Instructions: **Roll no.**

1. **The quiz will be conducted for an hour.**
2. **The quiz carries 25 marks that will be scaled down to one-third. The last question will fetch you a bonus of 5 marks.**
3. **Please write only in the space provided. Anything written outside the space provided will NOT be evaluated.**
4. **Have fun!!!**

The Indian mission to Mars (Mars Orbiter Mission (MOM), also called *Mangalyaan)* has successfully landed on Mars. On the surface, an explorer vehicle found many objects that look like the pictures below. As you are now an expert on biology, the Indian government comes to you with the Martian objects for further studies. As they look a lot like faces on Earth, you decide to name these objects "Happy" (Phenotype – Smiling face) and "Grumpy" (Phenotype – Sad face).

Qs. 1. You suspect that the Martian objects might be alive. Give 4 features of "life" that will help you to decide whether Happy and Grumpy are indeed alive. (4 marks)

A: **a) Order**
b) Adaptation
c) Response to environment
d) Energy Processes
e) Reproduction
f) Growth and development
g) Regulation

Lecture 1, Slide 16
1 Mark for each correct answer, we have given marks for only the above points as there were many strange answers that could have been interpreted differently by different people.

Qs. 2. You want to figure out if Happy and Grumpy are prokaryotes or eukaryotes. Give 2 differences between prokaryotes and eukaryotes that could help you decide. (2 marks)

A: **a) Prokaryotes have no nucleus or organelles.**

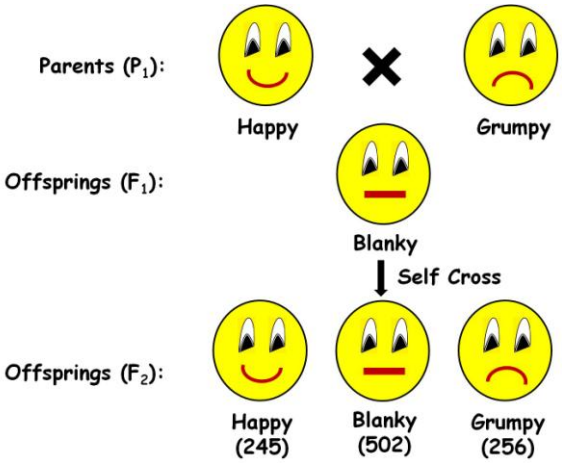
b) Prokaryotes are smaller than eukaryotic cells.

c) Differences in transcription and translation.

Lecture 1, Slide 23, any two of these answers got marks.

1 Mark for each correct answer, we did not give marks for prokaryotes being uni-cellular and eukaryotes being multi-cellular as there are many exceptions to this. Even if one of the slides suggested this, the textbook should have clarified your doubts.

Qs. 3. After doing some experiments, you realize that Happy and Grumpy are indeed alive and are eukaryotes. As you have been studying them for a while now, you have figured out how to cross Happy and Grumpy to produce offspring. You carry out crosses and get the results shown.



Show a Punnett Square for the cross above (2 marks) and infer whether smiling faces are dominant, recessive, or incompletely dominant (2 marks). Briefly justify your answer (2 marks). Assume genetics similar to Earth.

A: Assume Happy to be HH and Grumpy to be GG or hh.

(2 Marks)

Parents (F_1): Grumpy X Grumpy

HG X HG

Punnett Square:

	H	G
H	HH Happy	HG Blanky
G	HG Blanky	GG Grumpy

Ratio: 1:2:1 = Happy: Blanky: Grumpy

This is the data that fits with smiling face being incompletely dominant. (2 Marks)
Dominant and recessive will give 3:1 ratio in F_2, while incompletely dominant will give 1:2:1 ratio. (2 Marks)

Lecture 2, slide 22; example of incomplete dominance. We gave marks for Punnett Squares that used HG, Hh or other versions of the genotypes.

