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

ANSWER KEY

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, nor 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 12:30 pm on Monday Sept. 23. **EXAMS ARE DUE BY 12:30 pm ON MONDAY SEPTEMBER 23**. If you turn in your exam late, you will lose a letter grade for each day you are late. The **answers to the questions must be typed within this test** unless you want to draw on a separate page. 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.

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. You do NOT need to move the figure on your test. 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 sentence 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 print):

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?

Lab blended with lecture Questions:

4 pts.

1) I have provided you with a fictitious gene sequence below. Your task is to tell me which nucleotides you would choose as your promoter if you were going to clone it and test it the way you have done with your lab group. Draw a box around the nucleotides you would choose for your promoter. Draw your box carefully and don't draw through a letter. Make your lines go between letters only. Also, tell me if you are in the morning or afternoon lab.

Answer Limit: only a box drawn in ink and which lab group you are in (morning or afternoon).

morning lab should have 66-70 bases, afternoon lab should have 56-60 bp

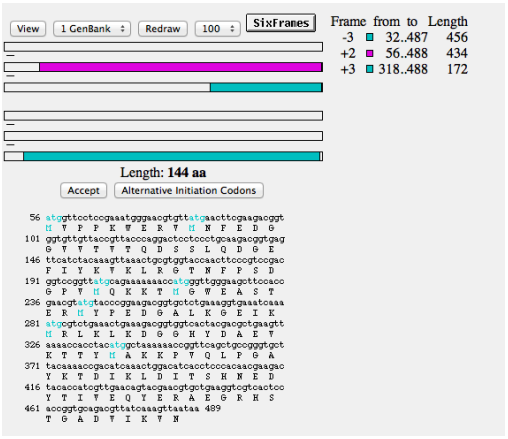
```
CAATACGCAAACCGCCTCTCCCCGCGCGTTGGCCGATTCATTAATGCAGCTGGCACGACAGGTTTCCCGACTGGAAA
                                                              -35
GCGGGCAGTGAGCGCAACGCAATTAATGTGAGTTAGCTCACTCATTAGGCACCCCAGGCTTTACACTTTATGCTTCC
      -10       +1                                            RBS
GGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAATTTCACACATACTAGAGAAAGAGGAGAAATACTAGATGGT
TCCTCCGAAATGGGAACGTGTTATGAACTTCGAAGACGGTGGTGTTGTTACCGTTACCCAGGACTCCTCCCTGCAAG
ACGGTGAGTTCATCTACAAAGTTAAACTGCGTGGTACCAACTTCCCGTCCGACGGTCCGGTTATGCAGAAAAAAACC
ATGGGTTGGGAAGCTTCCACCGAACGTATGTACCCGGAAGACGGTGCTCTGAAAGGTGAAATCAAAATGCGTCTGAA
ACTGAAAGACGGTGGTCACTACGACGCTGAAGTTAAAACCACCTACATGGCTAAAAAACCGGTTCAGCTGCCGGGTG
CTTACAAAACCGACATCAAACTGGACATCACCTCCCACAACGAAGACTACACCATCGTTGAACAGTACGAACGTGCT
GAAGGTCGTCACTCCACCGGTGCAGACGTTATCAAAGTTAATAA
```

10 pts.

2) Google NCBI's "ORF finder". Use ORF finder to tell me how many amino acids are in the protein encoded above. Support your answer with a screen shot.

There are _144__ amino acids in this fictitious protein.

Answer Limit: a number plus screen shot.

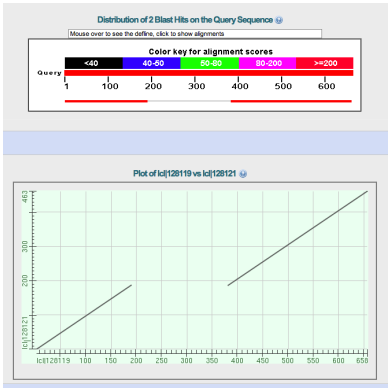


10 pts.

