

Name: _____

7.012 Exam Three -- 2006

Exam starts at 10:05 am and ends at 10:55 am.

There are 9 pages including this cover page.

Please write your name on each page.

Only writing on the **FRONT** of every page will be graded.
(You may use the backs, but only as scratch paper.)

Question 1 **28 pts**_____

Question 2 **18 pts**_____

Question 3 **33 pts**_____

Question 4 **21 pts**_____

TOTAL **100 pts**_____

Name: _____

1. (28 pts) Below is a list of some potential functions of some new anti-viral drugs that you are considering the possibility of creating and giving to humans:

Drug #1: blocks RNA-dependent RNA polymerases

Drug #2: blocks DNA-dependent RNA polymerases

Drug #3: blocks RNA-dependent DNA polymerases

Drug #4: blocks DNA-dependent DNA polymerases

Drug #5: blocks integrases

Drug #6: blocks ribosomes

(a, 5 pts) Which of these six drugs has been designed to specifically block only retroviruses? List all that apply.

(b, 5 pts) Which of these six drugs would affect the human host? List all that apply.

(c, 5 pts) Why does a (+) strand ssRNA virus NOT have to carry its viral polymerase protein in its capsid...
whereas a (-) strand ssRNA virus MUST carry its viral polymerase protein in its capsid?

Name: _____

(d, 5 pts) Rabies infections are often treated with an anti-rabies monoclonal antibody generated from a horse B cell. A patient is infected with the rabies virus and is given this horse antibody treatment. Five years later, the patient again becomes infected with rabies. The patient is treated with another dose of horse antibody treatment, and has a severe reaction to the treatment. Why did this happen?

(e, 4 pts) In an attempt to avoid this severe reaction, the patient is instead treated with an anti-rabies antibody extracted from human blood. From whom could this antibody have been extracted? Name one reason why such an antibody could exist in the blood of the human from whom it was extracted.

(f, 4 pts) Do you think that the human antibody treatment described in part **(e)** most likely consists of monoclonal or polyclonal antibodies?

2. (18 pts) Say you are studying early development of zebrafish. You find that the gene *Breatheasy* is required for gill formation in zebrafish.
(a, 3 pts) What kind of experiment could you have done to infer this?

Name: _____

(b, 3 pts) What would have been the result of this experiment that led you to this conclusion?

You find that the *Breatheasy* gene is only transcribed in gill cells.

(c, 3 pts) What kind of experiment could you have done to infer this?

(d, 3 pts) What would have been the result of this experiment that led you to this conclusion?

You find that expression of the *Breatheasy* gene is sufficient to induce the organization and formation of extra gills.

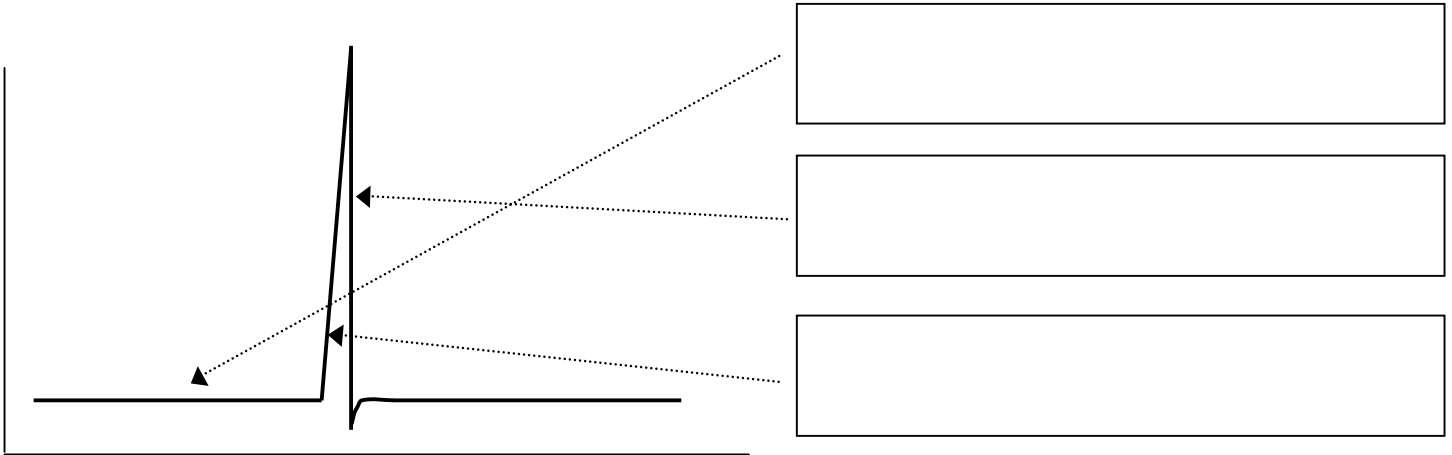
(e, 3 pts) What kind of experiment could you have done to infer this?

