

BIOE/BIOP/MCB/NEUR 419
EXAM 1 (20 pts total)
Spring 2007

Name: _____

(Provide the best response to each question. 20 questions, 1 point per question)

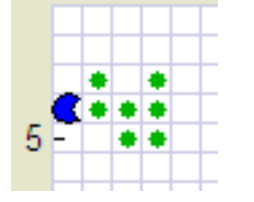
1. Life on earth is about 4 billion years old. Animals with nervous systems have existed for approximately what fraction of that time?
 - a) 1%
 - b) 5%
 - c) 15%**
 - d) 50%

2. In the evolutionary history of life on earth, unsegmented worms appeared earlier than segmented worms. *C. elegans* is a modern day example of an unsegmented worm and the earthworm is an example of a segmented worm. **TRUE / FALSE**

3. In Stephen Hawking's opinion, some aspect of human behavior represents a critical stage in evolution, comparable in importance with the development of DNA. What is that new aspect and why does Hawking think it is so important?

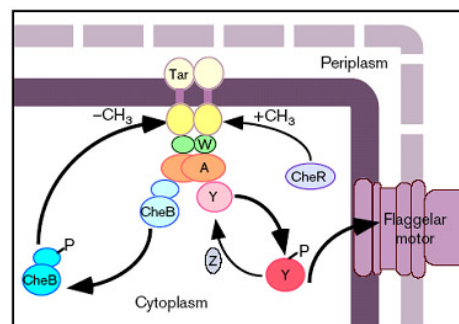
Language (particularly written language) allows information to be transmitted from one generation to the next much faster and with broader distribution than can occur via the genetic code. Evolution of information processing systems can progress much faster, without relying on DNA.

4. Consider the following scenario as in Homework #1. Recall that `bot('fwd')` moves the bot forward one square and `bot('left')` rotates the bot to the left without moving to a new square. How many food bits would the bot consume using the control code shown below?

	<pre> if (bot('sensor')==0) bot('left'); end bot('fwd'); </pre>
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- a) 3 food bits
 - b) 4 food bits
 - c) 5 food bits**
 - d) 7 food bits
5. Locomotor capabilities are important for microbes that have adopted a hunting life style that allows them to move to more favorable environments, while chemical secretion is more important for microbes with a farming life style that allows them to modify their local environment.

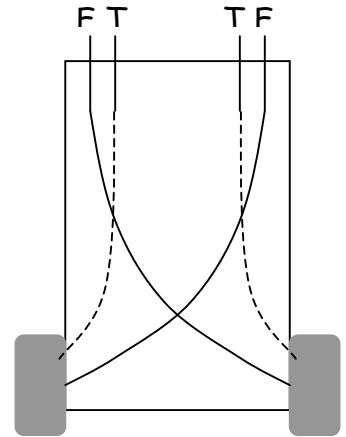
6. In the diagram to the right, the biochemical principles governing interactions among the various elements are most closely related to the _____ component of the information processing system.



- a) syntactic**
- b) semantic
- c) pragmatic
- d) hedonic

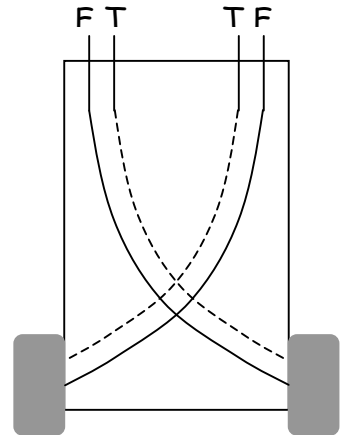
7. In bacterial chemotaxis, high internal levels of phosphorylated CheY protein occur when the organism is moving down an external concentration gradient of a chemo-attractant. This relationship is most closely associated with the _____ component of the information processing system.

- a) syntactic
- b) semantic**
- c) pragmatic
- d) platonic



8. The Braitenberg vehicle to the right has two food sensors (F) and two toxin sensors (T). Sketch the connection diagram that would allow this vehicle to approach food and avoid toxin. The vehicle should speed up as it get closer to food and slow down as it gets closer to toxin.

Use SOLID LINES to indicate EXCITATORY CONNECTIONS and DASHED LINES to indicate INHIBITORY CONNECTIONS.



Either of the two figures shown on the right

9. In terms of signaling mechanisms, list two ways in which a paramecium is like a neuron:

any two of: **electric signaling, entry of ions through ion channels, able to signal both excitation (depolarization) and inhibition (hyperpolarization), signal is conducted rapidly through entire cell, coordinates activity of entire cell**

10. Volvox (spherical colonial algae) tend to cluster in brighter regions of their environment. Which of the following mechanisms is responsible for this behavior:

- a) the flagella of all the cells in the colony speed up in the light
- b) the flagella of all the cells in the colony slow down in the light
- c) the flagella on the brighter side of the sphere beat faster
- d) the flagella on the brighter side of the sphere beat slower**

11. The zigzag motion of a moth tracking back and forth across a pheromone plume is indicative of which of the following control strategies:

- a) orthokinesis
- b) klinokinesis
- c) klinotaxis**
- d) tropotaxis

12. In Dusenbery's view, what are the three converging information pathways that influence an organism's behavior and over what time scales do they process/store information?

