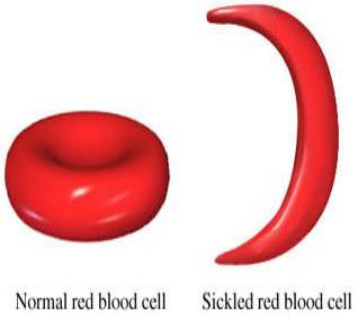
Biology
Grade:9

First Question: (5 points)

Sickle Cell Anemia

Sickle cell anemia is a blood disease due to the presence of defective hemoglobin. Like normal hemoglobin, the defective hemoglobin transports O_2, but once O_2 is liberated at the level of tissues, the defective hemoglobin becomes insoluble and precipitates in the red blood cell changing their shape and destroying them progressively. Thus the affected individuals have a decreased number of red blood cells, and a hemoglobin deficiency. Sickled red blood cell has a crescent shape, rigid with a life span of nearly 43 days. The deformed shape makes it hard for the sickle cells to pass through narrow blood capillaries and sometimes may obstruct them. Normal red blood cells possess an oval disk shape that allows them to circulate in very tiny blood vessels. Their life span is nearly 120 days.



1- By referring to the text, answer the following:
   a- Pick out the cause of sickle cell anemia.
   b- Construct a table of comparison between normal red blood cells and crescent red blood cells concerning their aspect, life span, and circulation in blood capillaries.
2- Write the equation of the reaction between hemoglobin and oxygen that takes place at the level of tissues.
3- What is the color of blood when this reaction ends?
4- Give the role of normal hemoglobin during the gaseous exchange.
5- Explain the effect of this disease on the transport and exchange of oxygen gas.

Second Question: (6.5 points)

The Rhesus Factor

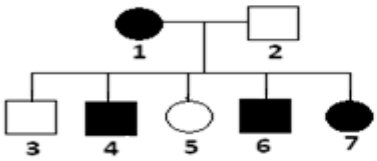
The blood groups of the ABO system are either positive or negative based on the presence or absence of a protein factor called Rhesus. The gene coding for the Rhesus factor is located on chromosome 1, and its hereditary transmission obeys Mendel laws. The Rhesus gene is presented in two versions, a positive dominant allele, and a negative recessive allele.

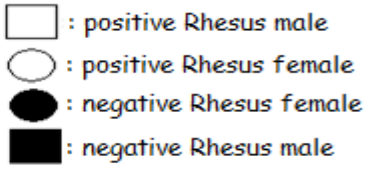
1- Indicate whether the hereditary transmission of Rhesus is autosomal or gonosomal. Justify your answer.
2- Designate by symbols the corresponding Rhesus alleles.

A female of negative Rhesus was married to a male of positive Rhesus and gave birth to five kids.

3- Give the possible genotype of the mother and those of the father.

The genealogical tree (pedigree) of this couple is represented by the figure below.

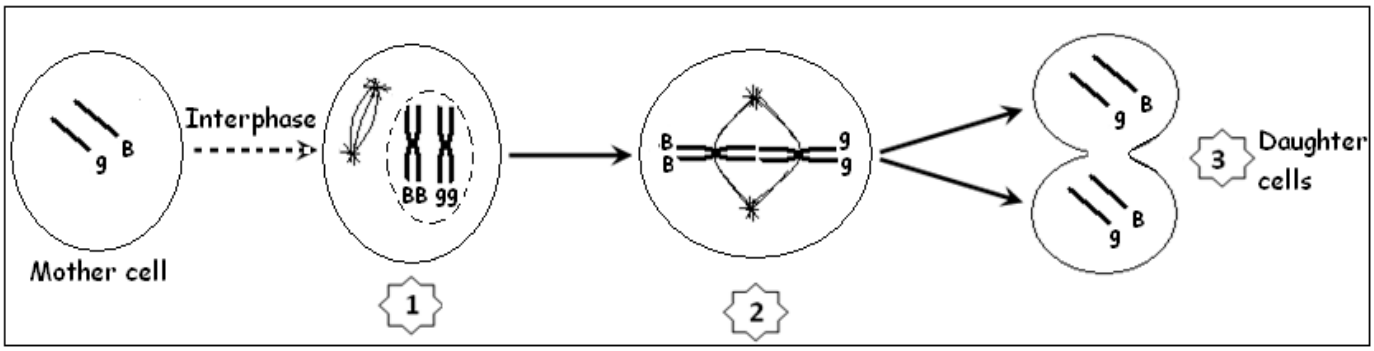




4- Indicate the real genotype of the father. Justify your answer.
5- Make the factorial analysis to verify the obtained results.
6- Which of Mendel laws is related to the applied situation?
7- **Serious incompatibilities of Rhesus exist when a pregnant woman is Rhesus negative and her fetus is Rhesus positive.** In which case does the probability to have this incompatibility increase: when the father is homozygote or heterozygote? Justify your answer.

