Biology 113 Closed Book Take-Home Exam #1 – Information

There is no time limit on this test, though I have tried to design one that you should be able to complete within 3 hours. There are 7 pages in this test, including this cover sheet and the data gallery. You are not allowed to look at someone else's test, use your notes, old tests, the internet, any books, nor are you allowed to discuss the test with anyone until all exams are turned in no later than **9:30 am on Monday Feb. 10**. If you *turn in hard copy* of your exam late, you will lose a letter grade for each day you are late. The **answers to the questions must be typed in this Word file** unless you are asked to draw on a separate page, or you want to use scratch paper. If you do not write your answers in the appropriate location, I may not find them. Tell me where to look if you put your answer at the back of your test. Submit a hard copy to be graded.

I have provided you with a "Data Gallery" in the form of figures and tables. To choose a figure in support of your answer, simply state Figure #x. Do not assume how many of the data images you will use, or not use. **Simply choosing the data is not sufficient support for your answer. You must explain the significance of the data and how they support your answer.** *I have given you word limits so be concise.*

-3 pts if you do not follow this direction.
Please do not write or type your name on any page other than this cover page.
Staple all your pages (INCLUDING THE TEST PAGES) together when finished with the exam.

Name (please type):

Read the pledge and sign if you can do so with honor:

____

On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.

How long did this exam take you to complete?

P20	P200	P1000
X	X	X
X	X	X
X	X	X

Lab blended with lecture Questions:

6 pts.

1) Draw in how to set each of the following volumes. Tell me which pipet you'd use (P20, P200 or P1000) and what you would see in the display window:

Volume = 125 µL pipet to use:____P200________

1
2
5

Volume = 2.5 µL pipet to use:____P20________

0
2
5

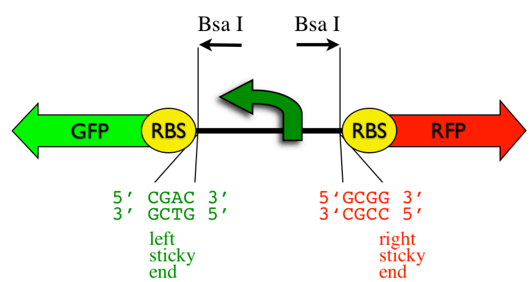
Volume = 854 µL pipet to use:____P1000________

0
8
||5

2 dashes to the left of 5

4 pts.

2) Figure 9 in the data gallery is a position weight matrix (PWM) based on Figure 19. Use the PWM on the *lower case bases* and circle one good promoter to produce RFP when cloned into pClone (see image →). The -10 sequence is underlined and the **-35 sequence** is bold letters. Explain how you reached your conclusion. Guessing is insufficient for any credit. Limit your answer to a maximum of 35 words.



CGACTAGCATGCtatattgGATAAGAGATGCATTC**ACAGTT**GAGCACAGGCGG

CGACTGCTATAT**ATGTAC**CAGATACAGTAACGATAgacgatgGCATATCGCGG

CGACGGCATGAC**TTGACA**GAGATATACAGATACAGttttaaaGGCCAATGCGG

CGACCACAGTAC**TTGACA**GATCACATATACAGATCatatataGAATTCAGCGG

First sequence points to GFP

Second sequence is the only -10 region with a PWM score above 1.

Textbook Questions:

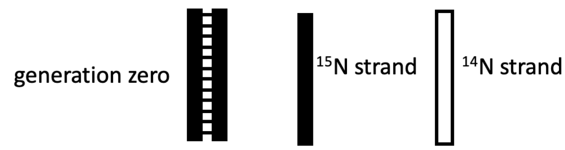
15 pts.

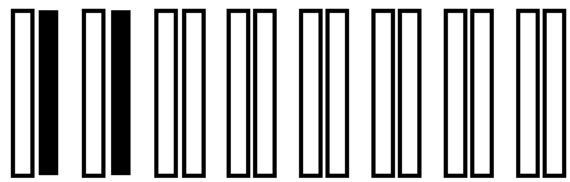
3) It cannot be proteins….

a) When Griffith isolated the S factor, he thought it was part of the cell wall but Avery thought it was in the cytoplasm. Explain these apparent contradictions. Support your answer with data. Limit your answer to a maximum of 35 words.