3) Use BLAST2 (blastn) to compare the sequence in question #1 with this sequence (#3):

```
TACGCAAACCGCCTCTCCCCGCGCGTTGGCCGATTCATTAATGCAGCTGGCACGACAGGTTTCCCGACTGGAAAGCG
GGCAGTGAGCGCAACGCAATTAATGTGAGTTAGCTCACTCATTAGGCACCCCAGGCTTTACACTTTATGCTTCCGGC
TCGTATGTTGTGTGGAATTGTGAGCGGATAACAACCATGGGTTGGGAAGCTTCCACCGAACGTATGTACCCGGAAGA
CGGTGCTCTGAAAGGTGAAATCAAAATGCGTCTGAAACTGAAAGACGGTGGTCACTACGACGCTGAAGTTAAAACCA
CCTACATGGCTAAAAAACCGGTTCAGCTGCCGGGTGCTTACAAAACCGACATCAAACTGGACATCACCTCCCACAAC
GAAGACTACACCATCGTTGAACAGTACGAACGTGCTGAAGGTCGTCACTCCACCGGTGCAGACGTTATCAAAGTTAA
T
```

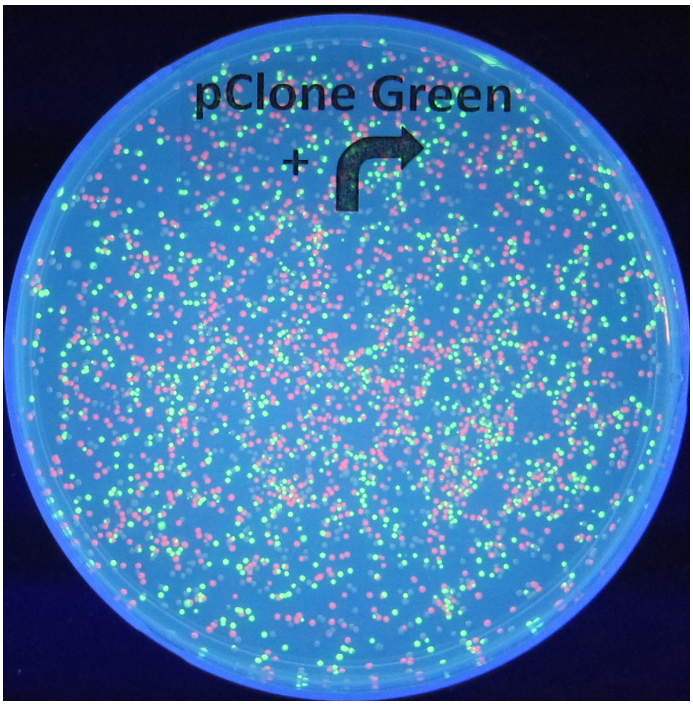
Provide a reasonable explanation to describe the relationship between sequence #1 and this sequence we will call sequence #3. Support your answer with a screenshot.
Answer Limit: a maximum of two sentences.



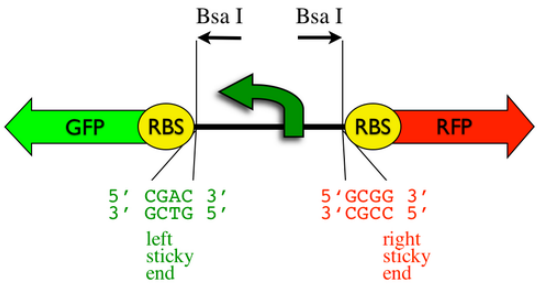
One intron with two exons. Longer sequence is gene and shorter sequence is cDNA or RNA converted to DNA code.

10 pts.

