27020_F23_SIM

Der anvendes en scoringsalgoritme, som er baseret på "One best answer"

Dette betyder følgende:
Der er altid netop ét svar som er mere rigtigt end de andre
Studerende kan kun vælge ét svar per spørgsmål
Hvert rigtigt svar giver 1 point
Hvert forkert svar giver 0 point (der benyttes IKKE negative point)

The following approach to scoring responses is implemented and is based on "One best answer"
There is always only one correct answer – a response that is more correct than the rest
Students are only able to select one answer per question
Every correct answer corresponds to 1 point
Every incorrect answer corresponds to 0 points (incorrect answers do not result in subtraction of points)

Which of the following properties of living systems is not constrained by basic physical laws?

Choose one answer

- ◯ Size of living cells
- ◯ Height of trees
- ◯ Body size of land animals
- ◯ Complexity of synaptic connectivity √

Why are dissipative structures relevant for understanding life?

Choose one answer

- ○ Because biological systems can be chaotic.
- ○ Because convection plays an important role in biology.
- ○ Because they demonstrate the generation of local order through overall entropy production. ✓
- ○ Because heat transport is crucial for the maintenance of biological systems out of equilibrium.

How many kg of phosphate ions are split off from adenosine triphosphate (ATP) per day in an average human (2000 kcal energy consumption)?

Choose one answer

- ◯ Ca. 13 kg
- ◯ Ca. 35 kg
- ◯ Ca. 70 kg ✓
- ◯ Ca. 7 kg

What is CORRECT about diffusion?

Choose one answer

- ◯ Diffusion coefficient scales inversely with particle size. ✓
- ◯ Diffusion is the fastest transport process in an animal.
- ◯ The diffusional flux is proportional to the square of the concentration gradient.
- ◯ Diffusion time scales linearly with diffusion distance.

Which are the most abundant chemical elements in living systems on earth?

Choose one answer

- ◯ Carbon, oxygen, phosphorus, nitrogen, sulfur, hydrogen ✓
- ◯ Carbon, oxygen, manganese, iron, hydrogen, helium
- ◯ Nitrogen, oxygen, phosphorus, hydrogen, cobalt, sodium
- ◯ Carbon, nickel, selenium, nitrogen, hydrogen, potassium

What are antibodies not used for?

Choose one answer

- ○ Diagnostics
- ○ Tissue staining ✓ coloring tissues using dyes
- ○ Therapeutics
- ○ Cell adhesion ?

Which of the following diseases is not linked to protein misfolding and aggregation?

Choose one answer

- ○ Parkinson's disease
- ○ Type I diabetes
- ○ Alzheimer's disease
- ○ Amyotrophic lateral sklerosis (ALS) ✓

Why can non-natural amino acids be included into proteins using the genetic code and ribosomes.

Choose one answer

- ○ Because the genetic code has redundancy.
- ○ Because the genetic code is ambiguous.
- ○ Because the genetic code is universal. √
- ○ Because some bacteria use special ribosomes that can use non-natural amino acids.

Which of the following is an example of an RNA sequence?

Choose one answer

- ○ GAAACCUGGCCAAU
- ○ GWEMAKTSSGQRYL
- ○ gtcatgggtggctg
- ○ GTAATCGTATACGA

How many DNA sequences can be designed to encode the following protein sequence? You should also consider that there are 3 different STOP codons:
Ile-Cys-Tyr-Val-*

Choose one answer

- ○ 144 ✓
- ○ 256
- ○ 864
- ○ 512

$3 \cdot 2 \cdot 2 \cdot 4 \cdot 3$

Order the following by size, smallest to largest:
a2 - Number of amino acid sequences of length 2
d3 - Number of DNA sequences of length 3
a4 - Number of amino acid sequences of length 4
d5 - Number of DNA sequences of length 5

Choose one answer

- a2, d3, a4, d5
- d3, a2, d5, a4
- a2, a4, d3, d5 ✓
- d3, d5, a2, a4

$a_2 = 20^2 \quad a_4 = 20^4 = 16000$

$262144 = d_3 = (4^3)^3 \quad d_5 = (4^3)^5$

What is the expected number of open-reading frames that encode for a 9-long amino-acid sequence (i.e. a very small protein with 9 amino acids) in a 1 mega-base long DNA sequence (i.e. 1e6 DNA base-pairs). Remember that the start codon encodes for methionine but the stop codon does not encode any amino acid, and that there are 3 different stop codons.

Choose one answer

- ca. 1000 ✓
- ca. 1e-3
- ca. 5e-4
- ca. 500

$$2 \cdot 1 \cdot 10^6 \left(\frac{1}{64}\right)\left(\frac{63}{64}\right)^8 \frac{3}{64} =$$

$$= 1300$$

Which of the following traits is most likely to be selectable?

