i.e. showed several Mitotic divisions. Whereas, cells removed from the diseased individual didn't.

4- How can you explain such results? (3)

Source:

German School Beirut Archive

Done by the teacher: Mohammed Estaiteyeh

Biology Worksheet
Title: Chromosomes and Mitosis
Grade: 11
Name: ……
Date: …….

Sheet 1

The picture below shows the chromosomal content of drosophilae (small flies).

A B

1- What is the chromosomal formula of drosophilae?

2- Which one is the male? And which one is female? Justify your answer.

3- a- Name the procedure that allows us to get such picture.

b- What are the advantages of such procedure?

4- Although human red blood cells are numerous and very easy to get, Mr. Mohammed (a well known biologist who's rarely mistaken) refused to use red blood cells in Karyotyping. **Do you agree with him?**

b- If yes, propose a hypothesis for such action.

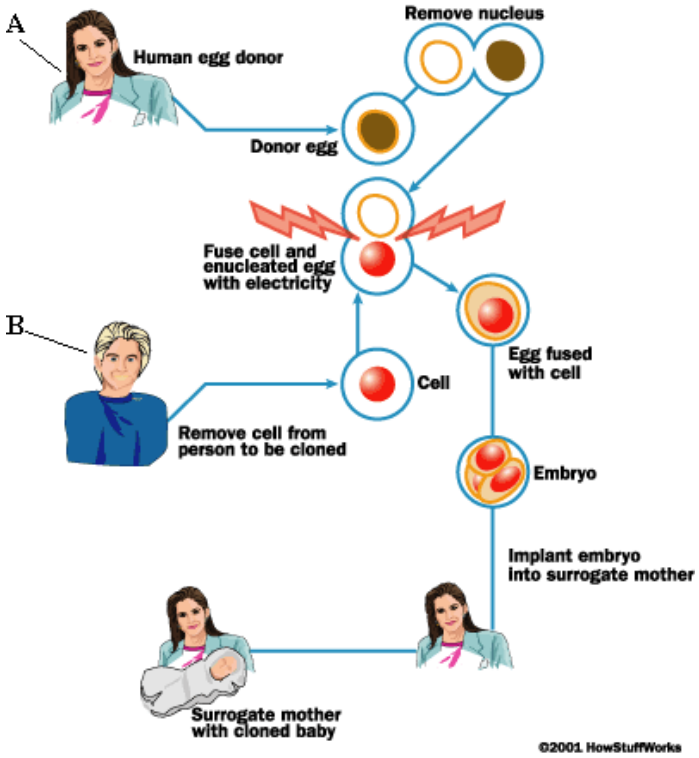
5- Amale drosophilae was born with Trisomy for 1 of its chromosomes.

a- Schematize the cell of the trisomic zygote.

b- Write the chromosomal formula of this drosophilae.

Sheet 2

I- Given the picture below:



1- Describe the procedure shown above.

2-Do you expect the child to be identical to person "A" or person "B"? Justify your answer.

II- A biologist is trying to figure out if there's any relationship between the ages of the mothers and having children with Down's syndrome. He obtained the table below.

Mother Age (years)	**20**	**25**	**28**	**32**	**36**	**40**	**45**
Down's Syndrome cases (%)	**0**	**0**	**1**	**3**	**10**	**12**	**14**

1- What is the biologist's hypothesis?

2- What are the two variables studied?

3- Which of the two variables is affecting the other?

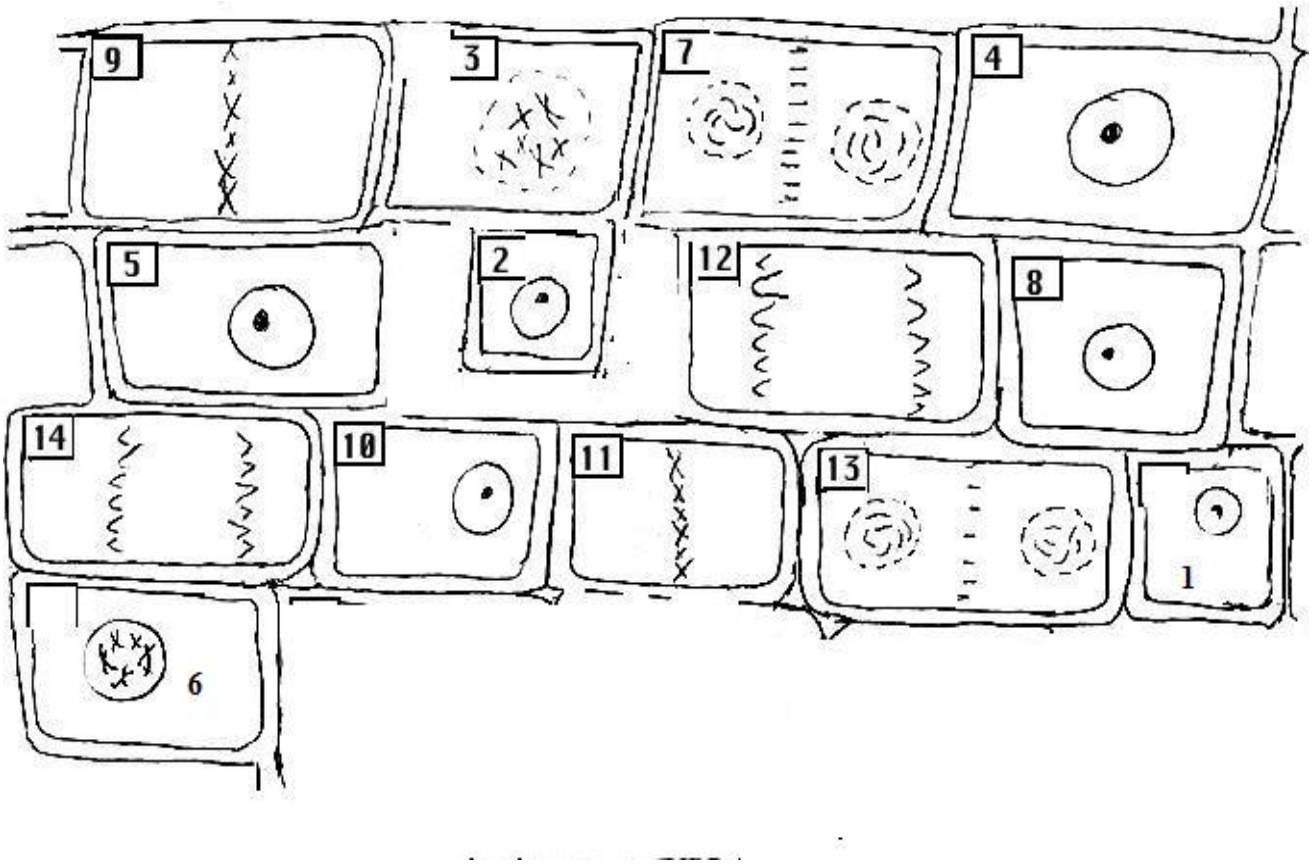
4- Give a title for the table shown above.

5- Plot the graph showing the variation studied.

6- Describe the graph. What can you deduce?

Sheet 3

Omar, a grade 11 student, was enjoying his free time in the Biology lab. He was looking at microscope slides showing a cell division. He then noticed that these slides were not labeled. He started nagging as usual! Although Omar is a good student who takes complete notes in class, he didn't get his copybook to the lab. He had difficulty in identifying these cells. He called for your help assuming you will give him the correct answers. Omar based his decision on the fact that you love Biology and believe it's interesting! Don't let him down by answering the following questions.



1- Is this a plant cell or an animal cell? Give 2 proofs.

2- Arrange the cells in chronological (time) order.