4) The photo here provides you with sample data similar to what you might produce in lab using plasmid J119137. Identify the different color colonies you see in the photo and explain how each color was produced. For this question, the promoter you were trying to test contained the sequence `TAWA`, where W could be either T or A. When the company synthesized this promoter, it put in the base T half of the time and A half of the time in place of the W indicated above. Support your answer with data from the gallery.
Answer Limit: Three sentences plus the number of your supporting data figure.



red = new functional promoter (TATA)
green = original promoter
no color = no promoter or bad promoter (TAAA)
see figure #9 that TAAA << TATA



Lecture Questions:

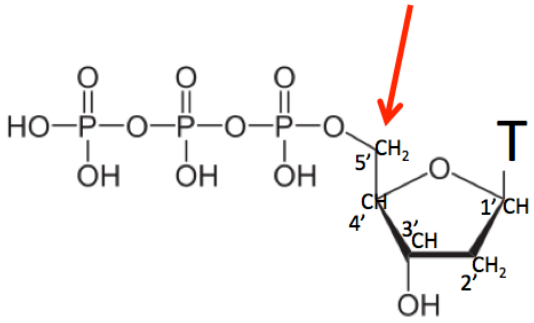
15 pts.

5)

a) In the space below, draw a picture of one deoxyribonucleotide triphosphate and add the single letter for the only base that would reinforce that you have drawn a deoxyribonucleotide. Your drawing should include every atom and bond in the sugar.

b) Number the carbons in your diagram.

c) Add an arrow to show which numbered carbon in your drawing would be closest to the nucleotide polymerized immediately before your nucleotide is incorporated into the polymer.

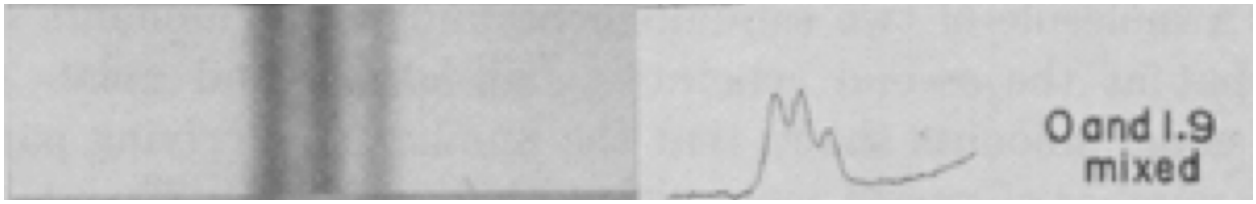


You should leave off the H on the OH's.

8 pts.

6) The image below was taken from Meselson and Stahl's classic experiment. Use this one row from their figure to answer this question. Which of the three models could be ruled out from this one row (0 = zero rounds of replication and ~2 rounds of replication)? You must use the data from this one row to support your answer.

Answer Limit: Three sentence maximum.



disproves both

conservative = only 2 bands, all light and all heavy

mosaic = only 2 bands, all heavy and 75%light/25% heavy

15 pts.

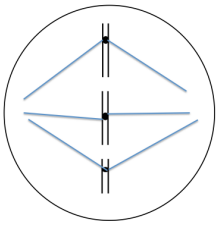
7)

a) Where do TFs and RNA polymerase bind in a gene? Support your answer with at least two data figures from the gallery. Explain how the data support your answer. *Answer Limit: Three sentence maximum.*

promoters. Figures #5 and #6 full credit. Half credit for #9, #2, #20 since they only show RNA polymerase binding

b) What is a signal sequence? What data did you produce in class that showed where signal sequences are located? *Answer Limit: Two sentence maximum.*
first 20ish amino acids of a protein being translated, causes ribosome to pause, dock on rER and then complete translation. We did a BLAST2 of insulin pre- and post- digestion.
c) Where in a cell is insulin translated? Be as specific as you can. *Answer Limit: One sentence maximum.*
rER

