Biology 113 Closed Book Take-Home Final Exam

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 final exam, including this cover sheet. 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 by 5pm Thursday Dec. 13. **HARD COPY of your EXAM IS DUE NO LATER THAN 5pm THURSDAY DECEMBER 13th**. If you turn in your exam late, then you lose a letter grade for each day you are late. The **answers to the questions must be typed directly under the questions** unless the question specifically says to write the answer in different place. If you do not write your answers in the appropriate location, I may not find them.

I have provided you with a "Data Gallery" in the form of figures and tables. To choose a figure in support of your answer, state Figure #x and do NOT move the image 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, however. 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 together when finished with the exam. Do not print test pages without answers. I only want to see your answers. You can type your answers right under each question.

Name (please type here):

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 Questions

10 pts.

1) Use CLUSTAL omega (https://www.ebi.ac.uk/Tools/msa/clustalo/) and three attached files to evaluate. The Word file contains two experimental sequences and one reference sequence. There are also two chromat files for the two experimental sequences. You will want to view the relevant chromat files (.ab1) to see if you can override any N bases. You can use the "find" function to locate non-N bases adjacent to the bases you want to evaluate. Once you have determined the correct bases for any Ns, then perform Clustal omega and **determine the *minimum* number of bases you would have to change to get both experimental sequences to match the reference sequence**. Maximum of 10 words for each experimental sequence.

Close:

Far:

Lecture Questions:

10 pts.

2) Weight, weight, don't tell me.

a) Propose an explanation for why obesity often generates many other health complications. Support your answer with two data figures. Maximum of 40 words in total.

1.
2.

b) Analyze one experimental human data from the gallery to explain how the lipostat works. Tell me which figure you chose. Maximum of 40 words.

15 pts.

3) Don't hold your breath if you want to get full credit for this question.

a) Incorporate data from two gallery images to explain why hemoglobin is an ideal delivery protein to supply oxygen where it is needed most. Maximum of 30 words for each figure.

1.
2.

b) What molecular movement produces hemoglobin's emergent property? Support your answer with an image from the data gallery. Maximum of 40 words.

15 pts.

4) Don't anthropomorphize molecules, they hate that.

a) Summarize the emergent property of the lambda switch shown in data gallery #29 and how this property permits phage to choose a particular lifestyle. Maximum of 40 words.

b) Use figures #27 and #35 to explain the consequence when a genetic circuit is long or short. Maximum of 30 words for each figure.

#27:

#35:

10 pts.

5) One for all, and all for one!

a) Use the data to show how the methods in figure #34 detected two different cellular components that affect bioluminescence production. Maximum of 40 words.

b) What mechanism allows slime mold cells to migrate towards a common meeting area? Support your answer with data. Maximum of 40 words.

10 pts.

6) What doesn't kill you makes you stronger.

a) What is the function of MHC I in a normal immune response (that does not involve transplants)? Support your answer with two data figures. Maximum of 30 words for each figure.

1.
2.

b) Differentiate the function of MHC IG from MHC I. Support your answer with data. Maximum of 40 words.

10 pts.

7) Remember, my gray hair is dyed to give the illusion of wisdom and intelligence.

a) Apply the data in figures #9 and #16 to support the disposable soma theory. Maximum of 40 words in total.

b) Propose a mechanism that explains how an animal's physiological response to stress has an impact on longevity. Support your answer with data. Maximum of 40 words.

10 pts.

8) You are the summation of molecular events that began *before* you were conceived.

a) Assemble three figures from the gallery to explain the current model of how X-linked gene dosage is addressed in women. Maximum of 30 words for each figure.

1.
2.
3.

b) Why is *Sry* necessary but not sufficient for male sex determination? Support your answer with two figures from the gallery. Maximum of 30 words for each figure.

1.
2.

c) President Trump has considered registering the genitalia of every baby born in the US as either male or female (see https://www.nytimes.com/2018/10/21/us/politics/transgender-trump-

administration-sex-definition.html). Explain in simple terms why this concept is not supported by science. Support your answer with two data figures. Maximum of 30 words for each figure.

1.
2.

Bonus Question (+4 pts): In the space below, draw two simple diagrams that represents the emergent properties describe in scenarios A and B. Name the emergent property in each scenario. Maximum of 10 words for each scenario.

