January 29, 2022

Exam for BIO105

Room : CE3

Duration : 08:15 to 11 :15

Instructions :

1. 3 A4 sheets of paper (6 pages) with supporting material are allowed.

2. Electronic calculators are not allowed.

4. In all answers, provide ***detailed*** calculations and explanations.
No point will be given for right answers with no justification or with incorrect justification.
It is allowed to submit additional sheets of paper with calculations or explanations when the space is not sufficient on the exam sheets.

5. Write your full first name and last name on the cover sheet.

First name : _____

Last name : _____

6. Put your initials on the other sheets, including any additional sheet.

Total number of points : 50 points

Grade = (your points / 10) + 1

Genetic code

	T		C		A		G		
T	TTT	phe	TCT	ser	TAT	tyr	TGT	cys	**T**
	TTC		TCC		TAC		TGC		**C**
	TTA	leu	TCA		TAA	stop	TGA	stop	**A**
	TTG		TCG		TAG		TGG	try	**G**
C	CTT	leu	CCT	pro	CAT	his	CGT	arg	**T**
	CTC		CCC		CAC		CGC		**C**
	CTA		CCA		CAA	gln	CGA		**A**
	CTG		CCG		CAG		CGG		**G**
A	ATT	ile	ACT	thr	AAT	asp	AGT	ser	**T**
	ATC		ACC		AAC		AGC		**C**
	ATA	ile	ACA		AAA	lys	AGA	arg	**A**
	ATG	met	ACG		AAG		AGG		**G**
G	GTT	val	GCT	ala	GAT	asp	GGT	gly	**T**
	GTC		GCC		GAC		GGC		**C**
	GTA		GCA		GAA	glu	GGA		**A**
	GTG		GCG		GAG		GGG		**G**

BIO-105 01.29.2022

Question 1 2 pt

In the field of gene expression define what is a promoter.

_____

_____

_____

_____

_____

Question 2 3 pt

Eukaryotic cells have 3 RNApolymerases able to transcribe genes.

2.1 Which one of the 3 RNApolymerases has a long C-terminal domain (CTD)?

a. RNApol I b. RNApol II c. RNApol III

2.2 Explain the function(s) of the long CTD during gene transcription.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Question 3 10 pt

Problem 3.1 Translation

The 200-base-pairs sequence given below is the coding strand immediately downstream for a promoter. The sequence of the coding DNA strand is identical to the sequence of the mRNA except for T replaced by U in RNA.

5’tgagatttaa ttgactgaat **a**gtgcgaagc tca**a**gcccat gttacacagg **c**gatattatt gctcaggatc tgagctgttt tg**g**cgttcca attgatcagt tgtgtgaaaa ataagatctg agtactctct ctctctcta agtttataga acca**ccgg**ca atggctgttg gacccactct gcaaggatgt ctcatgtgtc 3’