Griffith's method left the DNA chromosome attached to the membrane in the pellet and he could wash it off. Avery separated the DNA from membrane. DNA is in the cytoplasm.

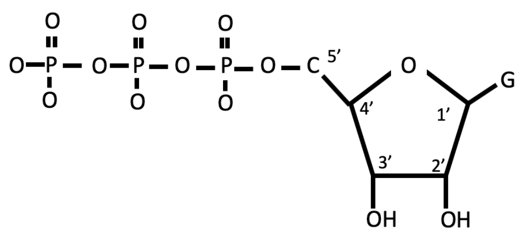
b) Starting with the strands of DNA provided here, draw a picture of all the DNA after three rounds of replication in Meselson and Stahl's experiment. Support your answer using data. Limit your answer to a maximum of 35 words.





You can see in Figure #8 that after 3 generations, ¾ of the DNA is all light whereas ¼ of the DNA is half heavy and half light.

c) Draw a GTP nucleotide that provides energy to ribosomes during translation. Write very neatly and label all the atoms and number the carbons correctly. You may use one letter to represent the entire base.



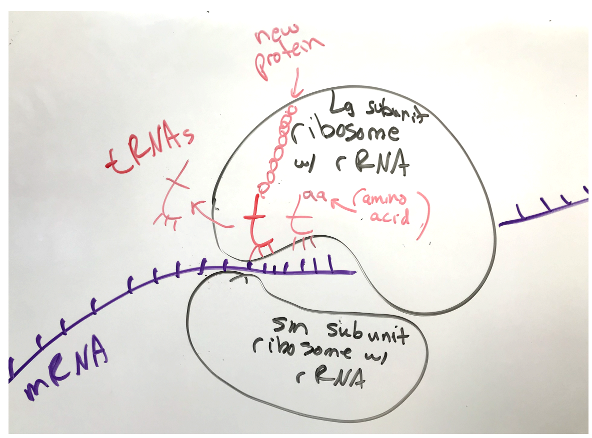
15 pts.

4) Proteins make the world go around…

a) Draw a simple picture that shows how all 3 RNA types interact as they perform their functions. Use experimental data from 2 figures to support your drawing. Label neatly. Limit your answer to a maximum of 40 words.

Figure 14: amino acid binds to tRNA

Figure 15: new mRNA binds to ribosomes and not rRNA



b) Translate this synthetic ORF into protein. Use the single letter code for amino acids and type them below the sequence shown here. The RBS is underlined.

AUGUAGACACAGGAAAGUAAGCG**AUG**GCCAAGGAGGCGUGCGCUACU**UGA**CUCGGGGUGUAA 3'