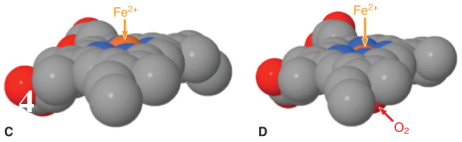
Scenario A: Student reads ahead for the first week of the semester in all classes. When assignments are due, the student does not fall behind and is able to submit all work on time without pulling an all-nighter. Over breaks and weekends, the student continues to read ahead so that the final exam period is all review with no new reading required.

Scenario B: Student falls behind in reading the first week of the semester. When the first test of the semester comes along, the student postpones work in other three classes to focus on the exam. Soon, all classes have assignments due and the student is constantly playing catchup in all courses. When semester break comes along, the student catches up on reading and sleep after pulling multiple all-nighters. When final exam period comes, the student remembers nothing due to cramming and lack of sleep and must pull all-nighters to prepare for final exams.

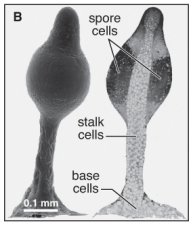
Dr. Campbell's Bio113 Exam #4 – Fall 2018

Data Gallery (3 pages)

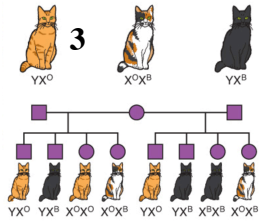
1



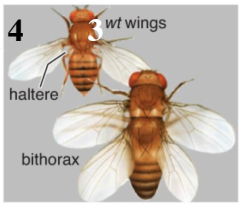
2



3



4



5

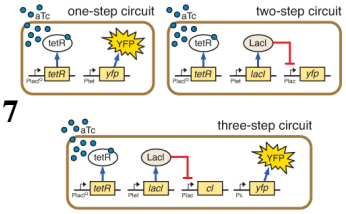
genotype	age (days)	free-feeding mice: body weight (g)	free-feeding mice: weight change (g)	free-feeding mice: percent fat	pair-fed mice: body weight (g)	pair-fed mice: weight change (g)	pair-fed mice: percent fat
wt	20	14.6 ± 0.5*	—	9.5 ± 0.4	15.1 ± 0.6	—	n.d.
wt	48	26.1 ± 0.9	+ 11.5	9.1 ± 0.8	21.4 ± 0.8	+ 6.3	14.9 ± 0.8
ob/ob	20	17.0 ± 0.5	—	23.8 ± 1.1	17.1 ± 0.4	—	n.d.
ob/ob	48	38.6 ± 0.4	+ 21.6	42.3 ± 1.4	25.6 ± 1.0	+ 8.5	43.7 ± 1.0
db/db	20	16.8 ± 0.4	—	24.3 ± 0.9	16.6 ± 0.5	—	n.d.
db/db	48	38.2 ± 0.5	+ 21.4	36.8 ± 0.8	24.3 ± 1.2	+ 7.7	41.7 ± 0.7

*mean values ± standard error of the mean with 4 mice in each group.

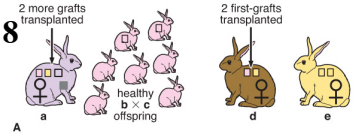
6

trait	high mortality rate: # of flies	high mortality rate: averages	low mortality rate: # of flies	low mortality rate: averages	p values
female development (hours)	389	254	345	272	0.0041
female dry weight (μg)	90	242	90	261	0.0156
fecundity (average # offspring)	340	40.8	322	27.0	0.0035
male development (hours)	389	260	334	276	0.0061
male dry weight (μg)	388	197	332	217	0.0182

7



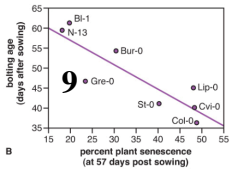
8



experimental conditions	baby skin transplanted to: foster mother A	baby skin transplanted to: unrelated rabbit D	rabbit E skin transplanted to: foster mother A	rabbit E skin transplanted to: unrelated rabbit D
average days graft survived	4.0*	6.5	6.0*	7.0