18 pts.
8)
a) Name two cell types in the pea plant that are products of meiosis. *Answer Limit: One sentence maximum.*
pollen and egg
b) Why can't you use Mendel's laws when looking at flu genetics? Support your answer with an image from the data gallery. *Answer Limit: Two sentence maximum.*
Mendel's laws (segregation and independent assortment) only apply to meiosis and flu does not go through meiosis. Flu randomly gathers 8 RNA chromosomes and in doubly infected cell, any 8 molecules can be grabbed randomly.
c) Draw a picture of metaphase II for a diploid species that has a total of 6 chromosomes.



d) If steroids can enter every cell in your body, why doesn't every cell in your body initiate transcription of the same genes? Support your answer with data. *Answer Limit: Two sentence maximum.*
steroids must bind to receptor to initiate transcription (figure #12 – move from cytoplasm to nucleus) and only a subset of cells have steroid receptors in cytoplasm.
e) Prophase I is unique for two main reasons. List the two unique aspects of prophase I and then explain the functional significance of both aspects you listed. *Answer Limit: One sentence maximum for each reason.*
1. homologous chromosomes come together and get separated according to law of segregation and law of independent assortment

2. recombination on all 4 chromatids when homologous chromosomes are together.

10 pts.

9) Fall is when many mammals mate so their offspring can be born in the spring. A short-eared, white, male rabbit matted with a long-eared, brown, female rabbit. They produced 45 offspring, all of which were brown with long ears. You found two of their F_1 bunnies and raised them together. One was called Robert and the other was named Doug. In the spring, you discovered Robert should have been named Roberta!

a) If Roberta and Doug produced 64 offspring, how many would you expect to have white fur and long ears? (show your work if you want to be eligible for partial credit) *Answer Limit: One sentence maximum.* 12/64

b) How many would you expect to look like the P generation female? *Answer Limit: One sentence maximum.* 36/64

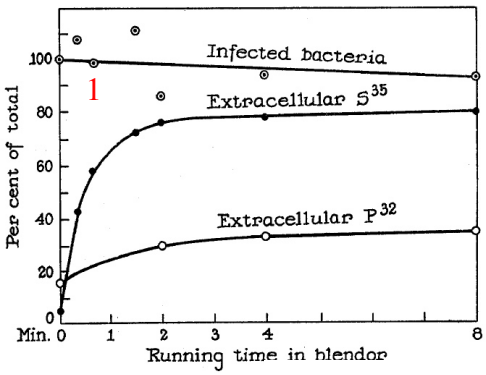
c) How many would you expect to be homozygous recessive for both traits? *Answer Limit: One sentence maximum.* 4/64

Bonus Question +2 pts: A human couple conceived two children separated by a year in age. Both parents are homozygous wild-type for a particular disease gene and neither has the disease. However, one child has the disease and the other one does not. The parents had their children's DNA sequenced but they found no differences between the parents and both children. Explain this clinical case. The children were not adopted and the parents are the biological parents. *Answer Limit: Two sentence maximum.*

epigenetic regulation of genes, not mutations

Data Gallery

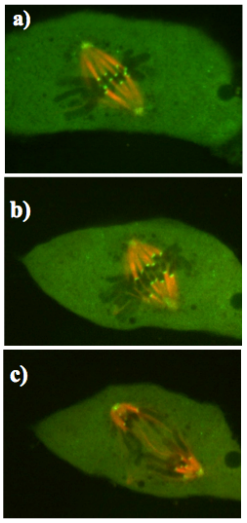
1



2

```
V-T7    5′ ...TAAACACGGTACGATGTACCACATGAAACGACAGTGAGTC... 3′
V-fd    5′ ...GCTTCTGACTATAATAGACAGGGTAAAGACCTGATTTTTG... 3′
V-SV40  5′ ...ATTGCAGCTTATAATGGTTACAAATAAAGCAATAGCA..... 3′
V-1     5′ ...ACTGGCGGTGATACTGAGCACATCAGCAGGACGCACTGAC... 3′
B-tRNA  5′ ...GTCATTTGATATGATGCGCCCCGCTTCCCGATAAGGGAGC... 3′
B-Lac   5′ ...TCCGGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAA... 3′
```