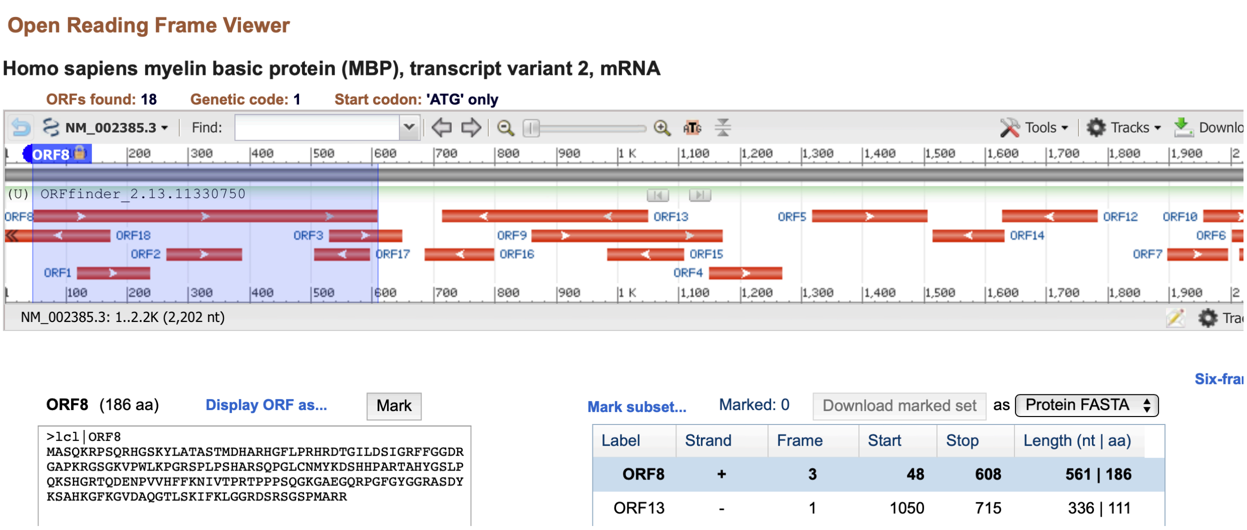
→ M A K E A C A T

c) Write the sequence of the 16S rRNA that binds to the RBS above. Be sure to label the 5' and 3' ends.
Answer here → 3' GUGUCCUUUC 5'

9 pts.
5) I want to be a promoter when I grow up…
a) What is the function of LacI$^+$ protein? Support your answer with data. Limit your answer to a maximum of 35 words.
LacI+ binds to the lacO promoter to suppress transcription. Lactose disables LacI to permit transcription. See Figure 20, rows 2 and 5 where LacI function is highlighted.

b) Draw a picture of a promoter that incorporates data gallery figure #5. Label any relevant promoter parts based on a bacterial promoter. Explain how your drawing illustrates the lesson from figure #5. Limit your answer to a maximum of 35 words.
Promoters can contain non-continuous information as shown in the purple boxes.

15 pts.
6) Six months in the lab can save you an afternoon on the computer.
a) Use ORF finder (https://www.ncbi.nlm.nih.gov/orffinder/) to identify how many amino acids are encoded in the largest ORF NM_002385. Support your answer with a screenshot. Limit your answer to a maximum of 20 words.
186 amino acids



b) Run a BLAST2 (https://blast.ncbi.nlm.nih.gov/Blast.cgi?PAGE=Proteins&PROGRAM=blastp&BLAST_PROGRAMS=blastp&PAGE_TYPE=BlastSearch&SHOW_DEFAULTS=on&BLAST_SPEC=blast2s

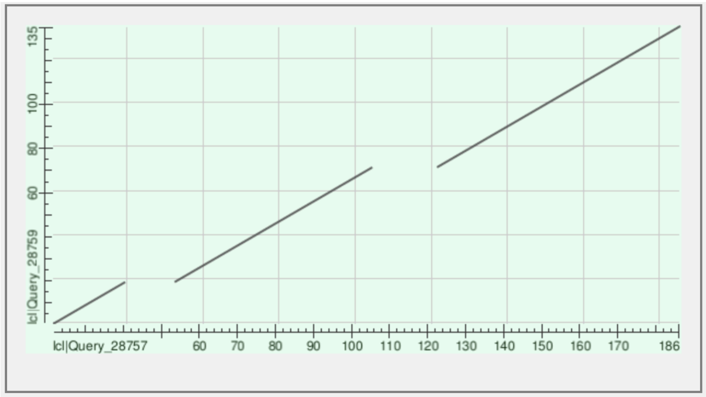
eq&QUERY=&SUBJECTS=) using the largest ORF from part a) above and this functional protein:

MDHARHGFLPRHRDTGILDKRGSGKVPWLKPGRSPLPSHARSQPGLCNMYKDSHHPARTAHYGSLPQKSHGPRTPPPSQGKGAEGQRPGFGYGGRAS

DYKSAHKGFKGVDAQGTLSKIFKLGGRDSRSGSPMARR

Describe what has happened to the functional protein. Include a screenshot of your BLAST2 results to earn full credit. Limit your answer to a maximum of 25 words.

The original protein was trimmed in 3 places. The first 20-odd amino acids were trimmed along with two internal portions of the protein.



c) Based on your analysis from part b), where was this protein translated? Explain how you reached your conclusion. Limit your answer to a maximum of 25 words.

Translated on rough ER as indicated by the trimmed off signal sequence (first 20-odd amino acids).

18 pts.

7) Mendel and his plants were like two peas in a pod. To get full credit, you must show your work.