*indicates $p < 0.01$; experiment replicated 5 times

9

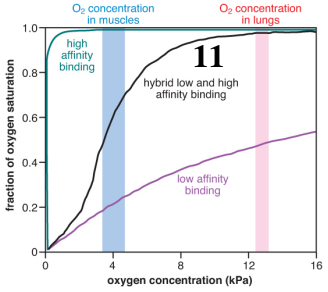


10

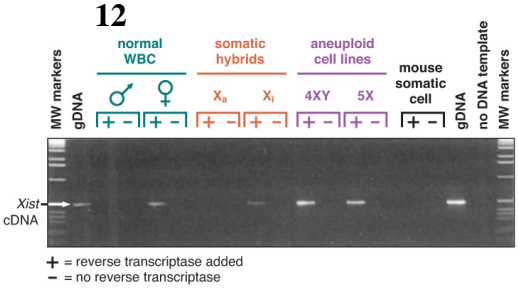
donor → recipient	number of animals	% rejected	average days to rejection ± stdev
male → female	16	0	n.a.
female → female	15	0	n.a.
female → male	15	0	n.a.
male → female	15	100	28 ± 3
male → primed female*	10	100	14 ± 2

*primed female injected with sperm two weeks prior to skin graft.
Modified from *Katsh etal.*, 1946; their Table 1.

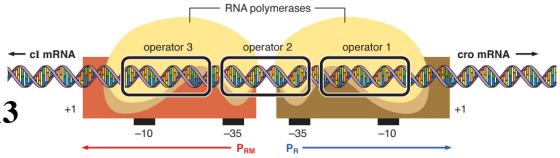
11



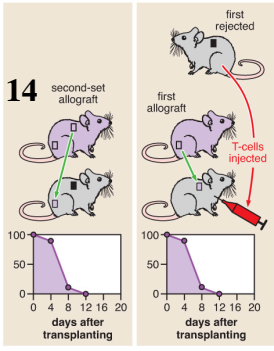
12



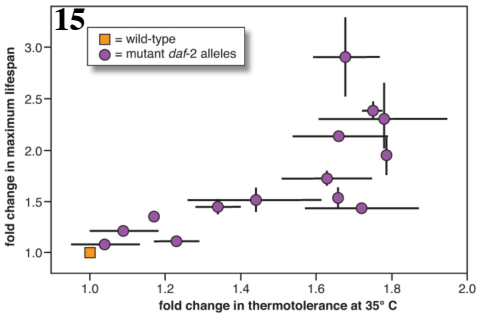
13



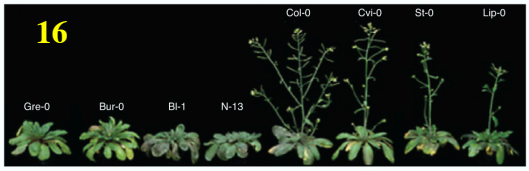
14



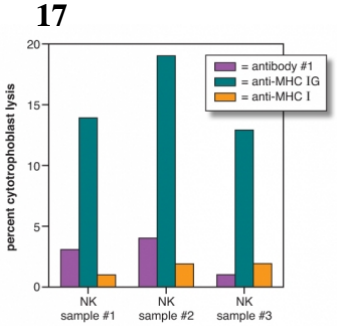
15



16



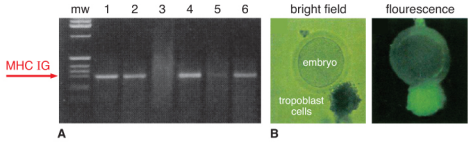
17



18

treatment	strain 1 cells	strain 2 cells
negative control media	delayed	delayed
strain 1 media	immediate	delayed
strain 1 media, filtered	immediate	nt
strain 1 media, boiled	delayed	nt
strain 2 media	delayed	immediate
strain 2 media, filtered	nt	immediate
strain 2 media, boiled	nt	immediate

19

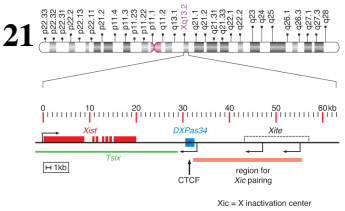


20

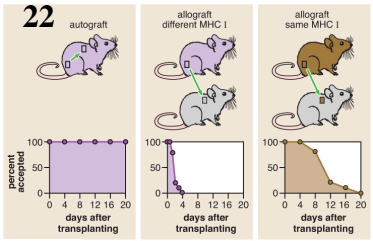
	wild-type	*daf*-2 mutant
median life span (d)	16.3 +/– 1.3	41.0 +/– 2.0
mean brood size	313 +/– 42	8.5 +/- 8*
average progeny (after 10 d)	0	6.6
age (d) when last egg laid	11	50