Choose one answer

- ○ Rheumatoid arthritis
- ○ Dementia
- ○ Fear of heights
- ○ Longevity, i.e. longer life span.

Evolution is a process that requires with of the following?

Choose one answer

- ○ A constant environment
- ○ Sexual reproduction
- ○ Natural selection
- ○ Millions of years

Mutations in DNA that can be transmitted to future generations are characterized by which of the following?

Choose one answer

- ○ They occur in germ-line cells
- ○ They provide a benefit
- ○ They have little or no effect
- ○ They occur in somatic cells ✓

Answer the following two True/False questions.
Q1: The theory of evolution was proposed only after the discovery of DNA as the genetic molecules of life.
Q2: Evolution can only be observed in a time scale of millions of years (i.e. requires fossil records)

Choose one answer

- ○ Q1:False, Q2:True
- ○ Q1:True, Q2:False ✓
- ○ Q1:False, Q2:False
- ○ Q1:True, Q2:True

What is the ecological justification for the de-extinction of the tasmanian tiger?

Choose one answer

- ○ It is useful for the spreading of seeds of threatened trees.
- ○ It plays an important role as apex predator to keep prey populations down. ✓
- ○ It prevents disease spread as a scavenger species.
- ○ It is good for ecotourism.

What is a problem resulting from too much nitrogen being introduced into the biosphere through human industrial fertilizer production?

Choose one answer

- ○ Acidification of soil.
- ○ Increase in nitrogen content of air.
- ○ Eutrophication of lakes which lead to algal blooms.
- ○ Destruction of ozone layer. ✓

Which of the following statements does NOT apply to microalgae?

Choose one answer

- ○ they can use CO_2 as carbon source
- ○ they can feed on bacteria
- ○ they can obtain energy from anaerobic respiration ✓
- ○ they can be toxigenic

Microorganisms can exchange genetic material through several processes; which of the ones below is such a process?

Choose one answer

- ○ syntrophy
- ○ conjugation
- ○ fermentation
- ○ mutations

The study of the full complement of proteins expressed by a genome is called

Choose one answer

- ◯ Proteomics ✓
- ◯ Proteome
- ◯ Genomics
- ◯ Protein formation

The primary reason why alphafold2 was substantially more accurate than alphafold was the implementation of transformers rather than recurrent neural networks (RNNs). What makes transformers better than RNNs?

Choose one answer

- ◯ Transformers process amino acid input data
- ◯ Transformers use a lot of non-linear transformations
- ◯ Transformers have existed longer than RNNs and thus implementation is easier
- ◯ Transformers process the entire input all at once and have self-attention ✓

What is the main focus of metagenomics research?

Choose one answer

- ○ Investigating the impact of environmental factors on gene expression
- ○ Analyzing the genetic material of entire microbial communities ✓
- ○ Studying the genetics of individual organisms
- ○ Studying the interactions between different species in an ecosystem

How much information (in bits) can theoretically be stored in a piece of double stranded DNA of 10 million base pairs?

00 01 10 11

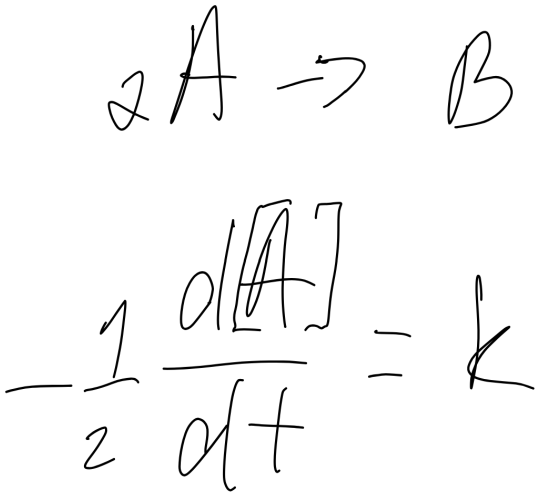
Choose one answer

- ○ 10 million
- ○ 20 million ✓
- ○ 2.5 million
- ○ 5 million

A chemical reaction where 2 molecule of species *A* is converted into 1 molecule of species *B* at the rate of *k*, can be written in Kaemika as, 2*A* -> *{k}B.* The rate of which *A* is consumed can be written as,

Choose one answer

- $\frac{\partial [A]}{\partial t} = k \cdot [A]$
- $\frac{\partial [A]}{\partial t} = -k \cdot [A]$
- $\frac{\partial [A]}{\partial t} = -2 \cdot k \cdot [A]$ ✓
- $\frac{\partial [A]}{\partial t} = -2 \cdot k \cdot [A]^2$



In electronic circuits, the flow of information is called the current and it is measured by the number of electrons passing a given cross-section of the wire during 1 second. This current determines the rate of which circuits are switching, i.e., how fast the concentration of electrons reaches the level which switches the state from 0 to 1. In biology we can express a similar flow of information based on how fast the concentration of a regulating protein reaches a level where it can repress (or induce) the production of another protein. But how is it defined?