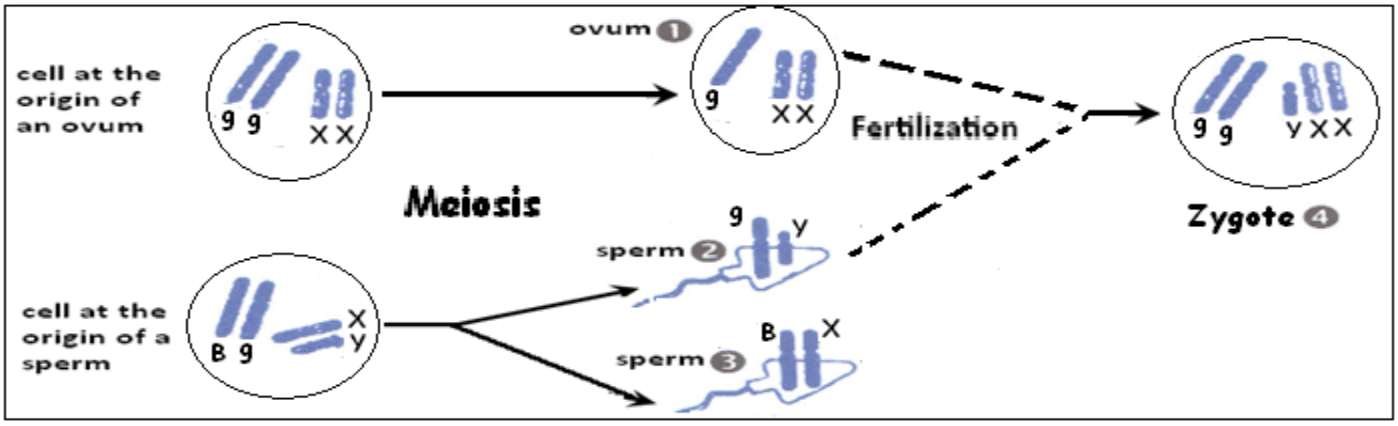
Third Question: (8.5pts)

The genes are carried by chromosomes. The same gene can present different versions called alleles. The gene responsible for eye color is carried by chromosomes 15.
An individual has two alleles: one is noted B for the dominant black color and the other is noted g for the recessive green color.
The document below represents a cell division in this individual. To simplify the drawing only chromosome pair 15 is represented.



1- Compare the chromosomes of the mother cell (1) to those of the daughter cells (3). Derive a conclusion concerning the transmission of the genetic information.
2- Give the name of the cellular division represented by the different phases of the above document.
3- Identify, with justification, each of the above phases (1, 2, and 3).
4- Give the name of the missing phase. Draw this phase and label it.
5- What is the phenotype of the above individual? Justify your answer.

This individual marries a woman of green eyes. The following figure shows the formation of the gametes of this couple and the corresponding egg cell (zygote).



6- Consider zygote 4:
   a- Give the phenotype concerning the eye color of the baby that will develop from this zygote.
   b- Identify the sex of this baby. Justify your answer.
   c- Indicate the gamete responsible for the anomaly.
7- Specify the phase of the meiotic division during which this anomaly took place. Explain.
8- Transform the above document into text. (legend: →produce)

Question		Answers	Score	Remarks
5pts	1	a- Presence of defective hemoglobin.	0.5	
		b- Table	2	
	2	Equation	0.5	
	3	Dark red color	0.5	
	4	Transport of respiratory gases	0.5	
	5	Oxygen gas is transported in fewer amounts because the defective Hb leads to a decrease in number of red blood cells. Also crescent shape does not allow the red blood cells to reach the tiny capillaries, thus organs irrigated by those capillaries will be deprived from oxygen.	0.5 0.5	
II 6.5	1	Autosomal. Since the gene is located on the chromosome 1	0.5x2	
	2	P: symbol of the allele positive Rhesus n: symbol of the allele negative Rhesus	0.5	Logical symbol
	3	Mother: nn Father: Pn or PP	025 0.25x2	
	4	Pn since some of the descendants are Rhesus negative with a genotype nn where one n is of maternal origin(homozygote) and the other n must be of paternal origin.	1	
	5	Genotypes of parents Pn X nn Gametes of parents: $P_{50\%}$, $n_{50\%}$ $n_{100\%}$ ♀ \ ♂ | $P_{50\%}$ | $n_{50\%}$ $n_{100\%}$ | $Pn_{50\%}$ | $nn_{50\%}$ Then the phenotypic percentage is verified: 50% positive rhesus 50% negative rhesus	0.25 0.5 0.5 0.5	If the results are given in proportions: Ok
	6	Second law: independant segregation of alleles.	0.5	
	7	Homozygous, in this case the descendants will be 100% positive Rhesus, while in the second case this probability is 50%.	1	if one case: 0.5
III A 8.5	1	The mother cell has homologous chromosomes one carrying B and the second carrying g identical to those carried by the daughter cells 3. Then the genetic information is conserved.	1	
	2	Mitosis.	0.5	
	3	Prophase: - Nuclear membrane disappears - Appearance of asters and spindle fibers Metaphase: the chromosomes are aligned at the equator Telophase: constriction of the cytoplasm.	1.5	
B	4	Anaphase schema + annotation	1	
	5	Phenotype: black eyes since black is dominant over green.	0.5	
	6a	Green	0.5	
	6b	Male since it carries y chromosome.	0.25 0.5	
	6d	The ovum	0.25	
	7	During anaphase 1, homologous XX chromosome didn't separate towards the opposite poles	1	
	8	The cell at the origin of an ovum has a pair of chromosome	1.5	

		carrying each the allele g and two X chromosomes, produces by meiosis ovum 1 with a chromosome carrying g and two X chromosomes. The cell at the origin of a sperm has a pair of chromosomes carrying each the allele g and XY chromosomes produce by meiosis sperm 2 with g chromosome and y chromosome and sperm 3 with chromosome carrying B and X chromosome. Sperm 2 fertilizes ovum 1 with to produce a zygote with a pair of chromosomes carrying each the allele g and with 2 X chromosomes and one Y chromosome.		