*$p < 0.005$ +/– standard error

21



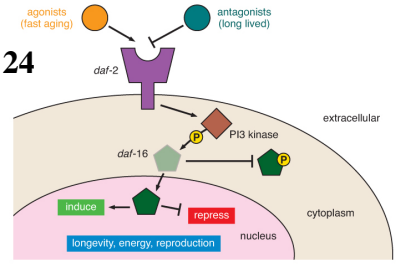
22



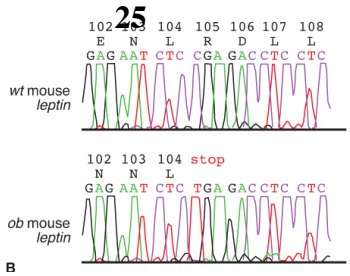
23

Xist RNA	DNA methylation	histone hypoacetylation	relative X^{GFP}	relative X^{Hprt}
wt	*wt*	*wt*	1X	1X
deleted	*wt*	*wt*	2.5X	100X
wt	blocked	*wt*	19X	12X
wt	*wt*	blocked	1X	ND
deleted	blocked	*wt*	30X	4,800X
wt	blocked	blocked	29X	ND
deleted	blocked	blocked	60X	ND
wt	*Dnmt1* deleted	*wt*	1,500X	ND
deleted	*Dnmt1* deleted	*wt*	2,500X	ND