One of Mendel's work-brothers found in a cup 37 yellow peas that came from one self-pollenated plant. He planted all of the peas and 36 plants grew. All 36 plants were self-pollenated. Twelve of the plants produced only yellow peas whereas 24 plants produced a mixture of yellow and green peas.

a) What was the genotype of the plant that produced the 37 peas? Yy

b) What was the genotype of the group of 12 plants? YY

c) The 24 plants produced a total of 912 peas. How many peas would you expect to be yellow?

d) At the Superbowl, every person in attendance was measured for genetically dry vs wet earwax. They determined 18,854 had dry earwax and 56,246 had wet earwax. Which allele is recessive? Dry earwax allele.

e) Imagine a couple where the man has dry earwax and the woman is heterozygous. What is the probability they would have two children from different pregnancies and both children have dry earwax?

Dd (mom) x dd (dad)

½ * ½ = ¼

f) What is the probability that this same couple's third child would be a girl with dry earwax or a boy with wet earwax?

Girl with dry = ¼ + boy with wet + ¼ for total of ½

8 pts.

8) Without reproduction, there can be no evolution.

a) How does a bacterial cell know when it is time to reproduce? Support your answer with two figures from the data gallery. Limit your answer to a maximum of 35 words.

When the cell gets big enough (figure 16) and when it replicates its genome (figure 22).

b) Distinguish the reproductive consequences if chromatids could recombine vs if they could not recombine. Limit your answer to a maximum of 40 words.

Lower diversity without recombination, possible identical offspring; more genetic variation with recombination leading to unique allele combinations.

10 pts.

9) Parenting: the days are long but the years are short.

a) Generate a numbered list of experimental evidence that epigenetic changes can regulate transcription. Support each numbered item with data from the gallery. Limit each numbered item to a maximum of 35 words.

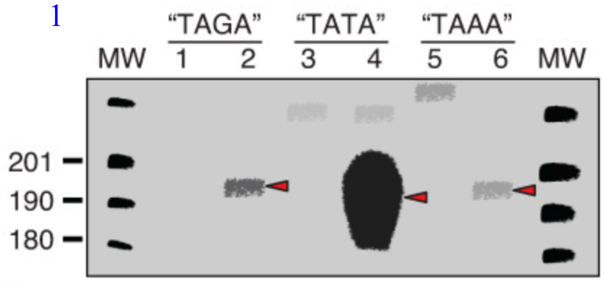
1. Figure 21 showed that fetal hemoglobin gene could be activated by blocking methylation.
2. Figure 7 showed that active genes are hypomethylated and inactive genes are hypermethylated.

b) Generate a numbered list of the mechanisms which contribute to genetic diversity in an F_1 generation. Support each numbered item with data from the gallery. Limit each numbered item to a maximum of 35 words.

1. Random combinations of gametes (figure 3)
2. Recombination of chromatids (figure 12)
3. Mutations (figure 20)

Data Gallery

1



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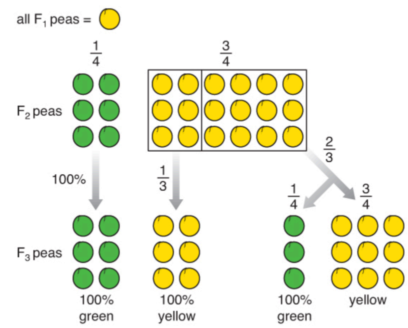
3



4

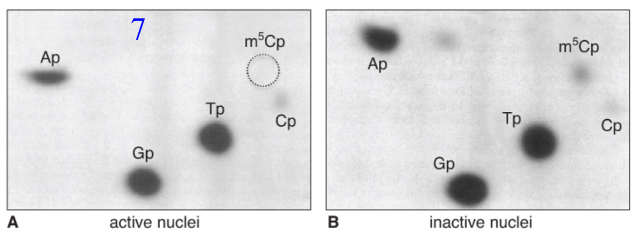
generation	wrinkled peas	smooth peas
P	5 true-breeding wrinkled plants	5 true-breeding smooth plants
F_1	0 wrinkled peas	281 smooth peas
F_1	0 plants from wrinkled peas	self-cross 253 plants from F_1 smooth peas
F_2	1,850 wrinkled peas	5,474 smooth peas

5

promoter length	doubling time	drug resistant
29 bp	no growth	none
78 bp	5 hours	none
113 bp	5 hours	none
155 bp	3 hours	yes
320 bp	3 hours	yes

