CSBL ROUND 3

TOSS-UP

1) Biology – *Multiple Choice* RNA is transcribed from the template of DNA by RNA polymerases. The process of transcribing RNA represents a crucial portion of the central dogma allowing the flow of genetic information from DNA to proteins. Which of the following RNA polymerases transcribes most protein-coding genes?

W) RNA Polymerase I
X) RNA Polymerase II
Y) RNA Polymerase III
Z) RNA Polymerase IV

ANSWER: X) RNA POLYMERASE II

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BONUS

1) Biology – *Short Answer* Identify ALL of the following that a typical mature protein-coding mRNA does NOT contain:

I. Start Codon AUG
II. 3' Cap (read: **3 prime cap**)
III. 5' Cap (read: **5 prime cap**)
IV. PolyU Tail

ANSWER: II - 3' Cap and IV - PolyU Tail

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TOSS-UP

2) Chemistry – *Short Answer* 100 mL of a 6 M HCl solution are added to 500 mL of a Group 2 Hydroxide analyte in order to reach equivalence. What is the molar concentration of the analyte?

ANSWER: 0.6 MOLAR (ACCEPT: 0.6, 0.6 M; DO NOT ACCEPT: 0.6 MOLE)

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BONUS

2) Chemistry – *Short Answer* Rank the following acid-base indicators from most acidic to most basic:
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I. Methyl Orange
II. Methyl Red
III. Phenolphthalein

ANSWER: I, II, III

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TOSS-UP

3) Physics – *Multiple Choice* Cars are able to move due to static friction with the road. A toy car with a mass of 2 kg is travelling on a straight road with a coefficient of static friction of 0.1. Which of the following is the maximum acceleration in m/s^2 that the car can reach without skidding?

W) 1.96
X) 1.0
Y) 0.98
Z) 0.2

ANSWER: Y) 0.98

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BONUS

3) Physics – *Short Answer* A modified atwood machine consists of Block A on a rough surface connected by a massless pulley to a hanging block, Block B. If Block B's mass is half of Block A's mass, what is the minimum coefficient of friction between Block A and the surface necessary for the blocks to remain at rest?

ANSWER: 0.5

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TOSS-UP

4) Earth and Space – *Multiple Choice* Which of the following best describes graupel?

W) Raindrops which do NOT freeze on contact with solid objects
X) Irregular masses of soft ice
Y) Supercooled cloud or fog droplets that freeze upon contact
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Z) Ice particles that form when raindrops freeze as they fall

ANSWER: X) IRREGULAR MASSES OF SOFT ICE

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BONUS

4) Earth and Space – *Short Answer* Identify ALL of the following situations that are likely to occur during an El Niño (read: **El NEEN-yo**) year:

I. Weak Trade Winds
II. Low Levels of Nutrients in the Pacific
III. Increased Flooding in the Gulf Coast

ANSWER: ALL

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TOSS-UP

5) Math – *Short Answer* What is the ordered pair of the point of intersection of the functions $f(x) = (x - 1)^2$ and $g(x) = 2x - 3$?

ANSWER: (2,1)

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BONUS

5) Math – *Short Answer* What is the area of the region enclosed by the line $y = 3x + 1$, the line $x = 3$, and the x- and y-axes?

ANSWER: 16.5

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TOSS-UP

6) Energy – *Short Answer* A team led by research scientists at Lawrence Berkeley National Laboratory have recently attempted to use cell fingerprinting to diagnose Alzheimer's. What is the term for the pairing and ordering of chromosomes?

ANSWER: KARYOTYPING

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BONUS

6) Energy – *Multiple Choice* Scientists at the Berkeley Lab and UC Berkeley have recently created the world's thinnest magnet. Which of the following is the most powerful known type of magnet in the universe?

W) Neutron Star Magnetar
X) Earth's Magnetic Field
Y) Lightning
Z) Iron

ANSWER: W) NEUTRON STAR MAGNETAR

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TOSS-UP

7) Biology – *Multiple Choice* The disease Chronic Myelogenous Leukemia (CML) is caused by a chromosomal abnormality. The resulting chromosome, a Philadelphia chromosome, is an example of what kind of chromosomal defect?

W) Deletion
X) Insertion
Y) Translocation
Z) Duplication

ANSWER: Y) TRANSLOCATION

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BONUS

7) Biology – *Multiple Choice* The formation of a Philadelphia chromosome causes the genes BCR and ABL1 to fuse together. This causes a tyrosine kinase to be constitutively expressed leading to unregulated cell division and cancer. Which of the following drugs was created to bind to the BCR-ABL1 enzyme product and suppress its effects?

W) Imatinib (read: **i-MA-ti-nib**)
X) Penicillin
Y) Ampicillin
Z) Oseltamivir (read: **ow-suhl-TA-muh-veer**)
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ANSWER: W) IMATINIB

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TOSS-UP

8) Chemistry – *Short Answer* Order the following types of radiation in terms of INCREASING penetration power:

I. Gamma
II. Beta
III. X-Ray
IV. Alpha

ANSWER: IV, II, III, I (ALPHA, BETA, X-RAY, GAMMA)

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BONUS

8) Chemistry – *Short Answer* Amy has 20g of an imaginary element ScienceBowlium. If the half-life of ScienceBowlium is 10 days, then how much of the element is left after 50 days?