(f, 3 pts) What would have been the result of this experiment that led you to this conclusion?

Name: _____

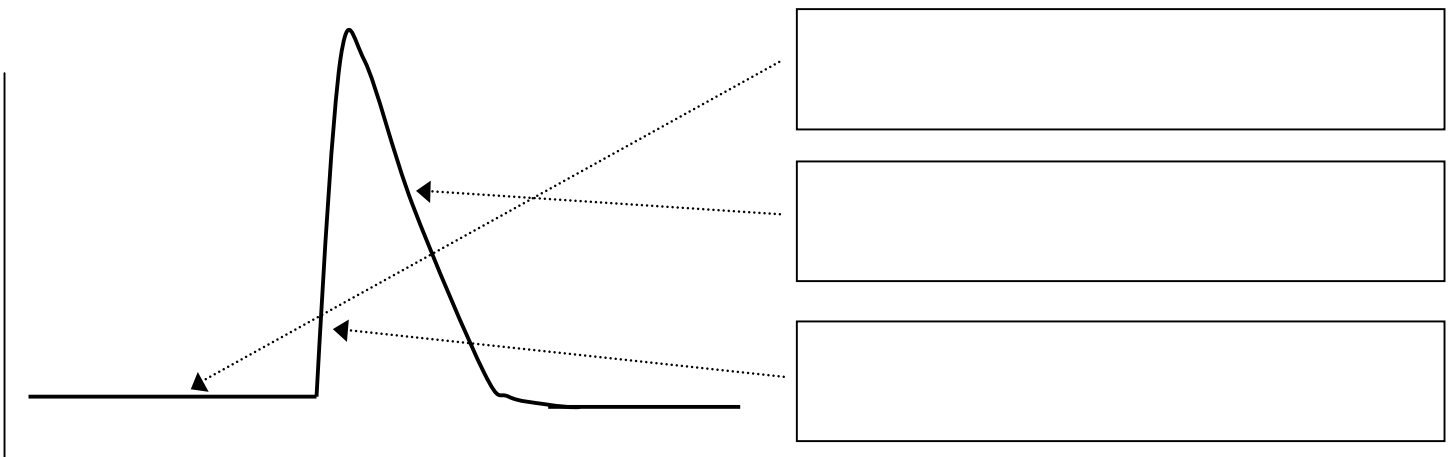
3. (33 pts) Below is a picture of a normal action potential.

(a, 3 pts) Fill in each blank box in this diagram with the **full name** of the channel that allows for that part of the membrane potential to be achieved.



Below is drawn an action potential in a mutant neuron in which a single type of channel has been inactivated.

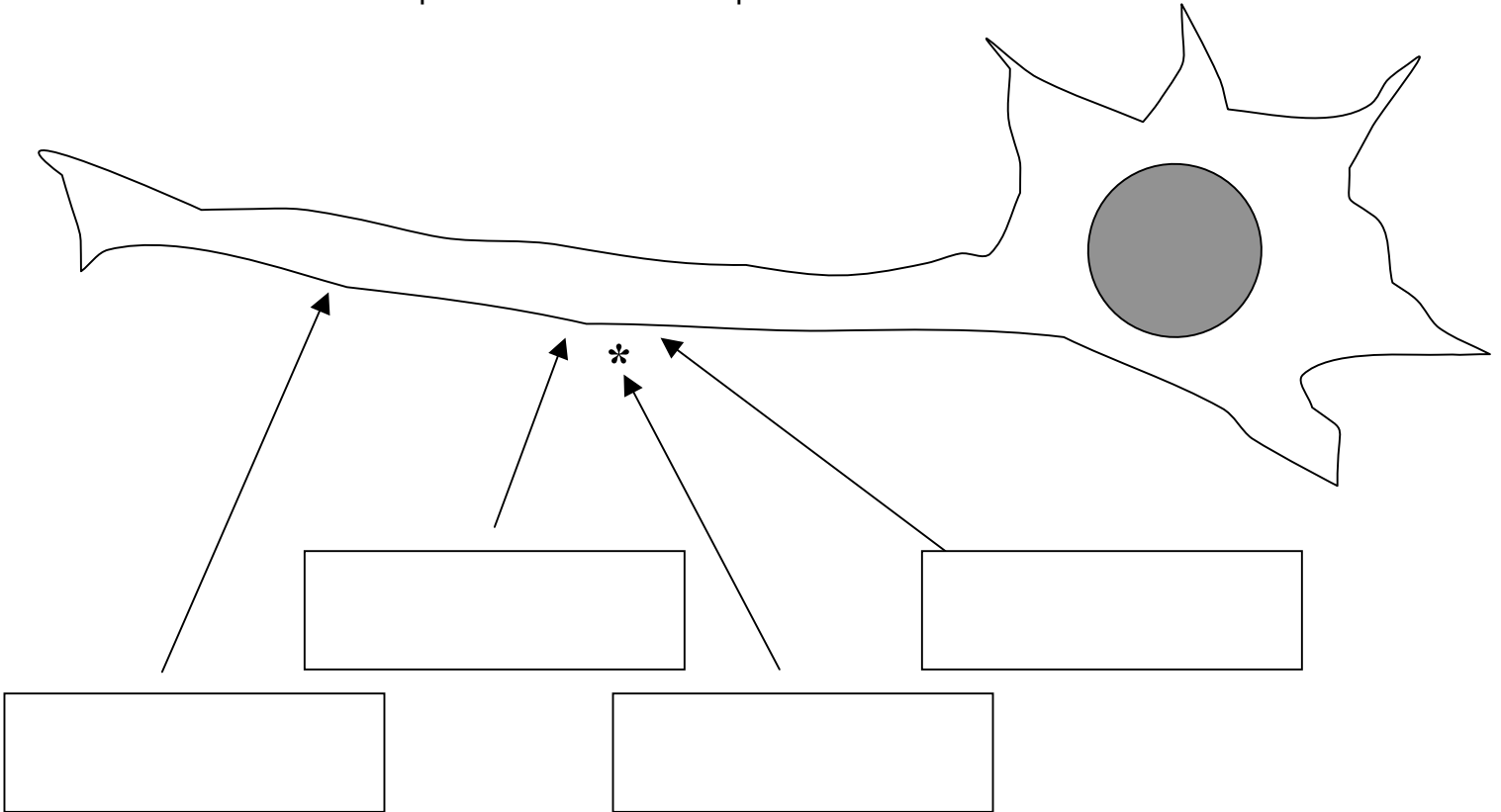
(b, 3 pts) Fill in each blank box in this diagram with the **full name** of the channel that allows for that part of the membrane potential to be achieved in this mutant neuron.