Qs. 4. Assuming genetics similar to Earth, which of the following statements is an incorrect assumption about Happy and Grumpy? (2 marks)

a) **They have a diploid genome**

b) **They are 'true-breeding'**

c) **The genes for smiling and sad faces undergo segregation**

d) **The genes for smiling and sad faces are on the same chromosome**

Happy and Grumpy are two alleles of the same gene which will be present on homologous pairs of chromosome and NOT on the same chromosome.

Only one correct answer; so only (d) should be checked.

Qs. 5. On Earth, what is the name of the enzyme or protein that synthesizes RNA using DNA as the template? (2 marks)

A: RNA polymerase

Qs. 6. You do more experiments and find the gene that gives the smiling and sad face phenotypes. There are two alleles (variants) of the gene and the DNA sequence of the allele (variant) found in Happy (phenotype: smiling face) is given below. Write the sequence of the RNA that will be transcribed from this gene if the lower strand is the template for RNA synthesis. Don't forget to label the 5' and 3' ends clearly. (2 marks)

5' TATCCATGGGATATGACCCCGAGACAGCTAGCTGGCTATAG 3'
3' ATAGGTACCCTATACTGGGGCTCTGTCGATCGACCGATATC 5'

5'UAUCC AUG GGA UAU GAC CCC GAG ACA GCU AGC UGG CUA UAG3'

2 Marks for completely correct answer, we did not give marks to anyone who started from a supposed TATA box for the following reasons. The TATA box sequence is 5' TATAAAA 3'. If you look carefully on the lower strand, there are 2 TATA sequences. One is 3' TATACTGG 5' which is not a TATA box. The other is 5' TATAGCC 3' which is also not a TATA box. If the second sequence is used, the RNA would be tiny! By the way, transcription starts 30 bases downstream of an authentic TATA box so this sequence is too short anyway. You were supposed to simply follow the instructions of writing the RNA sequence if the lower strand was the template.

Qs. 7. Now that you know the sequence of the RNA, begin from the start codon of the gene and using the genetic code table projected on the screen, write the sequence of amino acids that make the smiling face phenotype protein. (4 marks)

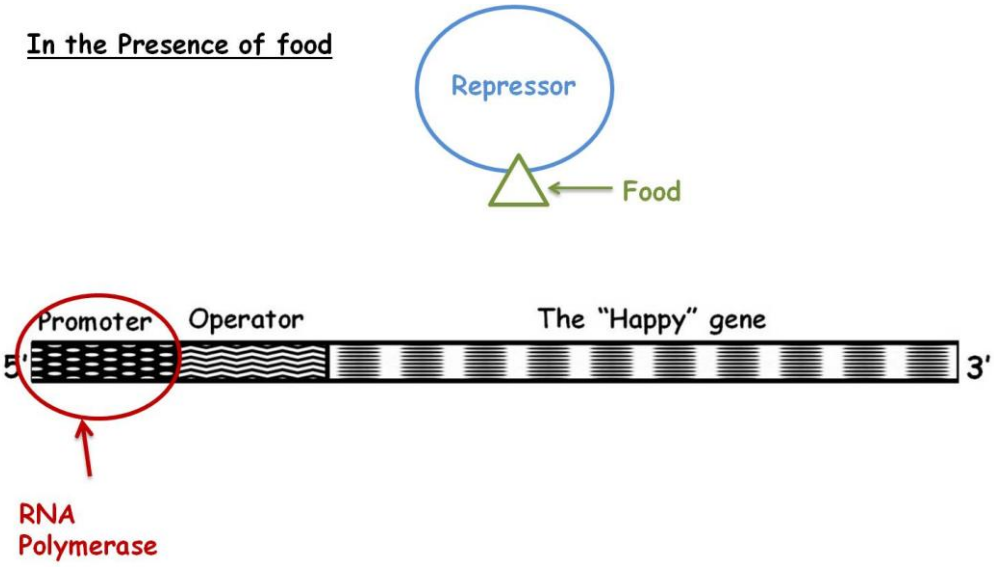
A: Met-Gly-Tyr-Asp-Pro-Glu-Thr-Ala-Ser-Trp-Leu-STOP (optional to show STOP)

Methionine is the start codon.