6

7



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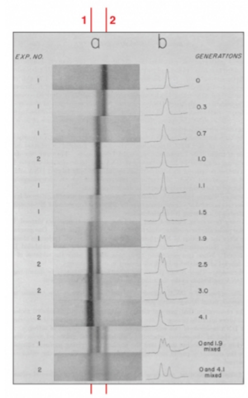


9

position #	1	2	3	4	5	6	7
A	−6.64	1.84	−6.64	0.84	1.26	−6.64	−0.72
C	−6.64	−6.64	−0.37	−6.64	−6.64	−6.64	−6.64
G	−0.37	−6.64	−6.64	1.18	−0.37	−6.64	1.92
T	1.57	−6.64	1.57	−6.64	−0.72	1.84	−6.64

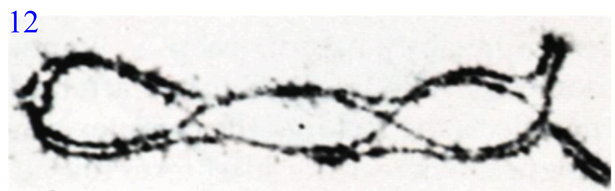
10

sample source	extracellular	intracellular
^{35}S-Protein Figure 1.8	~80%	~20%
^{32}P-DNA Figure 1.8	~30%	~70%
^{35}S-Protein refined experiment	~99%	~1%
^{32}P-DNA refined experiment	~30%	~70%

11

plant number	smooth pea	wrinkled pea	plant number	yellow pea	green pea
1	45	12	1	25	11
2	27	8	2	32	7
3	24	7	3	14	5
4	19	10	4	70	27
5	32	11	5	24	13
6	26	6	6	20	6
7	88	24	7	32	13
8	22	10	8	44	9
9	28	6	9	50	14
10	25	7	10	44	18
totals	336	101	totals	355	123

12



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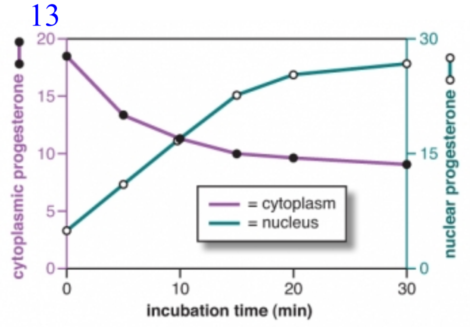

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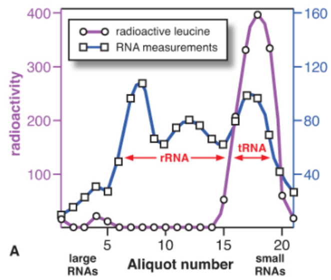

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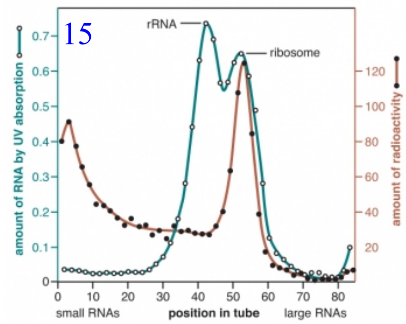
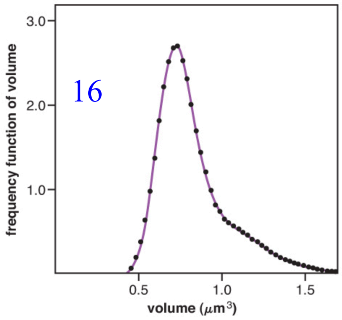
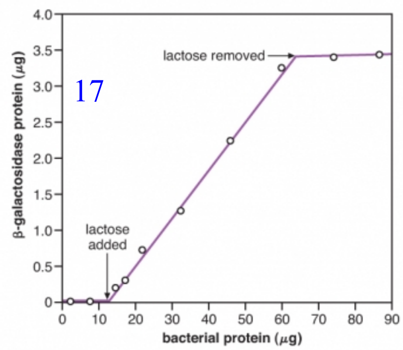