Give in amino acids the length of the protein encoded by the sequence above

1.1 as shown

_____ amino acids

In the following questions (1.2 to 1.6) consider only one change at the time

1.2 when at position 51, C is changed into A ggcga -> ggaga

_____ amino acids

1.3 when at position 83, G is changed into A ttttggcg -> tttgacg

_____ amino acids

1.4 when at position 21, A is deleted aat agt → aat gt

_____ amino acids

1.5 when at position 34, A is deleted tcaagc → tcagc

_____ amino acids

1.6 when a stuttering adds one T around position 80 gttttg -> gttttg

_____ amino acids

1.7 During which phase of the cell cycle does stuttering occur ?

Problem 3.2 PCR

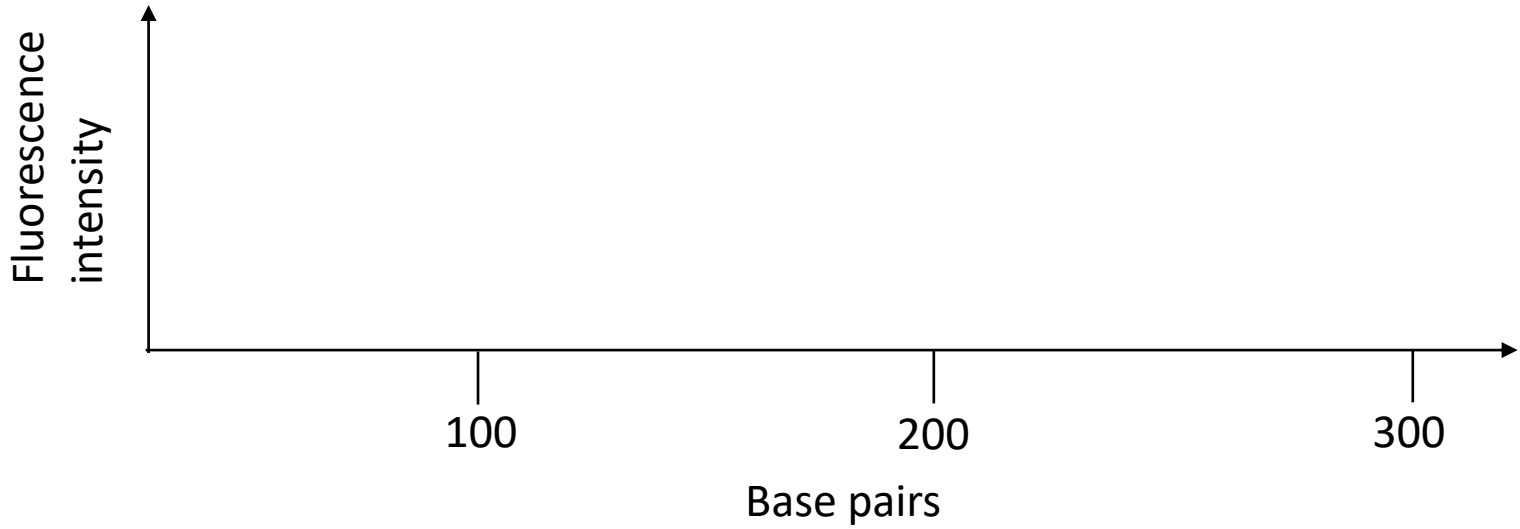
To amplify the given sequence by PCR you order 15-nucleotide long primers.
Indicate the sequence of the primers you order.

1. 5' _____ 3'

2. 5' _____ 3'

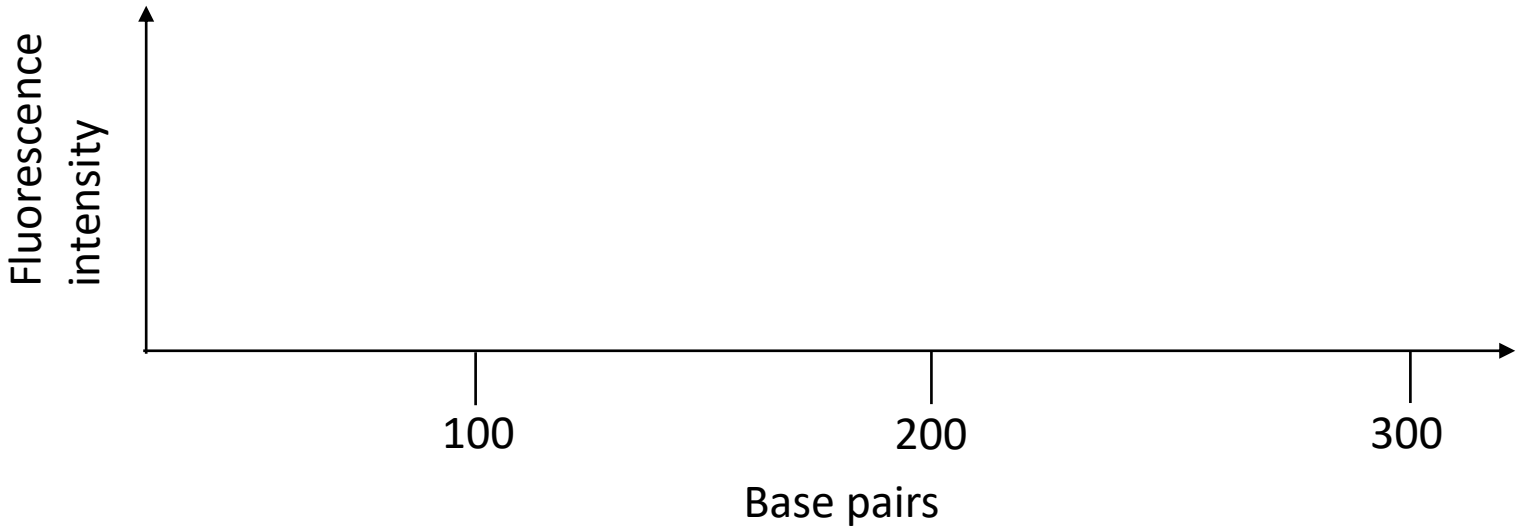
The 2 primers you have ordered are fluorescent primers. After the PCR is completed, you analyze de PCR product by electrophoresis in a capillary tube.