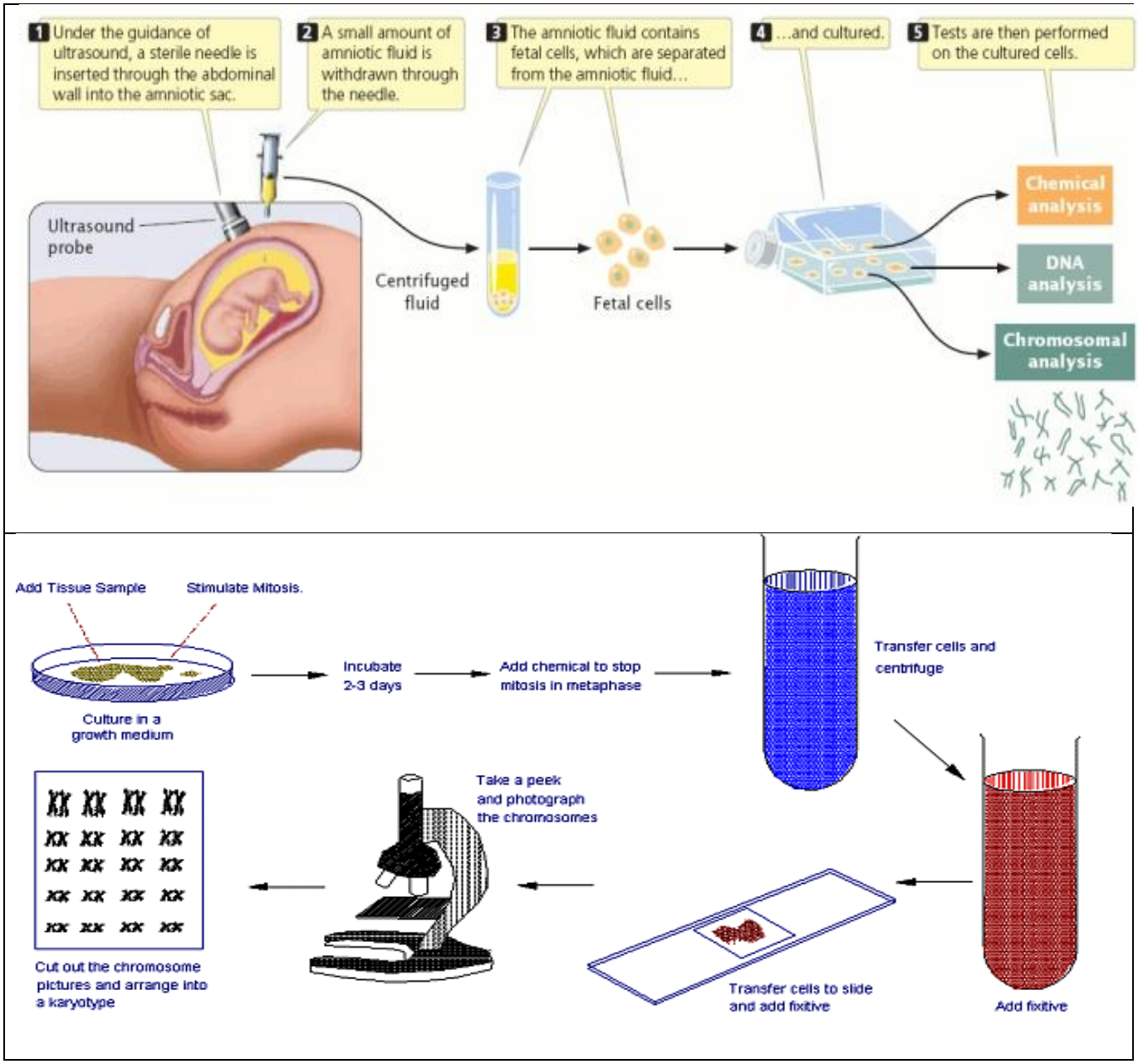
3- **State the number of the cell that shows each of the following: Prophase, Metaphase, Anaphase, Telophase, G1, and (S & G2 together).**

4- **What is the chromosomal formula of this cell?**

5- **What is the number of chromosomes in each of the 14 cells shown up?**

Sheet 4

Given the pictures below:

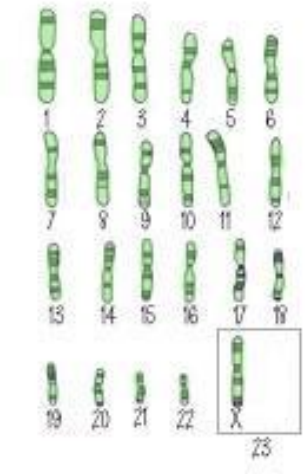


1- Name the procedure and describe its steps shown in the pictures above.

2- Name a chemical that is needed for this procedure. Why is it used?

3- Name a solution that is needed for this procedure. Why is it used?

The figure below shows the karyotype of an embryo being diagnosed:



4- Describe the karyotype above.

5- What is chromosomal formula of this embryo? Remember that "2n" means 2 copies of each chromosome!

6- What is the gender of this new born? Justify your answer.

7- The doctor who saw the karyotype screamed: "OH, MY GOD"! A tear drop was noticed on his right cheek☹! Why do you think he acted like this?!

8- Formulate a hypothesis for the reason behind such case.

9- What do you think will happen to the newborn? Why?

10- How did this procedure help us in this case?

Source:

German School Beirut Archive

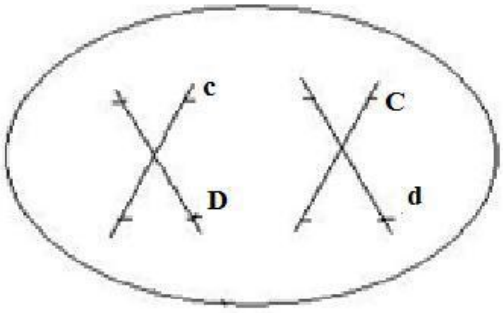
Done by the teacher: Mohammed Estaiteyeh

Biology Worksheet
Title: Meiosis

Grade: 11
Name: ……
Date: …….

Sheet 1

I- Draw all possible gametes that might result from the cell below:



II- A girl was diagnosed to have "Monosomy 12". We knew also that it's her father who caused the disease.

- **a- Write the chromosomal formula of this child.**
- **b- What does this disorder mean?**
- **c- Suggest a reason behind this disorder.**
- **d- Schematize what happened in both the father and the mother and lead to the birth of this girl with such disorder.**

Sheet 2

I- The horse has 60 chromosomes while the donkey possesses 66. The mule is the product of the crossing between a donkey and a mare (horse female).

- **a- What is the number of chromosomes in the donkey's sperm? Justify.**
- **b- What is the number of chromosomes in the mare's ovum? Justify.**
- **c- What is the number of chromosomes in each of the mule cells? Show your work.**
- **d- Do you think that mules are capable of reproduction? Why?**

II- Given a cell with 2n=6 chromosomes.

1- Schematize the detailed steps of Mitosis then Interphase, explaining the major events happening in this cell.

2- Schematize the detailed steps of Meiosis, explaining the major events happening.

3- Label the chromosomal content (i.e. how many chromosomes and chromatids per each chromosome) in each cell resulting at the end of each Mitosis, Interphase, Meiosis 1, and Meiosis 2.

III- The table below presents the variation of the quantity of DNA in this cell as function of time:

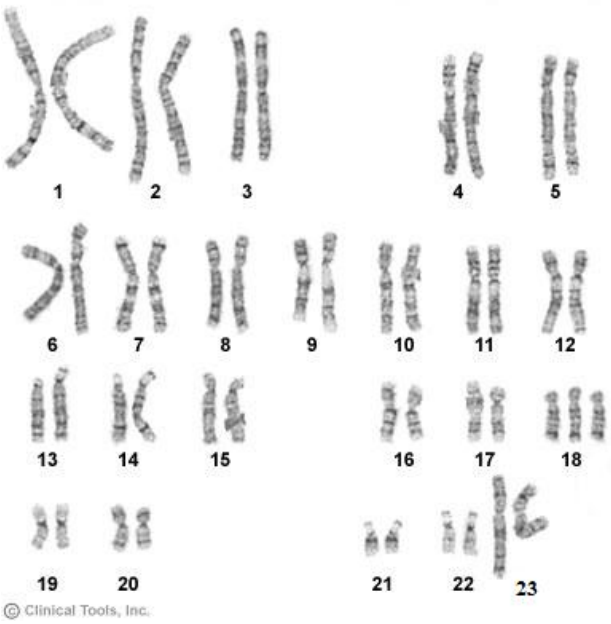
Time (days)	**0**	**4**	**6**	**10**	**10.5**	**13.5**	**15**	**19**	**19.5**	**21**	**23**	**24**	**25**
DNA (abu)	**7**	**7**	**14**	**14**	**7**	**7**	**14**	**14**	**7**	**7**	**3.5**	**3.5**	**3.5**

1- Construct the graph showing the variation shown above.

2- Divide the graph you plotted into sections and label these sections on the graph. You should use the following terms for labeling: Anaphase 2, Telophase 1, Reductional Division, Interphase, Equational Division, Anaphase 1, Telophase 2, Prophase & Metaphase 1, Prophase & Metaphase 2, Mitosis, Meiosis 1, Meiosis 2, and Meiosis.

Sheet 3

The figure below shows the karyotype of a human being.



1- Define karyotyping.
2- Give 2 aims behind this procedure?
3- Describe the figure of this karyotype.
4- What can you deduce about the gender of the person in this figure? How did you know this?