16



17



18

second base in codon

first base in codon	U	C	A	G
U	UUU phe F	UCU ser S	UAU tyr Y	UGU cys C
U	UUC phe F	UCC ser S	UAC tyr Y	UGC cys C
U	UUA leu L	UCA ser S	UAA stop	UGA stop
U	UUG leu L	UCG ser S	UAG stop	UGG trp W
C	CUU leu L	CCU pro P	CAU his H	CGU arg R
C	CUC leu L	CCC pro P	CAC his H	CGC arg R
C	CUA leu L	CCA pro P	CAA gln Q	CGA arg R
C	CUG leu L	CCG pro P	CAG gln Q	CGG arg R
A	AUU ile I	ACU thr T	AAU asn N	AGU ser S
A	AUC ile I	ACC thr T	AAC asn N	AGC ser S
A	AUA ile I	ACA thr T	AAA lys K	AGA arg R
A	AUG met M	ACG thr T	AAG lys K	AGG arg R
G	GUU val V	GCU ala A	GAU asp D	GGU gly G
G	GUC val V	GCC ala A	GAC asp D	GGC gly G
G	GUA val V	GCA ala A	GAA glu E	GGA gly G
G	GUG val V	GCG ala A	GAG glu E	GGG gly G

19

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V-T7    5´...TAAACACGGTACGATGTACCACATGAAACGACAGTGAGTC... 3´
V-fd    5´...GCTTCTGACTATAATAGACAGGGTAAAGACCTGATTTTTG... 3´
V-SV40  5´...ATTGCAGCTTATAATGGTTACAAATAAAGCAATAGCA...... 3´
V-1     5´...ACTGGCGGTGATACTGAGCACATCAGCAGGACGCACTGAC... 3´
B-tRNA  5´...GTCATTTGATATGATGCGCCCCGCTTCCCGATAAGGAGC ... 3´
B-Lac   5´...TCCGGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAA... 3´
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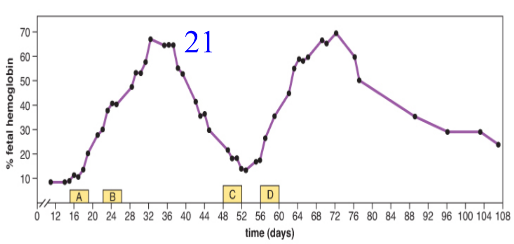
20

genotype	– lactose	+ lactose
I^+ O^+ β^+ P^+	1	100
I^- O^+ β^+ P^+	100	100
I^+ O^+ β^+ P^+ / I^+ O^+ β^+ P^+	1	240
I^D O^+ β^+ P^+	1	1
I^D O^+ β^+ P^+ / I^+ O^+ β^+ P^+	1	2
I^+ O^- β^+ P^+	<1	<1
I^+ O^- β^+ P^+ / I^+ O^+ β^+ P^+	1	100

21



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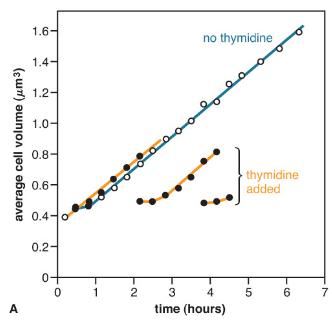

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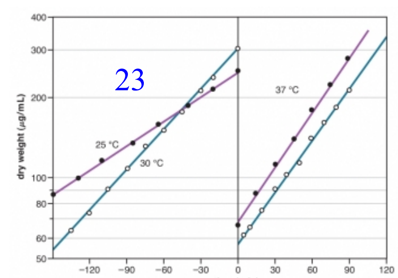

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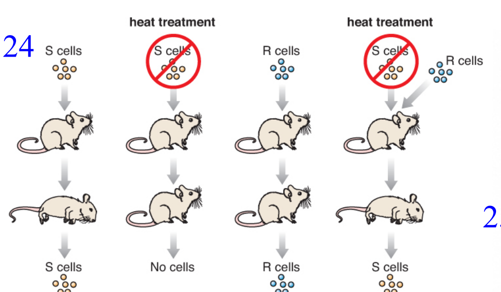

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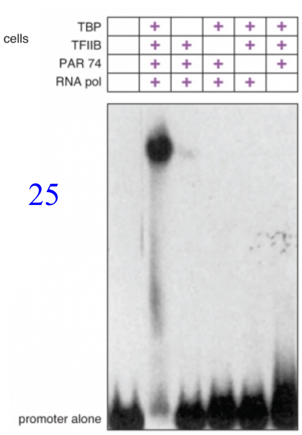

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