3. Draw the expected result:

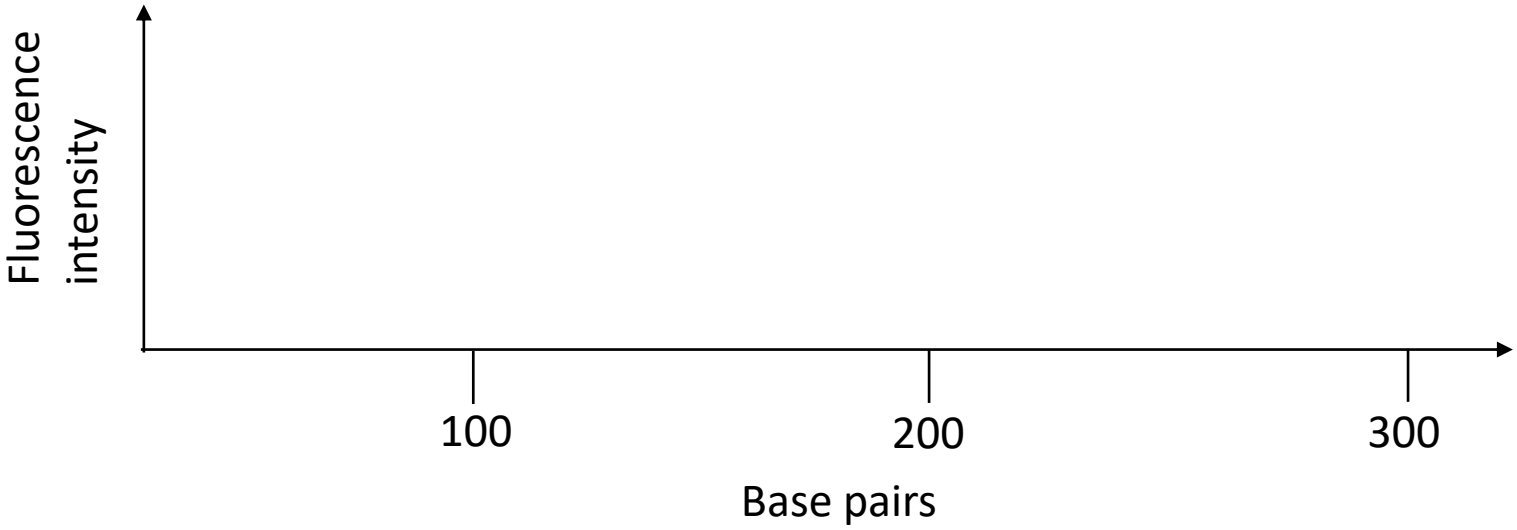


In your lab both restriction enzymes Hpa II and Msp I are available. Both enzymes recognize the sequence 5'CCGG3'. Hpa II is methylation sensitive, Msp I is methylation insensitive. Note the 5'CCGG3' is present in the given sequence (positions 155 to 158)

4. After the PCR is completed you digest the PCR product with the enzyme **Hpa II** and then run the electrophoresis. Draw the expected result:



5. After the PCR is completed you digest the PCR product with the enzyme **Msp I** and then run the electrophoresis. Draw the expected result:



Problem 3.3 Methylation

In cells, sometime DNA is methylated. Consider that the given sequence is a from a mammalian organism.

3.1 How many bases can potentially be methylated in the given sequence?

_____ base(s)

3.2 Describe an experimental procedure allowing you to find out whether in vivo the given sequence is methylated or not. Describe all the steps of the procedure and the expected results allowing you to conclude about methylation.