3



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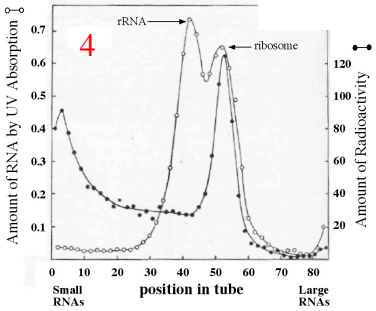
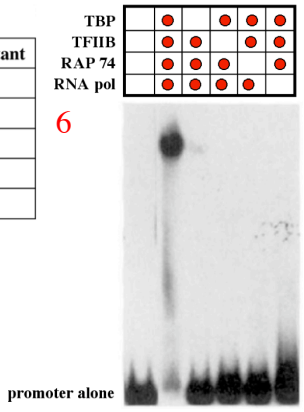


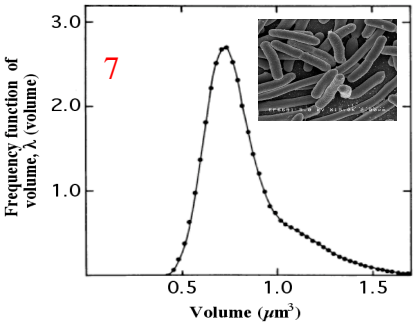
5

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

6



7



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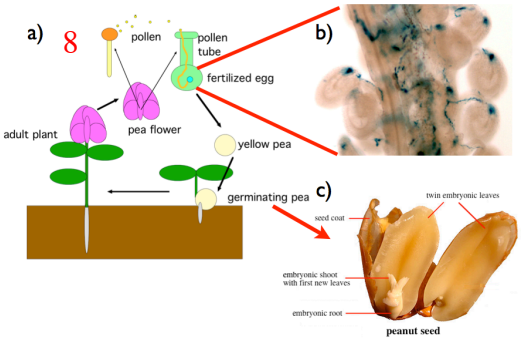
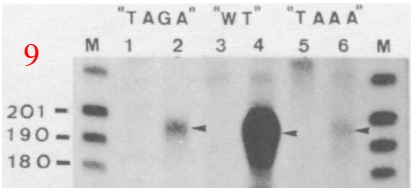
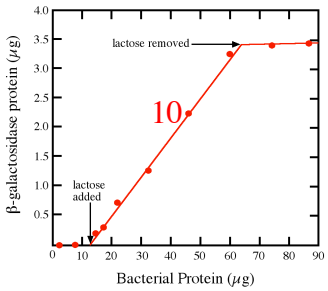


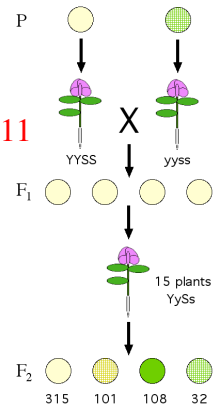
9



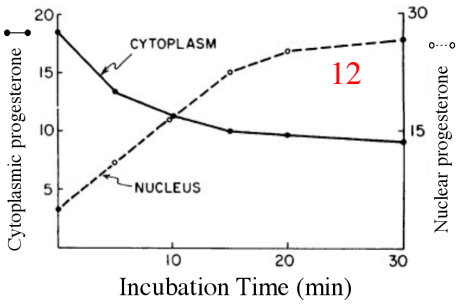
10



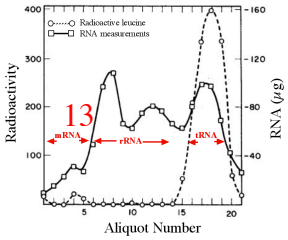
11



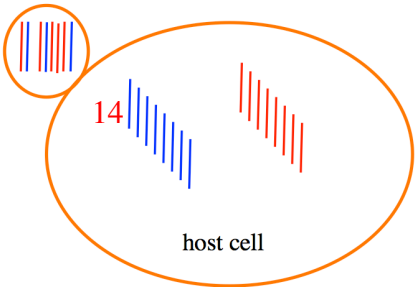
12



13



14



15

16

Cell volume 0.70 – 0.75		
Current # of cells in this volume category		100
Minus cells grown to larger volume category	100*0.08	- 8
Plus cells grown from smaller volume category	50*0.08	+ 4
Plus twice # cells that were 1.4 – 1.5 µm³ and divided in half	2*0.1*50	+10
Equals new # of cells after 10 seconds		106

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Table 1.1 Comparison of four independent preparations of the transforming factor and purified DNA.