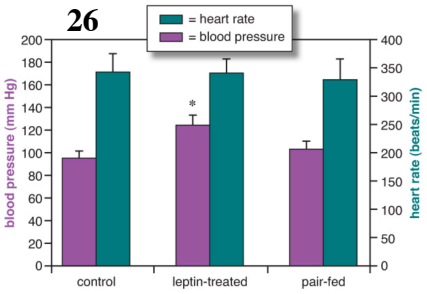
24



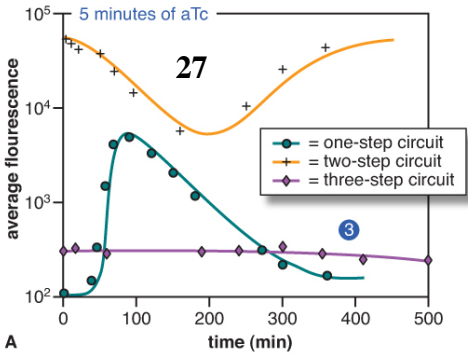
25



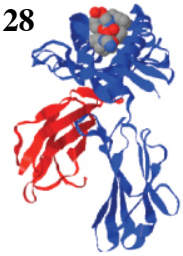
26



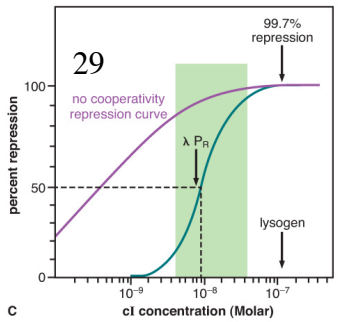
27



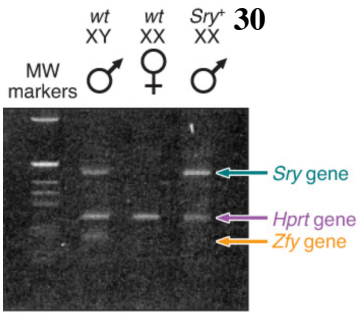
28



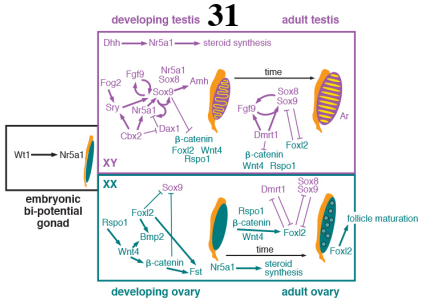
29



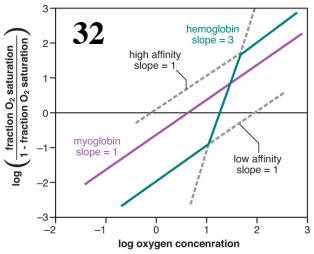
30



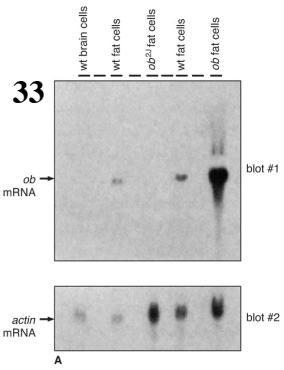
31



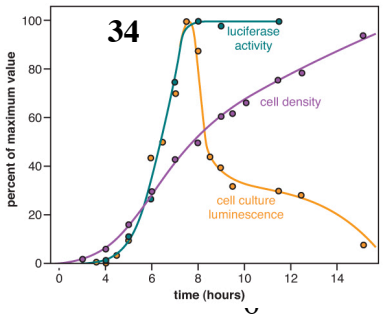
32



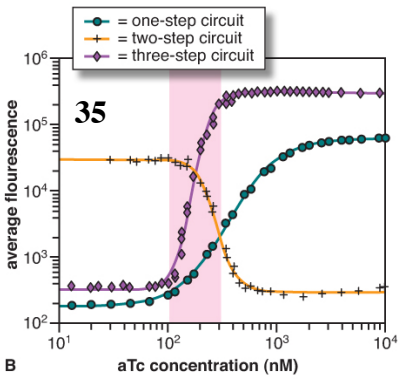
33



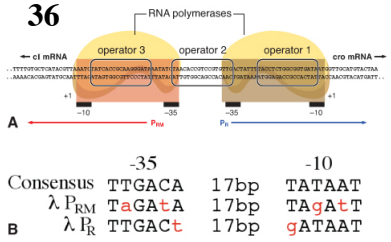
34



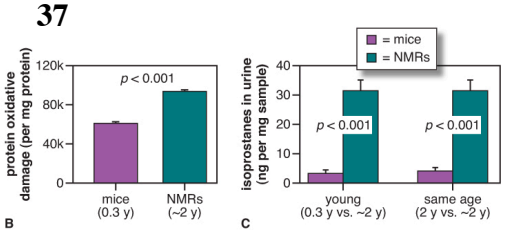
35



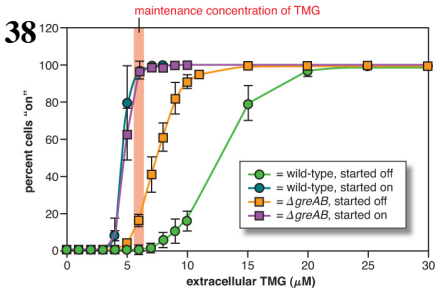
36



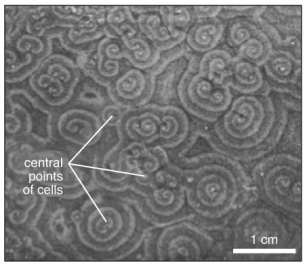
37



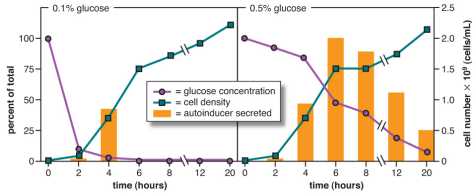
38



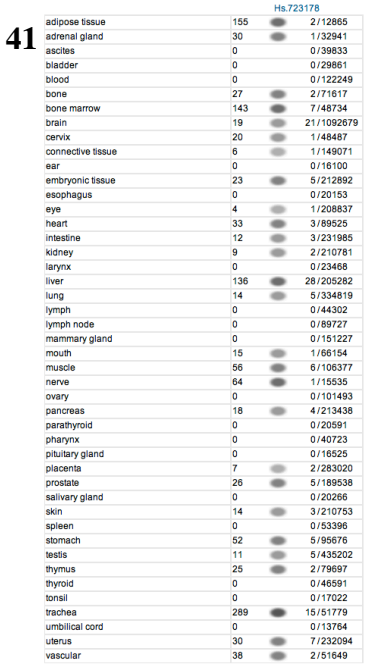
39



40

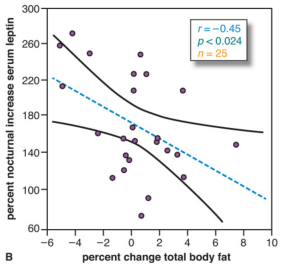


41

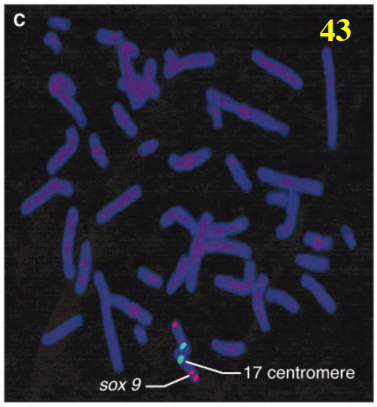


	Hs.723178	
adipose tissue	155	2/12865
adrenal gland	30	1/32941
ascites	0	0/39833
bladder	0	0/29861
blood	0	0/122249
bone	27	2/71617
bone marrow	143	7/48734
brain	19	21/1092679