_____

_____

_____

_____

_____

_____

_____

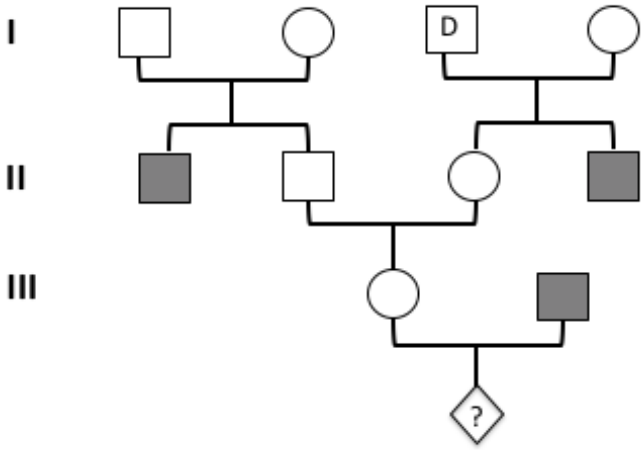
_____

_____

_____

Question 4 Gene transmission 12 pt

Problem 4.1



D = red / green color blindness

Filled symbols: red hair

The pregnant woman in generation III has
- a red hair paternal uncle
- a red/green colorblind maternal grandfather
- a red hair maternal uncle

1. For this woman what is her probability to be

- carrier for red hair _____
- carrier for color blindness _____

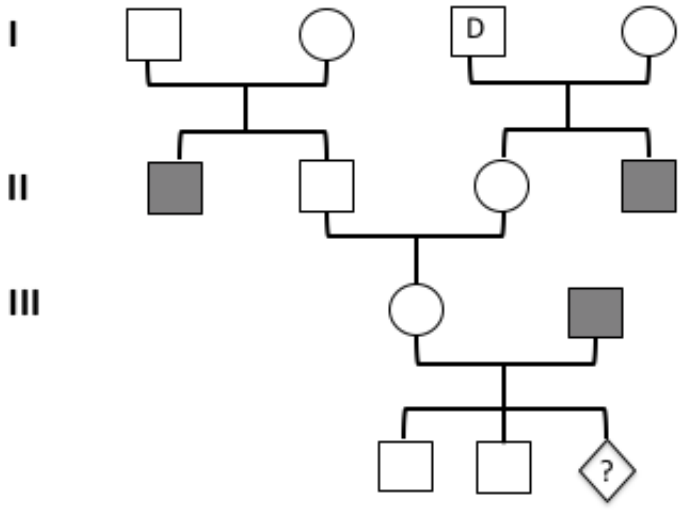
She is married to a man with red hair; he is not red/green color blind.

2. For the first child to be born what is the probability to present with

	for a boy :	for a girl :
dark hair & normal color vision	_____	_____
dark hair & red/green color blindness	_____	_____
red hair & normal color vision	_____	_____
red hair & red/green color blindness	_____	_____

Problem 4.2

10 years later, the same couple has now 2 boys and is expecting a third child.



Knowing that the 2 boys have dark hair and can distinguish red from green,

◊ calculate the probability for the third child to present with red hair.
(we consider only the hair color in this problem, we ignore color blindness)

◊ calculate the probability for the third child to present with color blindness
(we consider only color blindness in this problem, we ignore hair color)

- for a girl :

- for a boy :

Question 5 13 pt

In a plant species one observes 2 phenotypes:

- flowers color
- seeds surface

One crosses a plant with purple flowers and smooth seed with a plant having white flowers and wrinkled seed:

flowers:	purple		white
		X	
seeds:	smooth		wrinkled

From this cross the F1 shows: 100 % pink flowers and 100 % smooth seeds

Problem 5.1 (2 parts)
You know that
the flower color locus is located on chromosome 2
the seed surface locus is located on chromosome 4
Indicate the phenotypes and their expected relative frequencies in the F2 obtained by

5.1.a F1 x (white / wrinkled)

5.1.b F1 x F1

Problem 5.2 (only 1 part)

One starts with the same parental cross as for the previous problem.
Consider now that both locus are located on the same chromosome (chromosome 2), 8 cM (centimorgan) apart.