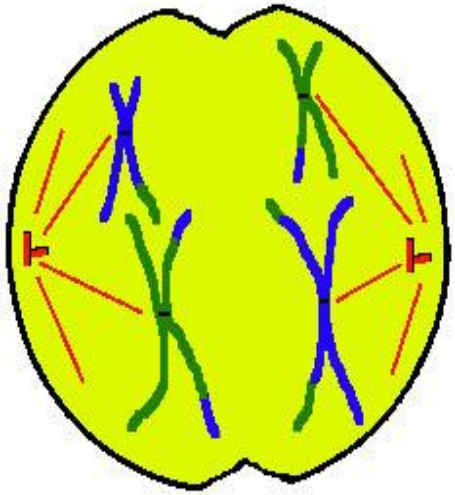
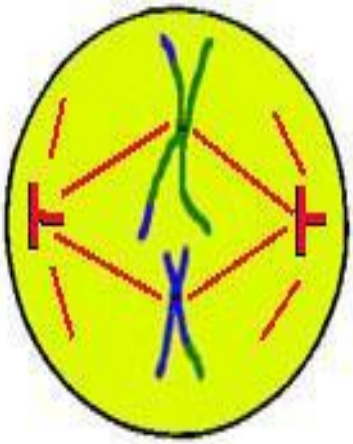
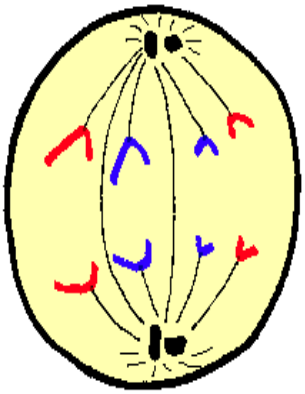
The doctor who analyzed the karyotype said that this person is suffering from "Edwards Syndrome".
5- After you analyzed the karyotype, what is this disease about?
6- Give another name for this disease.

7- The steps below were done to make this karyotyping.
Give the rationale behind the following steps:
a- adding colchicine:
b- putting the cell in a hypotonic medium

8- Explain this disorder by linking it to Meiosis.

Sheet 4

The figures below present cells during cell division. Only two pairs of chromosomes are shown.

A	B	C
		

1- Indicate the phase of division in each drawing. Justify your answer by explaining what happens in these phases.

The table below presents the quantity of DNA in this cell as function of time:

Time (days)	**0**	**4**	**6**	**10**	**10.5**	**13.5**	**15**	**19**	**19.5**	**21**	**23**	**24**	**25**
DNA (abu)	**7**	**7**	**14**	**14**	**7**	**7**	**14**	**14**	**7**	**7**	**3.5**	**3.5**	**3.5**

2- Construct the graph showing the variation shown above.

3- Analyze the plotted graph.

4- Divide the graph you plotted into sections and label these sections on the graph. You should use the following terms for labeling: Interphase, G1, Anaphase 2, Telophase 1, S, Reductional Division, G2, Equational Division, Anaphase 1, Telophase 2, Prophase & Metaphase 1, and Prophase & Metaphase 2.

5- Deduce the chronological order of A, B, and C. Justify your answer.

6- Draw the cell on days 6, 18, and 22.

7- Another person was taken, and the same analysis was performed. Yet, the mass of one of his cell's DNA on day 23 was 4.5 abu.

a- Formulate a hypothesis to explain the results.

b- Explain the origin (the cause) of such result.

Sheet 5

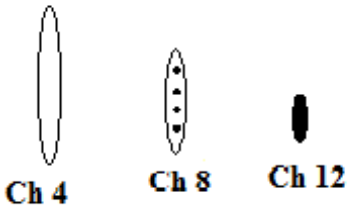
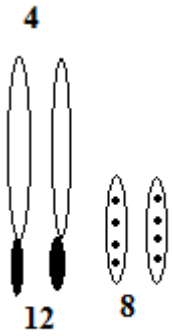
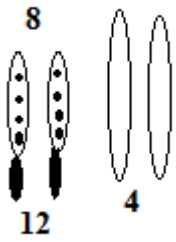
A) We propose to study certain particularities of sexual reproduction in mice. We measure the quantity of DNA present in different cells. The results are indicated in the table below:

Cells of the mouse	Liver	Pancreas	Spermatogonium (sperm mother cell)	Sperm Cell
DNA Quantity (pg)	6.199	6.2	6.2	3.1

a- Compare the obtained results.

b- Name the biological phenomenon that caused the observed difference.

B) Two mice A and B have two pairs of attached chromosomes as shown below:

Legend	Mouse A	Mouse B
		

c- How come A and B have normal phenotypes (appearance)?

d- Draw the gamete produced by A?

e- Draw the gamete produced by B?

f- Upon crossing A with B, we obtain a hybrid AB having a normal phenotype. Draw the cell of AB taking only these 3 chromosomes into consideration.
g- Draw all possible gametes of AB. Indicate the normal one.

Source:

German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

Biology Worksheet
Title: Pedigree
Grade: 11
Name: ……
Date: …….

I- Define the following:

1- Genes:

2- Gel Electrophoresis:

3- Restriction Enzymes:

4- Pathological Traits:

5- Autosomal Diseases:

II-Karim has his chromosomes 1 and 2 attached together, and chromosomes 3 and 4 also attached together. Samar, his wife, has her chromosomes 1 and 3 attached together, and chromosomes 2 and 4 also attached together.

1- Designate a shape for each chromosome.

2- Draw one of Karim's cells. Take only these 4 chromosomes into consideration.

3- Draw one of Samar's cells. Take only these 4 chromosomes into consideration.

4- AreKarim and Samar normal individuals? Justify your answer.

5- Draw the gametes that are produced by each Karim and Samar.

6- Tarek is their son. Draw one of his cells.

7- Draw Tarek's possible gametes.

8- Tarek married a normal girl with unattached chromosomes. He got 3 children.

Illustrate what's happening in each of the following cases:

a- His son Samir has Trisomy 2.

b- His daughter Amal has Monosomy 2.

c- His son Kamal is normal.

III- We cross couple of drosophilae of black eyes and long wings with others of red eyes and short wings. In F1, we obtain the drosophilae having black eyes and short wings.

1- Without performing the factorial analysis, what are the results of F1xF1 if the genes are independent? Justify your answer.

2- Perform the factorial analysis of F1xF1 if the genes are linked with distance=10 CM.

IV-

1- Define Pedigrees.

2- Why are they important?

3- Construct a pedigree showing the transmission of a recessive autosomal disease.

4- Prove that this disease is recessive.

5- Prove that this disease is autosomal.

If the disease occurs in a frequency of 1/10000, and the risk of having a heterozygote individual in Lebanon is 1/30 and that of Germany is 1/50.

In the following questions, assume that all individuals are normal unless the contrary is stated.

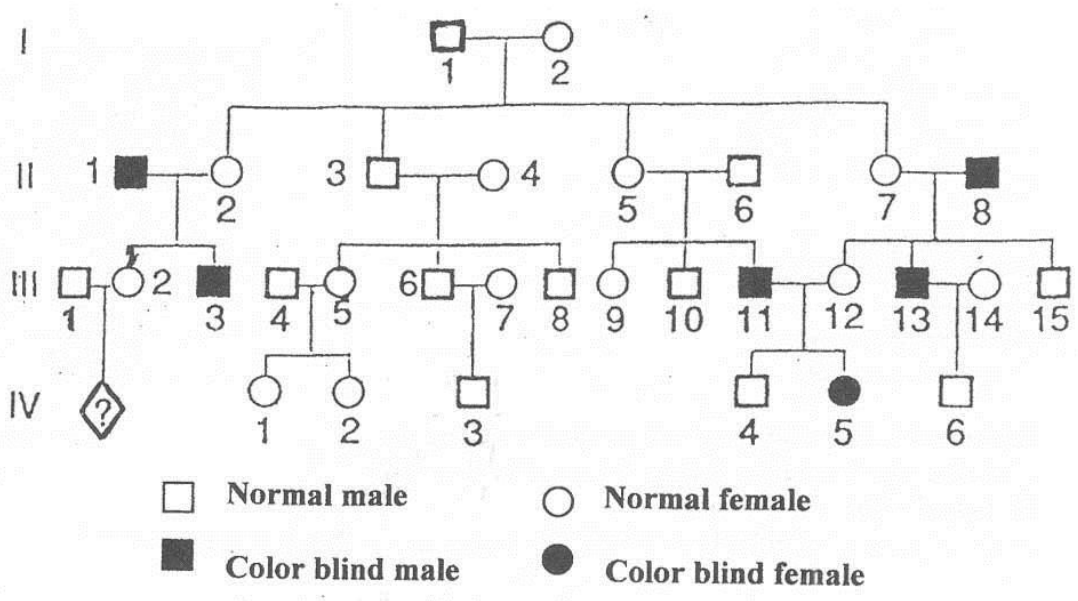
6- Calculate the risk of having a diseased child from: (show your work)

a- a Lebanese man married to a German woman and already had a diseased child.

b- a Lebanese couple with no family history.

c- a Lebanese man who has a diseased sister, married to a German woman with no family history.

V- Given the pedigree below:



Color blindness (Daltonism) is a defect in vision of colors. This defect is due to a gene localized on the non-homologous segment of chromosome X. The Document above represents the pedigree of a family, whose certain members are affected.

a- Is the allele responsible for color blindness dominant or recessive? Justify the answer.

b- Write the genotypes of the individual (III-2), her parents, and her husband. Justify the answer for each genotype.

c- Individual (III-2) is expecting a child and is worried if her child will be color blinded.