Name: _____

(c, 4 pts) Voltage-gated Na⁺ channels have three states: open, closed, and inactivated. These channels adopt the inactivated state for a brief period of time right after they have just been open. Label the following diagram of a neuron, in which an action potential is occurring at the place marked with a star (*), in the following ways:

- Mark the place where an action potential just occurred with an "X."
- Circle the place where an action potential is about to occur.



(d, 4 pts) At each arrow in the diagram above, fill in the box to indicate whether the voltage gated Na⁺ channels found there would be open, closed, or inactivated.

(e, 5 pts) What is the reason why a normal action potential only propagates unidirectionally down an axon?

Name: _____

(f, 5 pts) What would happen if you inserted an electrode into the middle of an axon that is at rest, and thereby induced a change in the membrane potential at that location to make it -40mV ? Would an action potential result? If yes, how would this action potential be similar and different from a normal action potential? If no, why not?

(g, 5 pts) What would happen if you inserted an electrode into the middle of an axon that is at rest, and thereby induced a change in the membrane potential at that location to make it -60mV ? Would an action potential result? If yes, how would this action potential be similar and different from a normal action potential? If no, why not?

(h, 4 pts) All synapses need a way to stop signaling from occurring continuously after an initial signal has been sent. How is this signal termination accomplished at nerve-muscle synapses?

Name: _____

4. (21 pts) The following is a description of the pathway in which Ras acts. A growth factor binds to the growth factor receptor, causing it to form dimers. This activates the enzymatic activity of the receptor, leading to activation of a protein that helps Ras bind to GTP instead of GDP. Active Ras activates a protein called MAPK. Active MAPK phosphorylates a transcriptional activator. When the transcriptional activator is phosphorylated, it undergoes a conformational change that allows it to be imported into the nucleus, where it turns on expression of its target genes.

(a, 3 pts) What is the highest level of protein structure for the receptor protein that is altered during the action of this pathway? (Your choices are: primary, secondary, tertiary, or quaternary.)

(b, 5 pts) Are the target genes of this pathway expressed under the following conditions, in the following cells? Fill in each block of this table with the word “yes” or the word “no.”

GROWTH CONDITIONS

<i>Mutant property of cell</i>	<i>NO growth factor present in the environment</i>	<i>Growth factors are present in the environment</i>
None (cell is wild-type)		
Ras cannot hydrolyze GTP		
Receptor cannot form dimers		
Receptor protein lacks transmembrane domain		
Activator protein has an aspartate at the position where it is normally phosphorylated		

Name: _____

(c, 5 pts) At what level are these genes regulated in this pathway? Your choices are: transcriptionally, post-transcriptionally, translationally, post-translationally.

-- the growth factor receptor

-- Ras

-- MAPK

-- The transcriptional activator

-- The target genes of this pathway

(d, 4 pts) Is the growth factor receptor gene a tumor suppressor gene or an oncogene?

(e, 4 pts) Which kind of mutation in the MAPK gene would promote the development of cancer, a loss-of-function mutation or a gain-of-function mutation?