Indicate the phenotypes and their expected relative frequencies in the F2 obtained from the cross

F1 X (white / wrinkled)

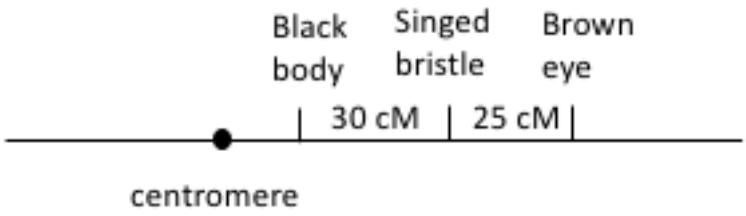
Problem 5.3

In Drosophila, a genetic map indicates that 3 locus are located on the same chromosome:

Black body is located 10 cM from the centromere (wild-type : gray body)

Singed bristle is located 40 cM from the centromere (wild-type : straight bristle)

Brown eye is located 65 cM from the centromere (wild-type : red eye)



One does the following cross

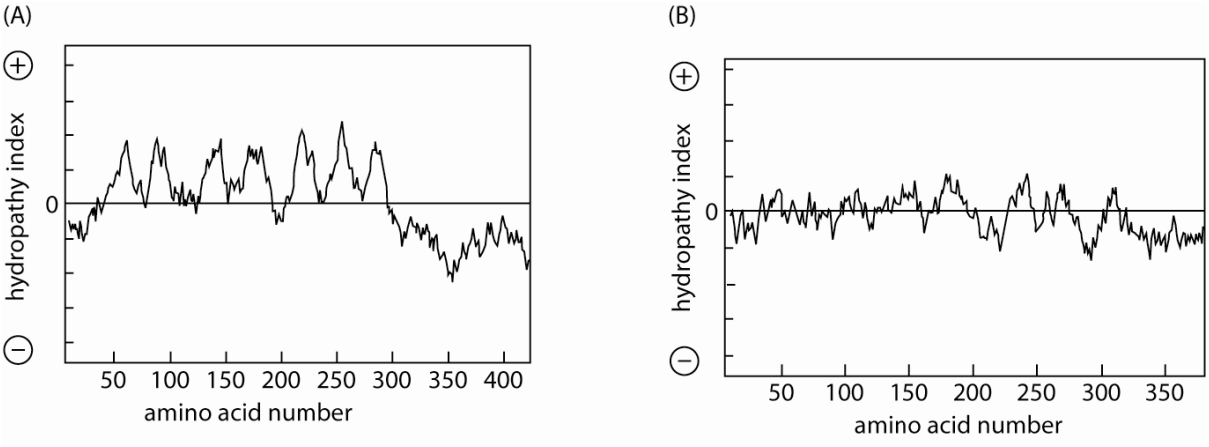
Female		**Male**
gray body		black body
	X	
red eyes		brown eyes

The F1 shows 100% gray body and 100% red eye. A F2 is generated by crossing some F1 females with a male presenting a black body and brown eyes.

Indicate the phenotypes and their expected relative frequencies in the F2.

Question 6 5 pt

Examine the two hydropathy plots in Figure A & B.
The Kyte Doolittle scale has been used : positive values indicate hydrophobicity.



6.1 Which protein is most likely a transmembrane protein?

A B

6.2 Which of the protein is most likely located in the cytosol?

A B

6.3 For the transmembrane protein, what is the probable number of transmembrane domains?

_____

Justify your answer:

6.4 To generate an hydropathy plot one has to define a “window size”. Which window size is best to identify transmembrane domains? Explain why.

Window size : _____

Justification :

_____

_____

_____

_____

_____

_____

Question 7 5 pt

A person with a male appearance has a karyotype **47, XYY** in all the blood cells that have been analyzed. The chromosomal abnormality is probably due to a nondisjunction.

1. in which parent did the nondisjunction occur?

a. mother b. father

2. during which stage of the meiosis did the nondisjunction occur?

a. meiosis I b. meiosis II

3. If cheeks cells are sampled by rubbing a swab in the oral cavity and a sex chromatin test is performed on the cheeks cell, how many **Bar bodies** do you expect to see?

a. 0 b. 1 c. 2 d. 3

4. If the karyotyping test had revealed that 64% of the cells have a **46, XY** karyotype and 34% have a **47, XYY** karyotype, which term used to describe such a condition?

_____

5. Explain how the condition described in the question 4 can occur.

_____

_____

_____

_____

_____

_____

_____

_____

(Blank page you may use as needed)