Make a table of the cross to find the probability of the child to be color blinded.

d- Make the necessary analysis to determine the possible proportions of the descendants of

IV 5 in each of the following cases:

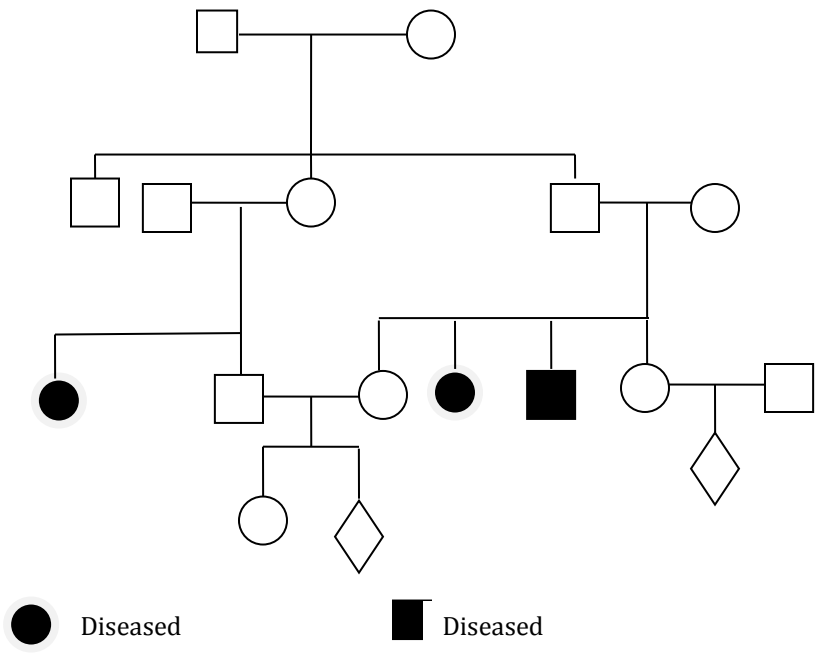
1- If her husband is not affected by Daltonism.

2- If her husband is affected.

VI- "Phenyl-Ketoneria" is a metabolic disease of genetic origin that affects 1/10000 children at birth. It is characterized by the accumulation, in the blood, of the phenyl pyruvate. This product is harmful for the neurons during the first 10 years of life. Normally, the phenylalanine (food amino acid) is metabolized by PAH enzyme into tyrosine in the presence of a cofactor. The most frequent reason for the disease is the absence of

PAH activity. In this case, the excess phenylalanine will be transformed into phenyl pyruvate. Statistics done on an isolated community identified 1 heterozygous out of 40 tested individuals.

The pedigree below shows the transmission of this disease in a certain family.



1- What is the major cause for this disease?

2- Label the pedigree by giving numbers to generations & individuals (1-17).

3- What is the mode of transmittance of this disease? Justify your answer.

4- Logically, discuss the localization of this gene.

5- By justifying your answer, calculate the risk of having:

a- a diseased child from a couple taken at random from this community.

b- a diseased child from a normal couple already having a diseased child.

6- By factorial analysis, explain the appearance of a child 8 from her parents.

7- On the pedigree above, give the possible genotypes of all individuals.

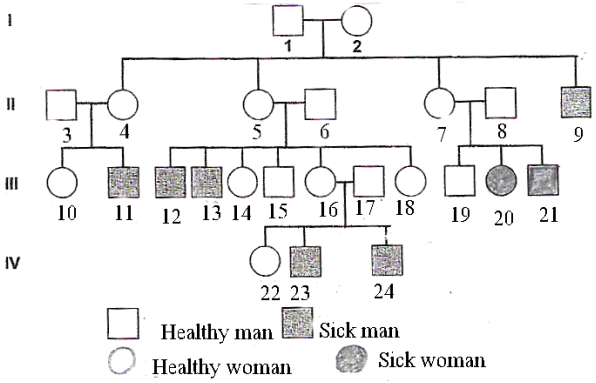
8- The family is expecting 2 newborns. What is the risk of having each as a diseased individual? Show your work in each case.

9- Individual 8 was in love with a man having Phenyl-Ketoneria, and wanted to marry him. Her family totally refused this marriage. When asked why, they stated that he has the same disease she has… However, those two married, and surprisingly they got a normal child!

a- Why do you think we said "surprisingly"?

b- Give a hypothesis that can explain this result.

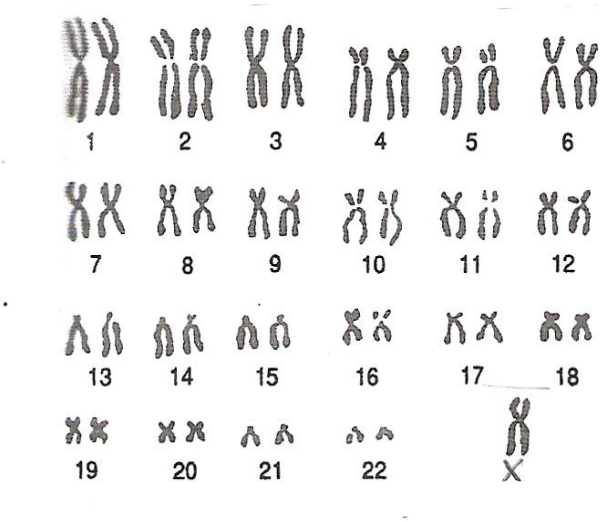
VII- Document 1 represents the pedigree of a family with some of its members, shown in black, having a rare hereditary disease that occurs mainly in males and very rarely in females.



Document 1: Pedigree of the transmission of the disease

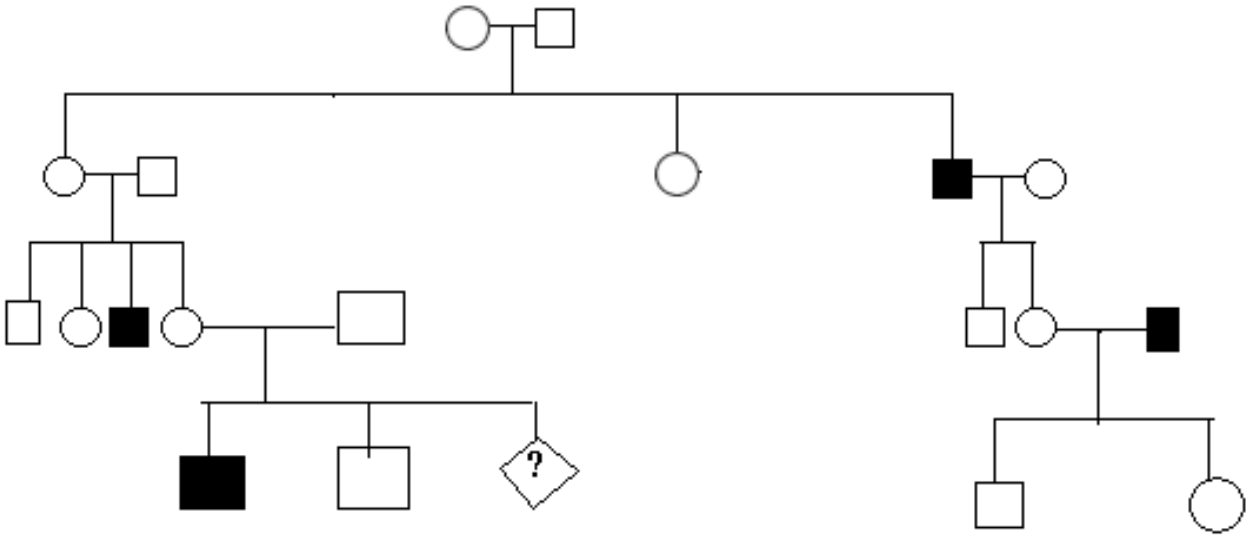
a- Is the allele responsible for the disease dominant or recessive? Justify the answer.
b- Discuss logically the chromosomal localization of the gene responsible for this disease (without considering female 20).
c- Illustrate, chromosomally, the genotype of each of the individuals 13 and 16. Justify the answer.

Female 20 presents, besides her disease, an abnormality, which is manifested by the absence of menstruation, absence of the development of mammary glands…
To identify this abnormality we perform the karyotype of female 20: Results are shown in the below document.



d- Write the chromosomal formula of this female. Give the name of the abnormality revealed by the karyotype.
e- Based on the karyotype, how can you explain the appearance of the disease in female 20?
f- Knowing that this chromosomal abnormality results from an error in meiosis during spermatogenesis, schematize the chromosomal behavior of the concerned chromosomes only (consider one case only).

VIII- Hemophilia B is a rare hereditary disease characterized by deficiency in blood coagulation. This disease occurs mainly in males, and very rarely in females. The pedigree below shows some members with this disease.



1- Determine if the allele responsible for the disease is dominant or recessive. Justify your answer.

2- By logical reasoning, and by making use of the given information, locate precisely the gene coding for hemophilia.

The table below represents the number of alleles of this gene in certain members of this family.