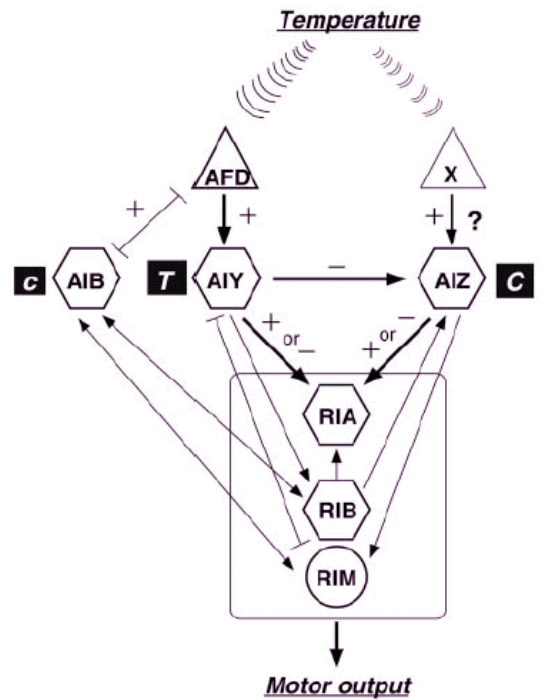
PATHWAY	TIMESCALE
a) <u>genome</u>	<u>evolutionary (multiple generations)</u>
b) <u>memory</u>	<u>individual organism's lifetime</u>
c) <u>sensory</u>	<u>immediate state of environment</u>

13. Sowbugs (also called pillbugs, woodlice, roly-polies) are often found under rocks, boards and other damp places. In dry areas, sowbugs generally increase their level of locomotor activity; once they find a damp spot, they tend to slow down and become almost motionless. This behavior is best described as a type of:

- a) tropokinesis
- b) orthotaxis
- c) tropotaxis
- d) orthokinesis**

14. In the diagram to the right, AIB is a(n):

- a) sensory neuron
- b) interneuron**
- c) motor neuron
- d) accessory neuron



15. In *C. elegans*, a neuron with its cell body in the nerve ring near the head and a long neurite projecting along the ventral nerve cord is most likely a:

- a) sensory neuron
- b) primary (sensory) interneuron
- c) secondary (pre-motor) interneuron**
- d) motor neuron

16-19. One hundred bots are initially distributed at random in an environment with smoothly varying regions of light intensity. All the bots in the population then run the same controller code. For each of the following blocks of code, use the letters B, D or R to indicate whether the final distribution of bots would tend to be:

(B) biased toward **brighter** regions of the environment

(D) biased toward **darker** regions of the environment

(R) **randomly** distributed in the environment

16. B	<pre> if(sensor.light(L) < sensor.light(R)) motor.wheel(L) = 1.0; motor.wheel(R) = 0.5; else motor.wheel(L) = 0.5; motor.wheel(R) = 1.0; end </pre>
17. D	<pre> motor.wheel(L) = sum(sensor.light) + 0.1*rand; motor.wheel(R) = sum(sensor.light) + 0.1*rand; </pre>
18. D	<pre> motor.wheel(L) = -1*sum(sensor.light) - 0.1*rand; motor.wheel(R) = -1*sum(sensor.light) - 0.1*rand; </pre>
19. R	<pre> motor.wheel(L) = sensor.light(L) - sensor.light(R); motor.wheel(R) = sensor.light(R) - sensor.light(L); </pre>

20. A perceptron neuron has three inputs A , B and C . Each input can be either 0 or 1. The output of the perceptron is 1 if the weighted sum of the inputs exceeds a threshold θ , and is 0 otherwise.

Let A , B and C stand for Apples, Bananas and Cauliflower. As part of a feeding circuit, we want to design a perceptron that gives an output of 1 if and only if fruit (apples and/or bananas) is present and cauliflower is absent.

Find a set of weights and threshold value that will accomplish this goal:

w_A : 1 w_B : 1 w_C : -2 θ : 0.5

Using your selected values, fill in the table below showing the weighted sum and the output of the perceptron for all 8 possible combinations of A , B and C .

A	B	C	WEIGHTED SUM: ($w_A A + w_B B + w_C C$)	PERCEPTRON OUTPUT
0	0	0	0	0
0	0	1	-2	0
0	1	0	1	1
0	1	1	-1	0
1	0	0	1	1
1	0	1	-1	0
1	1	0	2	1
1	1	1	0	0

Note: other solutions are possible, this is one example

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