Choose one answer

- ○ The number of RNAP (RNA Polymerase) molecules passing any cross-section of the DNA.
- ○ The speed of which the translated string of amino acids fold into the final protein structure.
- ○ The number of base-pairs in the regulator gene in the DNA determines how fast the protein is created.
- ○ The number of RNAP (RNA Polymerase) molecules passing a cross-section of the regulator gene in the DNA. √

Is it possible to program cells to communicate, i.e., one is transmitting while another is receiving?

Choose one answer

- ◯ Yes, but only if the two cells touch each other
- ◯ Yes, but only if the two cells are of the same type
- ◯ Yes ✓
- ◯ No

How can we validate that a gene logic function producing protein *P* works when inserted into a cell?

Choose one answer

- We can use a gene which translates into a fluorescent protein, in the medium surrounding the cell.
- We can add a fluorescent protein into the medium surrounding the cell, which can bind to the gene of protein P.
- We can use a gene which translates into a fluorescent protein, and have it next to the gene producing *P*.
- We can use a gene which translates into a fluorescent protein, and have it been induced by *P* in a separate gene logic function.

Which statement is FALSE about the spinal cord?

Choose one answer

- ○ If the spinal cord is damaged, it can impair movement.
- ○ The spinal cord contains motor neurons that control voluntary movement of the arms and legs.
- ○ The spinal cord must involve the brain in order to generate movement. ✓
- ○ The spinal cord passes ascending sensory signals to the brain.

Which statement is TRUE about a McCulloch-Pitts neuron?

Choose one answer

- ◯ The inputs have weights. ✓
- ◯ It can be used for binary classification.
- ◯ The number of inputs is limited to two.
- ◯ The output of the activation function (f) is calculated first and the summation function (g) is calculated second.

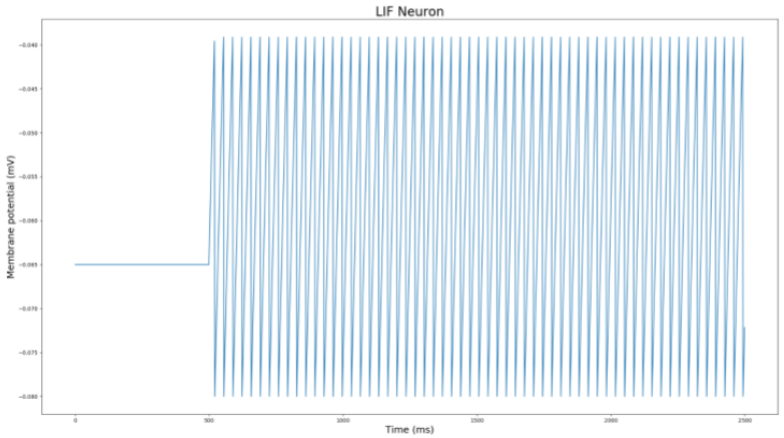
Which of the following is NOT true about signal propagation?

Choose one answer

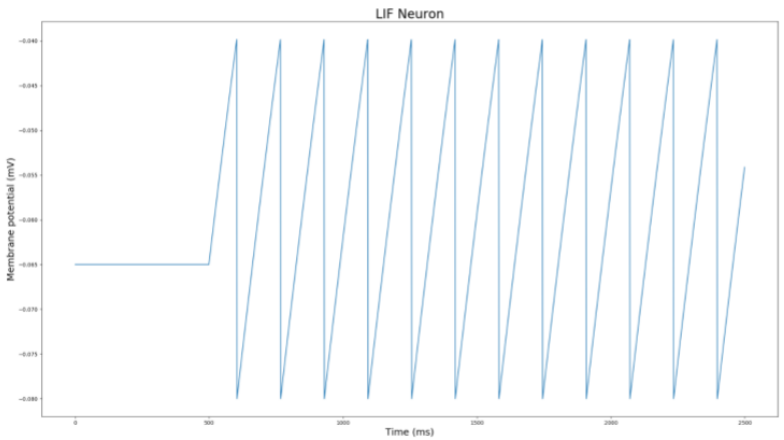
- ○ A neuron changes from stable to firing at a specific threshold. ✓
- ○ A neuron cannot fire when receiving multiple inputs.
- ○ A neuron does not propagate signals when it is in a refractory period.
- ○ When an excitatory pre-synaptic neuron fires, it increases the likelihood of the post-synaptic neuron firing.

Plots A and B show the membrane potential (mV) of a LIF neuron. Which parameter change would produce the difference from plot A to plot B?

A



B



Choose one answer

- ○ Decrease in rest potential
- ○ Increase in capacitance ✓
- ○ Decrease in potential threshold
- ○ Increase in reset potential