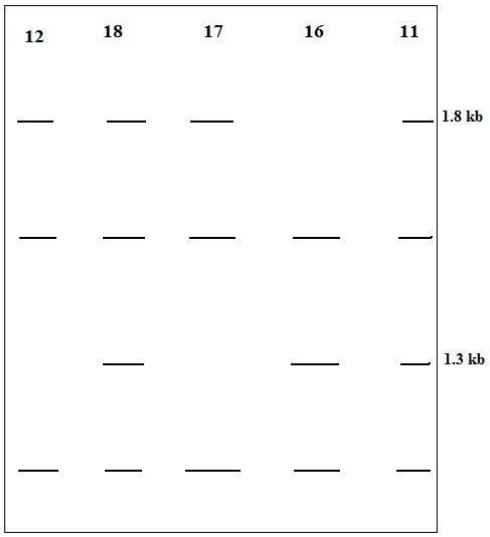
Number of alleles responsible for the non-hemophilic character						
Number of alleles responsible for Hemophilia B						

3- Do the results verify the answer of question 2? Why?

4- Relate the results a, b, c, d, e, and f with individuals 3, 4, 8, 9, 10, and 11 giving precisely their genotypes.

5- Perform the factorial analysis to calculate the risk of having a diseased child (# 18).

To know the exact genotype of this fetus, genetic counseling was performed. The alleles carried by the chromosome were visualized by a certain method, and the following picture was obtained:



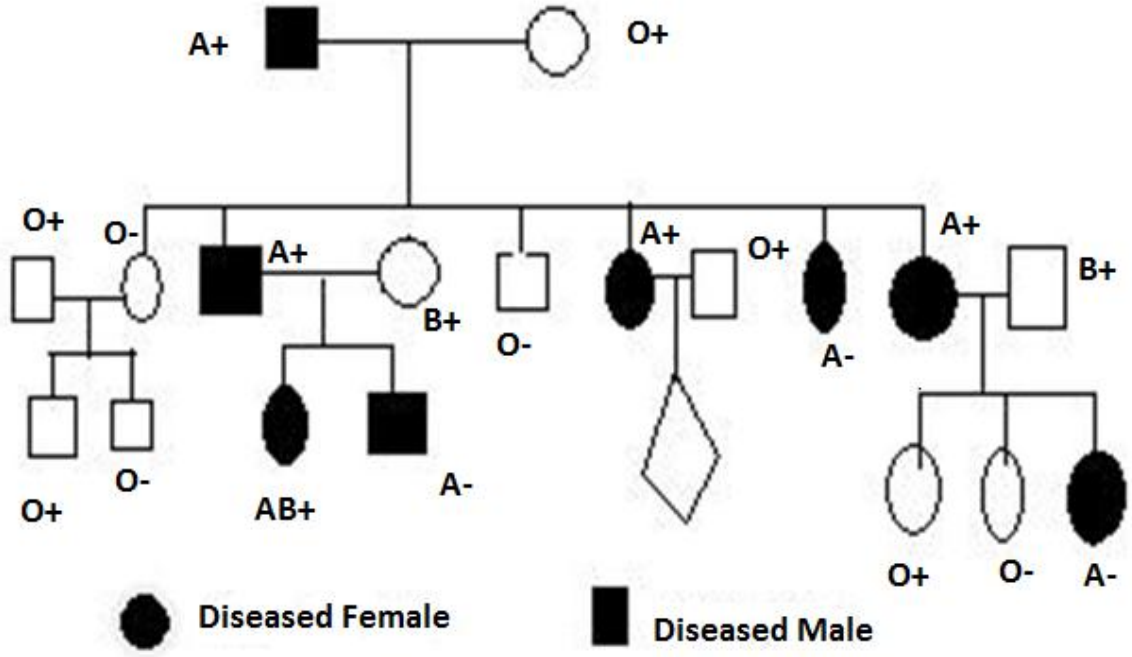
6- What is the name of the method?

7- By analyzing the results above:

a- Circle the allele that is responsible for the disease. Explain your answer.

b- What are both the genotype and the phenotype of this fetus?

IX- Blood groups of ABO system are determined by a gene located on chromosome 9. Those of Rhesus system (+/-) are located in chromosome 1.
Onychoarthrose is a very rare genetic disease that manifests itself by the absence of nails. The following pedigree is for a family who has some affected members.



1- Determine if each of the 3 alleles is dominant or recessive. Justify.

2- Specify the localization of the gene of Onychoarthrose.

3- Is there any relationship between any of the 2 genes? Which genes? And what is this relationship? Justify.

4- By factorial analysis, what are the possible phenotypes of the fetus III-5 taking only the 2 related genes?

5- III-5, the fetus, is affected by the disease. His group is (O -) how can you explain such result?

6- Perform the factorial analysis to justify the birth of III-5. Take the 3 genes into consideration.

Source:
German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

Biology Worksheet
Title: Summary - Concept Map
Grade: 11
Name: ……
Date: …….

Construct a concept map summarizing all the lessons you took till now. As a reminder, your concept map should include information about: Cell Organelles, Microscopes, Transport across the Cell Membrane, Cell Cycle, Karyotyping, Meiosis, Chromosomal Abnormalities, DNA and its processes, and Biotechnology processes.

Notes:
- These are the major concepts i.e. the titles of the lessons. Your concept map should include the details of these concepts.
- Don't forget to put the relationships on the arrows connecting the concepts.

For example:
When you connect the microscope to the cell, you should state on the arrow: "viewed by". Now, the whole sentence can be read like this: Cells are viewed by microscopes.

Grading:
Total: 20 points
Details:
0.25 point will be given for every term in the concept map. A minimum of 50 terms should be included.
5 points will be given for the relationships stated on the arrows.

Source:
German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

Genetics Online Exercises; in-class and home practice:

1- http://highered.mcgraw-hill.com/sites/0078617340/student_view0/chapter5/math_practice.html
2- http://biology.clc.uc.edu/courses/bio105/geneprob.htm
3- http://www.ksu.edu/biology/pob/genetics/intro.htm
4- http://www.zerobio.com/drag_gr11/pedigree/pedigree2.htm
5- Virtual crossing: http://www.mhhe.com/biosci/genbio/virtual_labs/BL_15/BL_15.html

Appendix C: Quizzes

Grade: 11 **Time:** 20 minutes **Subject:** Biology **Date:** **Biotechnology Quiz**	**Name:** ……

STUDENT GRADE	CLASS AVERAGE
_____ 20	

1- **Explain the steps of genetic engineering (transgenesis). You can take the example of tomatoes that produce insulin. (8)**
2- **Explain the steps of DNA fingerprinting. (8)**
3- **List one scientific threat and one ethical/religious problem that may be caused by genetic modification of plants and animals. (4)**

Source:

German School Beirut Archive

Done by the teacher: Mohammed Estaiteyeh

Grade: 11

Time: 15 minutes

Subject: Biology

Total Points: 20

Cell Division Quiz

STUDENT GRADE	CLASS AVERAGE

Name: ……...

1- **Explain 3 differences between Mitosis and Meiosis. (6)**
2- **Name 3 processes that happen causing more variety in the children of human beings. You should explain these processes in 2 sentences for each. (6)**
3- **Draw the results of Meiosis 1, Meiosis 2, and fertilization of a mother and a father leading to Trisomy 21 knowing that the mother caused it. Show chromosomes 21 and 23. (6)**
4- **Draw Anaphase II of Meiosis and Anaphase of Mitosis of a cell having 2n=4. (2)**

Source:

German School Beirut Archive

Done by the teacher: Mohammed Estaiteyeh

Grade: 11

Time: 20 minutes

Subject: Biology

Date:

Name: ……...

STUDENT GRADE	CLASS AVERAGE
____ 20	

Crossing-1 Quiz

We crossed male drosophilae having long antennae and black bodies with female drosophilae having short antennae and grey bodies. All drosophilae of F1 had long antennae and grey bodies.

A second cross between females F1 and males F1 gave the following results:

- 1117 drosophilae with long antennae and grey bodies,
- 373 drosophilae with long antennae and black bodies,
- 374 drosophilae with short antennae and grey bodies,
- And 125 drosophilae with short antennae and black bodies.

1- Indicate the genotypes of the parents and individuals obtained in F1. (1)

2- Calculate the proportions of the results. What can you conclude about the relative position of the 2 genes? (3)

3- Schematize the results (with percentages) of meiosis of a drosophilae from F1. (1)

4- Perform the factorial analysis to explain the results obtained from the second cross. (2)

5- What would be the results of all crosses done above if the considered genes are linked with distance=10 cM? Make the chromosomal factorial analysis. (3)

Source:

German School Beirut Archive

Done by the teacher: Mohammed Estaiteyeh

Grade: 11
Time: 20 minutes
Subject: Biology
Date:

Crossing-2 Quiz

Name: ……..…...

STUDENT GRADE	CLASS AVERAGE
20	

The cross between drosophilae of yellow body and long wings with others of green body and short wings gave drosophilae having green body and long wings only in F1.