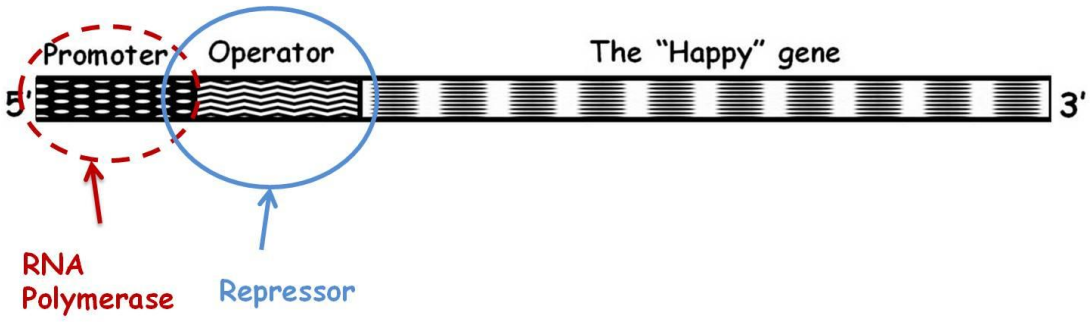
Lecture 4, slide 13, 17 and screen
4 Marks for completely correct answer. The start codon of a gene is usually an AUG. Alternate start codons are extremely rare in eukaryotes. Even if there are alternate start codons, these are GUG, UUG, AUU and CUG. If you started translation at the first three bases of the RNA, there is no biological logic to that decision.

Qs. 8. When the Happy organisms (smiling face phenotype) were deprived of their food source, their phenotype changes such that the face completely disappears. On further analysis, it was observed that the gene sequence of the organisms remained the same; however, a repressor was activated in the starvation condition. On the diagram below, draw the ON and OFF switches of the "Happy" gene in conditions of food availability and starvation. Clearly show the enzyme that synthesizes RNA, the repressor and the food molecule in your diagram. (3 marks)

ON



In the Absence of food (Starvation):



OFF

Lecture 5, slides 9 and 10; lac operon concept
3 Marks for completely correct answer. If you did not show the position of any of the proteins or showed the RNA polymerase and repressor binding anywhere other than the promoter and operator respectively you did not get any marks.

Qs. 9. FIVE BONUS MARKS: Having worked on the allele (variant) in Happy, you next study the allele found in Grumpy (sad face phenotype). Given below are DNA sequences for two possible alleles of the Grumpy gene. Based on the sequence alone, which one of the following possible alleles could code for the sad face phenotype protein? Hint: Translate the two sequences as you did in Question 7 and see which protein fits into the result of the genetic cross in Question 3. Justify your answer briefly.

1. 5' TATCCATG**T**GATATGACCCCGAGACAGCTAGCTGGCTATAG 3′
   3′ ATAGGTAC**A**CTATACTGGGGCTCTGTCGATCGACCGATATC 5′

2. 5' TATCCATGGGATATGACCCCGAGA**A**AGCTAGCTGGCTATAG 3′
   3′ ATAGGTACCCTATACTGGGGCTCT**T**TCGATCGACCGATATC 5′

A: **Allele 1 Protein: Met-STOP**
Allele 2 Protein: Met-Gly-Tyr-Asn-Pro-Glu-Lys-Ala-Ser-Trp-Leu-STOP

The answer to the genetic cross in Qs. 3 was incomplete dominance.
For incomplete dominance, there should be "blending" of the phenotype at the protein level. For example, red pigment and white pigment will give pink pigment in case of Snapdragon cross discussed in the class. Allele 2 could give rise to an altered protein, similar to white pigment. Allele 1 will give rise to no protein. Therefore, Allele 2 is the Grumpy allele.