Sample #	% carbon, C	% hydrogen, H	% nitrogen, N	% phosphorus, P	N/P ratio
37	34.27	3.89	14.21	8.57	1.66
38B	no data	no data	15.93	9.09	1.75
42	35.50	3.76	15.36	9.04	1.69
44	no data	no data	13.40	8.45	1.58
Pure DNA	**34.20**	**3.21**	**15.32**	**9.05**	**1.69**

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Table 2.2 Amount of radioactive RNAs per milligram of total RNA.

Type of RNA	Radioactivity after 7 minutes	Radioactivity after 30 minutes
tRNA	8,620	12,400
rRNA (small)	1,260	2,660
rRNA (large)	714	2,160

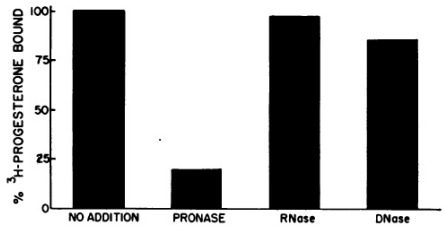
19

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

20

	% β-galactosidase induction		% Permease induction	
Genotype	**- lactose**	**+ lactose**	**- lactose**	**+ lactose**
$I^+ O^+ \beta^+ P^+$	1	100	1	100
$I^- O^+ \beta^+ P^+$	100	100	90	90
$I^+ O^+ \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	240	1	270
$I^D O^+ \beta^+ P^+$	1	1	1	1
$I^D O^+ \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	2	1	3
$I^+ O^- \beta^+ P^+$	<1	<1	<1	<1
$I^+ O^- \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	100	1	100

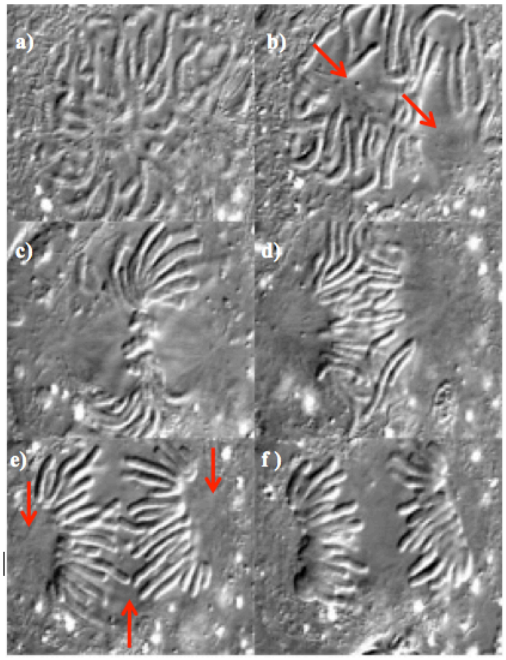
21



22

Time	Incorporation into long DNA polymers	
	pmoles ^{32}P primers	pmoles ^{3}H dNTPs
0 minutes	14.4	4.5
20 minutes	74.4	480.0
40 minutes	78.6	765.0
80 minutes	82.2	1062.0

23



24

Generation	Green Peas	Yellow Peas
P	5 true-breeding green plants	5 true-breeding yellow plants
F_1	0 green peas	273 yellow peas
F_1	0 plants from green peas	258 plants mature from F_1 yellow peas
F_2	2,001 green peas	6,022 yellow peas

25

Second Base in Codon

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