The cross between F1 and drosophilae having yellow body and short wings gave the following results:

460 drosophilae having yellow body and long wings
460 drosophilae having green body and short wings
40 drosophilae having yellow body and short wings
40 drosophilae having green body and long wings

a- What can you conclude from the first cross? (2)

b- What is the relative position of the 2 genes? Justify your answer. (3)

c- i- What is the reason behind the results of the second cross? (2)

ii- Schematize what happened. (2)

d- Calculate the distance between the 2 genes. Show your work. (2)

e- Perform the factorial analysis of F1xF1. Use the chromosomal illustration. (3)

f- Without explaining, what will be the results of cross 2 if the genes were of a different relative position? (1)

Source:
German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

Grade: 11

Time: 30 minutes

Subject: Biology

Total Points: 20

DNA Quiz

STUDENT GRADE	CLASS AVERAGE

Name: ……...

1. **Explain 3 differences between DNA and RNA. (3)**
2. **Explain the function of: ligase, RNA polymerase, helicase, DNA Polymerase I and II. (5)**
3. **Name 2 types of RNA (full name), and explain their function. (4)**
4. **Explain the steps of the process of translation. (6)**
5. **What's meant by: (2)**
    - **a- Gene Expression.**
    - **b- Semi-conservative replication.**

Source:

German School Beirut Archive

Done by the teacher: Mohammed Estaiteyeh

Appendix D: Tests

Grade: 11
Time: 55 minutes
Subject: Biology
Date: ……..
Total Points: 40

Cell Division Test

Name: ……...

STUDENT GRADE	CLASS AVERAGE

Sheet 1 (……. / 17)

I. Complete each statement by circling the correct term or phrase in the brackets. (4)

1. The purpose of **meiosis** is to produce [diploid / haploid] [somatic / gamete] cells.
2. In the production of sex cells, the **cell divides** [once / twice].
3. The **pairing up and crossing over** of homologous chromosomes takes place in [interphase / prophase I].
4. In **metaphase I** of meiosis, chromosomes line up [in homologous pairs / single file].
5. Meiosis results in [two / four] daughter cells which are genetically [identical to / different from] the parent.
6. In **plant cells**, a new cell wall is formed by [vesicles / cell plates] holding cell wall materials.

II. In the space provided, write the name of the stage of the Meiosis that is being described. (5)

1. _____ The chromosomes divide, and the chromatids move to opposite poles of the cell.
2. _____ Takes place prior to meiosis I, DNA is duplicated.
3. _____ Nuclei reform in all four daughter cells. Chromosomes unwind back into chromatin.

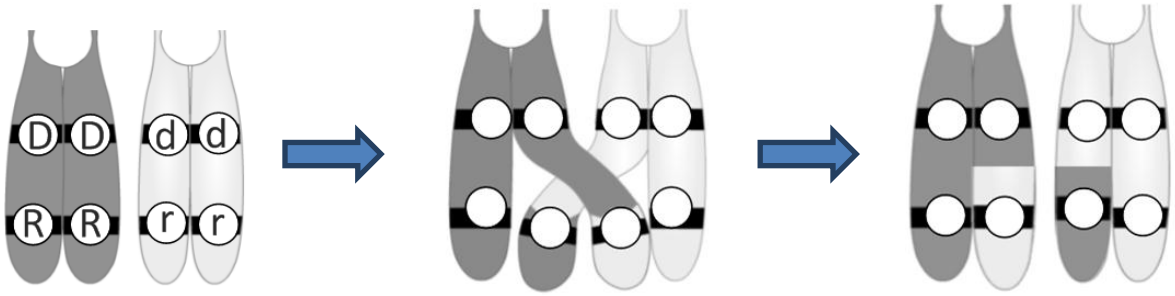
4. _____ The homologous chromosomes separate. Chromosomes are pulled to the poles.
5. _____ Chromosomes form. Homologous chromosomes pair up and crossing over occurs.
6. _____ Both nuclei disappear and chromosomes condense in each cell.
7. _____ Takes place following meiosis II. Results in four sperm or one mature egg cell.
8. _____ Chromosomes line up single file along the middle of each cell.
9. _____ Two nuclei reform. Results in two haploid daughter cells.
10. _____ Homologues attach to spindle fibers and align in the middle of the cell.

III. Answer the following questions: (8)

1. How are **metaphase I** and **metaphase II** of meiosis different from one another?
2. How are **anaphase I** and **anaphase II** of meiosis different from one another?
3. Describe **crossing over**. How does crossing over benefit an organism?
4. Compare *spermatogenesis* and *oogenesis*.

Sheet 2 (……. / 7)

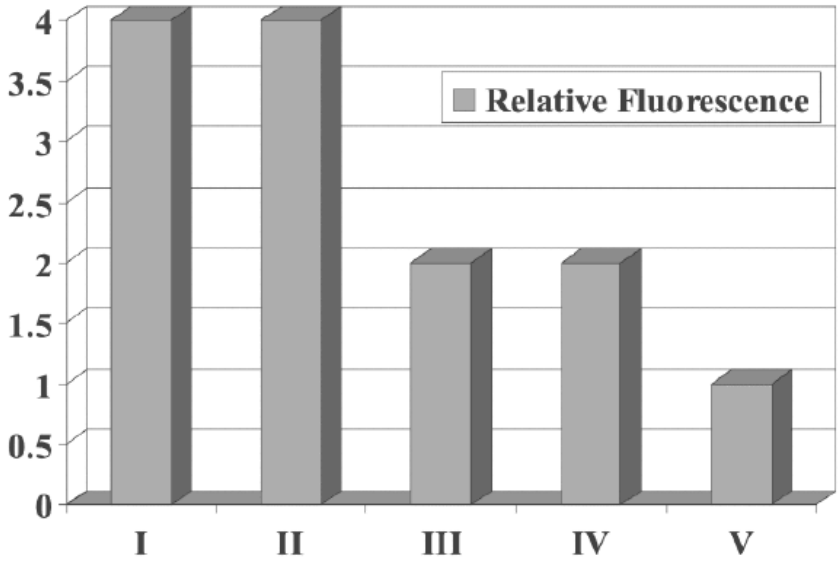
IV. Label the following diagram that shows crossing over. (2)



V. Draw the cells that result from meiosis 1 and meiosis 2 of each a father and a mother, and the cell resulting from fertilization knowing that the embryo has Monsomy 13. Show the chromosomes number 13 and 21 in the cells. (5)

Sheet 3 (……. / 9)

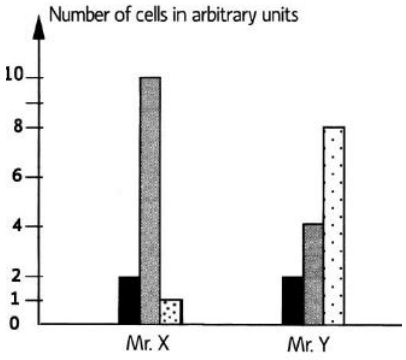
VI. The amount of DNA in a cell can be determined by measuring the fluorescence of a dye that binds in direct proportion to the amount of DNA. The histogram below represents the fluorescence of a eukaryotic germ cell during different stages of cell division (I, II, III, IV and V).



1. **Identify the names of the stage of the cell cycle related to each number (I, II, III, IV and V) and justify your answer for each stage. (5)**
   You should use the following terms: Telophase 1, Interphase G2, Prophase & Metaphase 2, Prophase & Metaphase 1, Telophase 2.
2. **Draw a cell having 2n= 4 (show the chromosomes) at the following stages II, then II, then V. (3)**
3. **Estimate the amount of relative fluorescence in a cell having a trisomy at stage V. Justify your answer. (1)**

Sheet 4 (……. / 7)

VII. We perform a quantitative study for the amount of DNA of the germ cells extracted from the testicles of a sterile man (Mr. X) and that of a fertile man Mr. Y. Three different populations (types) of germ cells are obtained. The numbers of each cell population, as well as the amount of DNA in each of them are shown below. Note that the amount of DNA in each cell is indicated by the symbol, and the number of the cells is indicated on the Y-axis.



Population 1; [DNA] = 2Q (arbitrary units)

Population 2 ; [DNA] = Q

Population 3; [DNA] = Q/2

1- What process causes the production of population 2 from population 1? And the production of population 3 from population 2? Justify the answer. (2)

2- Mr. Y is fertile (can get children). Explain the reason behind the variation of the number of the germ cells of the three populations in the fertile man Mr. Y. (2)

3- a- What is the reason of the sterility of Mr. X? (1)

b- How can you explain the number of cells of population 2 in Mr. X? (1)

4- Name the cells of population 3. (1)

Source:
German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

Grade: 11 **Time:** 55 minutes **Subject:** Biology **Total Points:** 30 **DNA Test**	**Name:** ……...