cervix	20	1/48487
connective tissue	6	1/149071
ear	0	0/16100
embryonic tissue	23	5/212892
esophagus	0	0/20153
eye	4	1/208837
heart	33	3/89525
intestine	12	3/231985
kidney	9	2/210781
larynx	0	0/23468
liver	136	28/205282
lung	14	5/334819
lymph	0	0/44302
lymph node	0	0/89727
mammary gland	0	0/151227
mouth	15	1/66154
muscle	56	6/106377
nerve	64	1/15535
ovary	0	0/101493
pancreas	18	4/213438
parathyroid	0	0/20591
pharynx	0	0/40723
pituitary gland	0	0/16525
placenta	7	2/283020
prostate	26	5/189538
salivary gland	0	0/20266
skin	14	3/210753
spleen	0	0/53396
stomach	52	5/95676
testis	11	5/435202
thymus	25	2/79697
thyroid	0	0/46591
tonsil	0	0/17022
trachea	289	15/51779
umbilical cord	0	0/13764
uterus	30	7/232094
vascular	38	2/51649

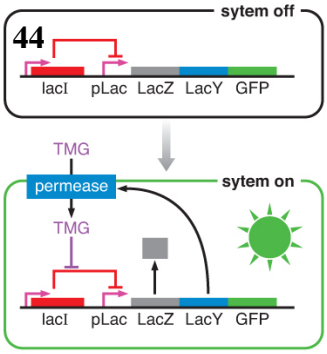
42



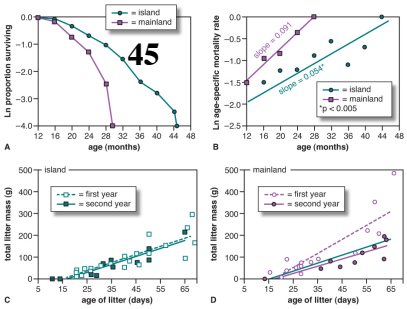
43



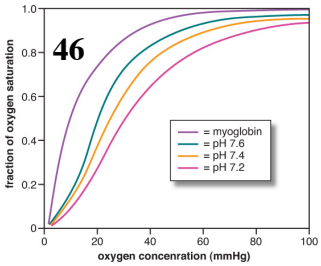
44



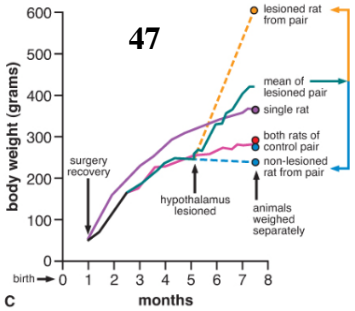
45



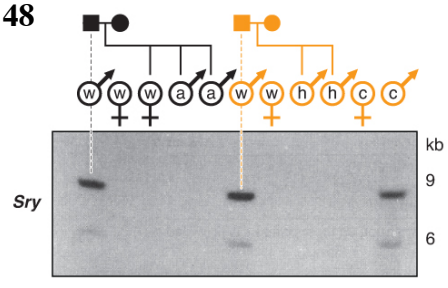
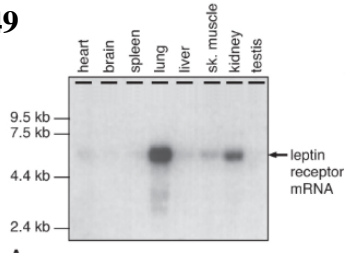
46



47



48



49