STUDENT GRADE	CLASS AVERAGE

Sheet 1 (……. /9)

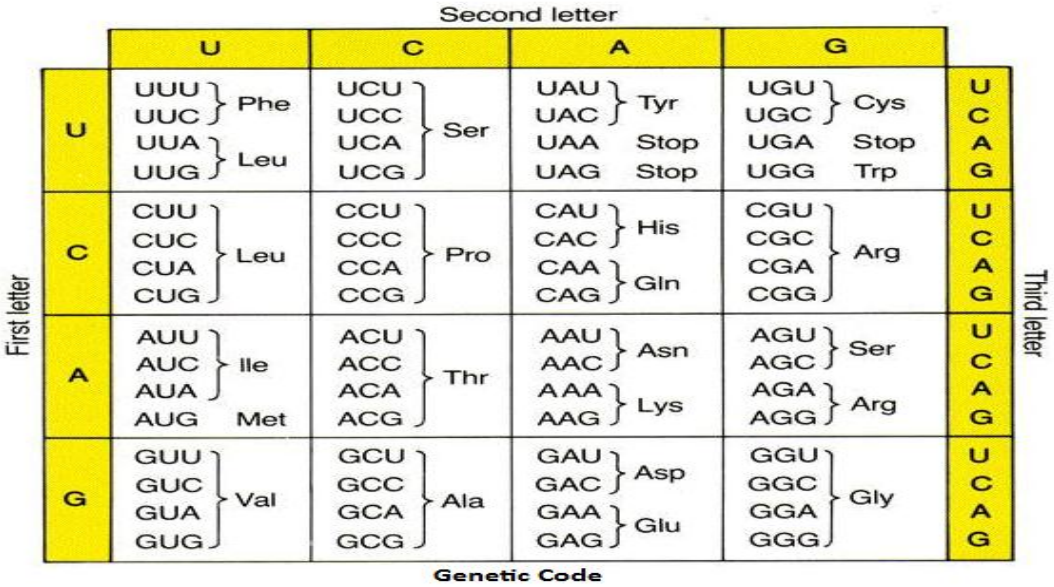
1- **Explain the process of translation. (5)**
2- **Define: (4)**
   - **a- semi-conservative**
   - **b- anti-parallel**
   - **c- nucleotides**
   - **d- Mutations**

Sheet 2 (……. /7)

The next shows the transcribed DNA sequence for hemoglobin:
TTA- CCG- TAC- CAC- GTG- AAA- CCC- CTA- GAC- CAC- CTA- GGA- ATA- GTG-ATT

1- **Give the sequence of mRNA that result from transcription of this DNA. (1)**
2- **Specify the sequence of amino acid in the produced protein. (1)**
3- **What is the total number of nucleotide possibilities for this protein? (2)**
4- **Suggest and explain how we can do: (3)**

a- A silent mutation to this gene.
b- A non-sense mutation to this gene.
c- A mis-sense mutation to this gene.



Genetic Code

Sheet 3 (……. /8)

In order to know the pathway of the synthesized RNA, some cells are cultured in vitro in the presence of specific RNA precursor (radioactive uracil) and are then studied by autoradiography. The results are shown below:

Time (seconds)		**0**	**60**	**120**	**240**	**320**	**400**
Level of radioactivity in the RNA synthesized (a.u.)	**In the nucleus**	**60**	**48**	**20**	**12**	**5**	**4**
	In the cytoplasm	**0**	**12**	**20**	**31**	**38**	**47**

1- **Plot the graph. (2)**
2- **Compare the results of the table. (2)**
3- **What can you conclude about the pathway of the RNA in the cell? Justify. (2)**
4- **If this gene is composed of 300 nucleotides:**
    a- **How many nucleotides will be in the mRNA? Explain. (1)**
    b- **How many amino acids are coded by this gene? Explain. (1)**

Sheet 4 (……. /6)

The red blood cells (erythrocytes) of human do not have a nucleus when they are found in the blood. They come from erythroblasts (nucleated cells of bone marrow).

The following table (Table 1) shows the amount of hemoglobin (protein synthesized by red blood cells) responsible for transporting oxygen.

	Erythroblasts	**Erythrocyte**
Quantity of DNA	++	-
Synthesis of hemoglobin per day per cell (10^{-12})	0.5	0

Caption: (+) present (-) absence

1- **Interpret the result of the table. (2)**

We extract a group of erythroblasts and incubate them in presence of radioactive uracil, and then we detect the degree of radioactivity after certain interval of time. The results are tabulated below (Table 2):

Type of cell	**Erythroblast**	**Erythrocyte**
% of radioactivity	50	0

2- How do the results of Table 2 justify the results of table 1? Explain. (2)

3- Based your acquired knowledge, what are the processes happening and not happening in each of the erythroblasts and erythrocytes? (2)

Source:
German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh

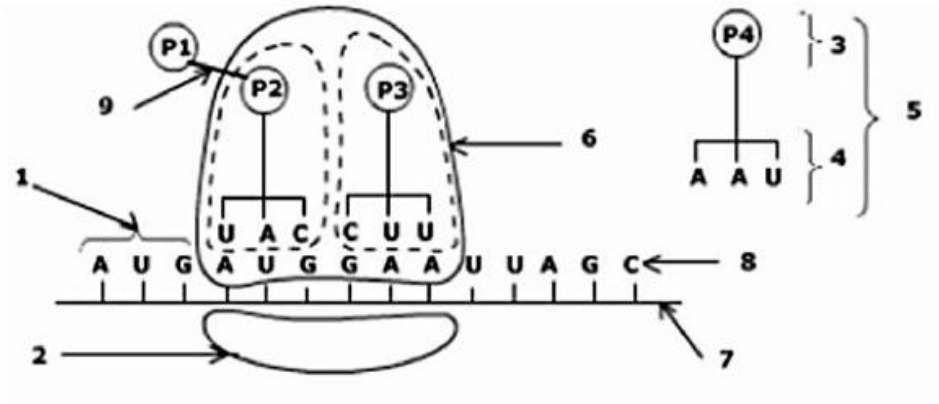
Grade: 11 **Time:** 90 minutes **Subject:** Biology **Date:** **Genetics Summative Test**	**Name:** …….…...

STUDENT GRADE	CLASS AVERAGE
_____	

Sheet 1 (…../18)

1- List 3 enzymes needed for DNA replication stating their function. (3)

2- Given the picture below:



a- Label the strcutures (from 1 to 9). (4.5)

b- What do we call this process? (0.5)

c- What do we call this step? Justify. (1)

3- Starting with a cell having 2n=4,

a- Draw the result of:

- Mitosis then interphase. (1)

- Meiosis 1 then Meiosis 2. (1)

b- Write the chromosomal formula of the cells obtained in part a. (2)

4- a- Draw the results of Meiosis 1, Meiosis 2, and fertilization of a male and a female cells giving birth to a boy having trisomy 21. Your figures should include chromosomes 21 and 23. Note that the female is the one who caused the trisomy. (4)

b- What do we call what happened causing Trisomy? (1)

Sheet 2 (…../15)

Retinitis pigmentosa, a hereditary disease, is the main cause of visual impairment (30% of visual deficiencies). The disease starts by affecting night vision and reducing the visual field. It is caused by progressive degeneration of rod cells, which are photoreceptor cells of the retina containing the protein rhodopsin. To understand the origin of this disease, we study the structure of proteins encoded by different alleles of the rhodopsin gene.

The rhodopsin gene consisting of 1044 pairs of nucleotides encodes a protein of 348 amino acids.

Document 1 below represents a portion of the transcribed (template) nucleotide sequences (from triplet 131 to 136) of the alleles of the rhodopsin gene in individuals with normal phenotype and individuals with retinitis pigmentosa.

Individual's Phenotype	**Portion of the nucleotides sequence of the allele**
Normal (AlleleA1)	131 ↓ … GAC CGG TAG CTC GCC ATG…
Affected with retinitis pigmentosa (Allele A2)	131 ↓ … GAC CGG TAG CTC GAA ATG…

1- **Pick out from the text the cause of retinitis pigmentosa. (1)**
2- **Can we detect retinitis pigmentosa using karyotyping? Why? (1)**
3- **Determine the mRNA sequence of the normal allele and the retinitis pigmentosa allele. (1)**
4- **Using the genetic code table, determine the amino acid sequence of the portion of each of the rhodopsin protein coded by the alleleA1 and by the allele A2. (1)**

Second letter

First letter	U	C	A	G	Third letter
U	UUU, UUC: Phe UUA, UUG: Leu	UCU, UCC, UCA, UCG: Ser	UAU, UAC: Tyr UAA: Stop UAG: Stop	UGU, UGC: Cys UGA: Stop UGG: Trp	U C A G
C	CUU, CUC, CUA, CUG: Leu	CCU, CCC, CCA, CCG: Pro	CAU, CAC: His CAA, CAG: Gln	CGU, CGC, CGA, CGG: Arg	U C A G
A	AUU, AUC, AUA: Ile AUG: Met	ACU, ACC, ACA, ACG: Thr	AAU, AAC: Asn AAA, AAG: Lys	AGU, AGC: Ser AGA, AGG: Arg	U C A G
G	GUU, GUC, GUA, GUG: Val	GCU, GCC, GCA, GCG: Ala	GAU, GAC: Asp GAA, GAG: Glu	GGU, GGC, GGA, GGG: Gly	U C A G

5- **Compare the two nucleotides sequences and the two amino acids sequences presented in document 1. (1)**
6- **Draw out the origin of this disease. Give its specific name. (2)**
7- **Explain how the modifications in the nucleotides sequence of the allele (doc.1) lead to the appearance of the previously mentioned symptoms of retinitis pigmentosa. (1)**

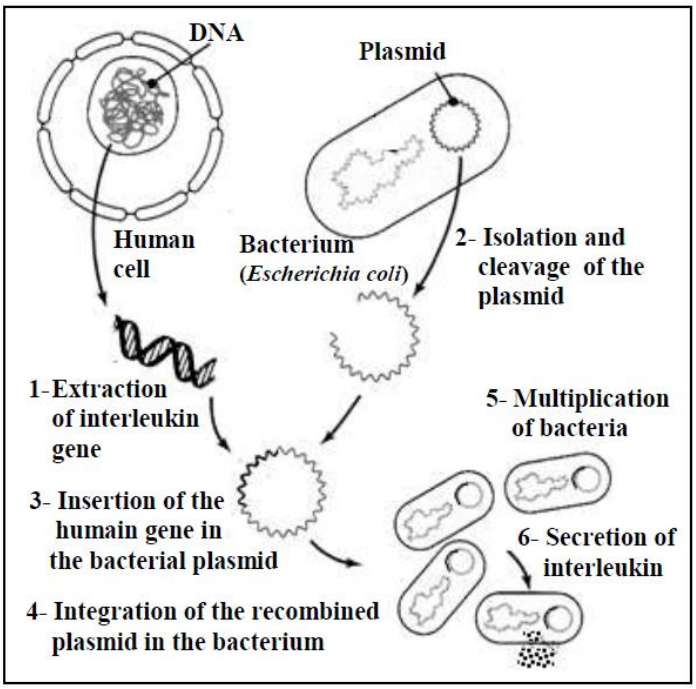
We can separate, by electrophoresis, the rhodopsin protein coded by the allele A1 and rhodopsin protein coded by allele A2. Electrophoresis is performed for three different individuals: A, B and C. Individual A is healthy, and individuals B and C are affected by retinitis pigmentosa. The results are presented in document 2 below:

	Reference electrophoresis	Individual A	Individual B (Affected)	Individual C (Affected)
Rhodopsin protein (coded by allele A1) Rhodopsin protein (coded by allele A2)				

8- **a- Knowing that we are putting the DNA samples on top, and they are migrating downwards. Which allele is heavier? Justify. (1)**
b- Why does the answer in part 8-a contradict with the answer of question 6? Explain. (1)
9- **From the given in Document 2, determine the dominant allele and the recessive one. Justify the answer. (1)**
10- **How many nucleotide sequences are possible for the peptide sequence of the normal allele? Show your work. (2)**
11- **Suggest a non-sense mutation for this allele. Justify. (1)**
12- **Draw one of the tRNA molecules that were used in the process of producing rhodopsin protein from rhodopsin gene. (1)**

Sheet 3 (…../15)

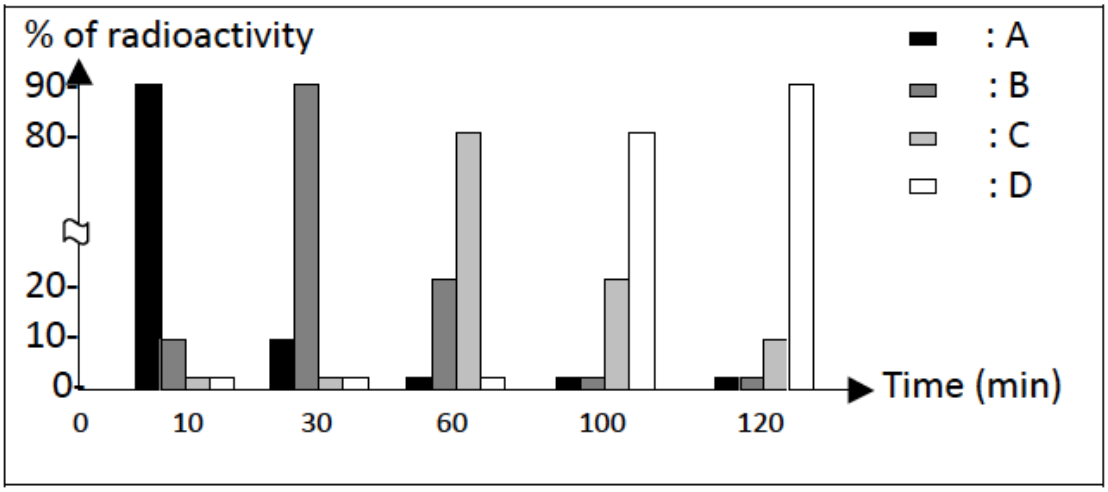
Interleukin is a human molecule necessary for the stimulation of cells that destroy cancer cells. We seek to obtain large quantities of this molecule by synthesizing it using bacteria (Escherichia coli). The steps of this biotechnology method are presented in the document below.



1- **a- Write a short text describing the different steps of this technique. (2)**
   b- State its advantage. (1)
2- **Pick out from the document the donor and the recipient of the transferred gene. (1)**
3- **Name the enzymes used in steps 1 and 3. (2)**
4- **Explain why the manipulated bacterium is qualified as transgenic. (1)**
5- **Draw out the medical application of this biotechnology method. (1)**
6- **Does this experiment confirm that DNA is «the universal carrier of genetic information»? Justify this statement. (2)**
7- **State the role of the plasmid. (1)**
8- **Assuming that we can know if a baby can have cancer before his birth, how can we use this transgenesis process in a different way than the one shown in the figure above, and make this baby produce this protein by himself? Justify. (2)**
9- **If we are injecting genes in humans bodies, state:**
   a- One scientific threat of the process. (1)
   b- One ethical concern about this process. (1)

Sheet 4 (…../12)

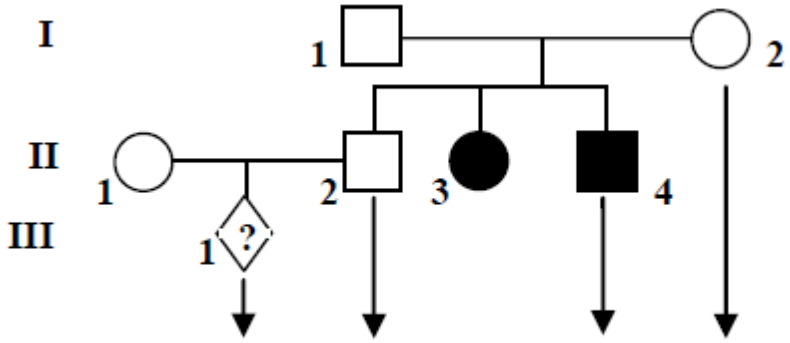
In order to study the fate of a synthesized protein, we culture β cells of Langerhans (specialized cells in the pancreas) in the presence of radioactive amino acid such as leucine for 5 minutes. Then the cells are transferred and cultured in absence of any radioactive amino acid, after which we detect for radioactivity in 3 cellular regions and in the culture medium (outside the cell) as indicated in the following documents.



1- **Construct a table showing the variations shown above (only for A and D). (2)**
2- **Compare the variation of % of radioactivity in regions A & B at 10 and 30 min. (2)**
3- **What can you conclude about the pathway of the proteins in this experiment? Justify your answer. (2)**
4- **Give with justification the names of the regions indicated by A, B, C & D, knowing that 3 of them are cellular organelles, and one of them is the culture medium (outside the cell). (4)**
5- **Functional proteins leave the cells to do a certain function outside, while structural proteins stay inside the cell. What is the type of this protein studied in the experiment above? What would it be? Justify. (2)**

Sheet 5 (…../7)

The pedigree below shows the transmission of Albinism disease. The black color indicates the presence of the disease.



1- **Explain the mode of transmission of the disease. (1)**
2- **Explain the localization of the gene. (3)**
3- **Indicate the symbols of the alleles. (1)**
4- **Indicate the genotypes of all individuals of generations I and II in this pedigree. (2)**

Sheet 6 (…../12)

The crossing between two pure races of rabbits: one of deformed paws and smooth hair, the other of normal paws and rough hair, gives in F1 descendants of normal paws and smooth hair.

1- What conclusions can we draw out from this crossing? (1.5)
2- Designate by symbols the corresponding alleles. (0.5)

Male rabbit of rough hair and deformed paws is crossed with a female of F1 results in:
8 rabbits of smooth hair and normal paws
72 rabbits of smooth hair and deformed paws
72 rabbits of rough hair and normal paws
8 rabbits of rough hair and deformed paws.

3- What do we call this type of crossing? (1)
4- What is the relative position of the 2 genes? Justify. (3)
5- **How do you explain such results? (1)**
6- **Calculate the percentage of each phenotype obtained in cross 2. (1)**
7- **Calculate the distance between the genes. (1)**
8- **Make the necessary chromosomic factorial analysis to verify the above experimental results. (2)**

9- What will the results be if individuals of F1 were crossed among each other, if the genes are of different relative positions than the one indicated in question 4. Don't show your work. (1)

Source:
German School Beirut Archive
Done by the teacher: Mohammed Estaiteyeh