ANSWER: 0.625 g

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TOSS-UP

9) Physics – *Multiple Choice* Which of the following is theorized to cause accelerating expansion of the universe?

W) Dark Matter
X) Strange Matter
Y) Dark Energy
Z) W and Z Bosons

ANSWER: Y) DARK ENERGY

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BONUS

9) Physics – *Multiple Choice* The equations of quantum mechanics allow for the existence of negative mass. Assuming the INERTIAL mass of a particle is negative and NOT assuming the validity of the equivalence principle, which of the following could be definitively concluded about the particle's properties?

W) It would accelerate in the SAME direction as the direction of net force on the particle
X) It would accelerate in the OPPOSITE direction as the direction of net force on the particle
Y) It would be gravitationally REPELLED by normal matter
Z) It would be gravitationally ATTRACTED by normal matter

ANSWER: X) IT WOULD ACCELERATE IN THE OPPOSITE DIRECTION AS THE DIRECTION OF NET FORCE ON THE PARTICLE

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TOSS-UP

10) Earth and Space – *Short Answer* Identify ALL of the following statements that are TRUE regarding earthquakes and plate tectonics:

I. The theory of continental drift was first proposed by Alfred Wegener
II. The Richter Scale measures the intensity of an Earthquake
III. P waves are slower than S waves

ANSWER: NONE (First proposed by Abraham Ortelius in 1596, and Richter Scale measures amplitude of an earthquake)

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BONUS

10) Earth and Space – *Multiple Choice* Which of the following volcanoes is a shield volcano?

W) Olympus Mons
X) Paricutin
Y) Stromboli
Z) Pinatubo

ANSWER: W) OLYMPUS MONS

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TOSS-UP
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11) Math – *Short Answer* Kyle rolls two fair 6-sided dice. What is the probability that the sum of the two upward faces is divisible by three?

ANSWER: 1/3

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BONUS

11) Math – *Short Answer* Kyle is playing a game which consists of rolling a fair 6-sided die two times. After seeing the result of the first roll, he decides whether to bet $5 on the second roll being smaller. If he is correct, he gets back his bet along with an additional $5. Kyle is perfectly rational, except that he will always bet if he sees his favorite number, 3. Starting with $5, what is his expected amount of money after one round?

ANSWER: 4.44 (ACCEPT: 40/9)

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TOSS-UP

12) Energy – *Multiple Choice* Scientists at Lawrence Berkeley National Laboratory are studying the stability of compounds formed with Berkelium, a heavy element. In the formation of the oxides they are studying, which of the following best describes whether each element is oxidized or reduced?

W) Berkelium is oxidized; Oxygen is oxidized
X) Berkelium is oxidized; Oxygen is reduced
Y) Berkelium is reduced; Oxygen is oxidized
Z) Berkelium is reduced; Oxygen is reduced

ANSWER: X) BERKELIUM IS OXIDIZED; OXYGEN IS REDUCED

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BONUS

12) Energy – *Short Answer* Scientists at Lawrence Berkeley National Laboratory first synthesized Californium, another heavy element they are studying, by bombarding Curium with what particle?

ANSWER: ALPHA PARTICLE (ACCEPT: HELIUM-4 NUCLEI)
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TOSS-UP

13) Biology – *Multiple Choice* Jacob and Monod formulated a model into how a bacterial gene's expression can be regulated through the presence of a molecule. Specifically, they discovered the lac operon, which metabolizes lactose when present. In the presence of allolactose, which of the following can the mRNA transcribed from the lactose metabolizing gene be described as?

W) Polycistronic
X) Monocistronic
Y) Bicistronic
Z) Pre-mRNA

ANSWER: W) POLYCISTRONIC

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BONUS

13) Biology – *Short Answer* The three proteins translated from the polycistronic lac operon mRNA are Thiogalactoside transacetylase (read: **thay-o-ga-LAC-to-side tranz-a-SEE-ta-layz**), Lactose permease (read: **LAC-tos PER-mee-ayz**), and Beta-Galactosidase (read: **BEY-ta ga-lac-TO-si-dayz**). Answer the following 2 questions about these 3 proteins:

I. Which of these three proteins is responsible for splitting lactose into monosaccharides?
II. What are the identities of the monosaccharides produced by the lactose metabolism?

ANSWER: BETA-GALACTOSIDASE; GALACTOSE AND GLUCOSE

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TOSS-UP

14) Chemistry – *Multiple Choice* Which of the following describes what mass spectrometry measures?

W) Mass-to-charge ratio of ions
X) An isotopes' atomic mass
Y) Absorbance of solutions
Z) Phosphorescence of solutions

ANSWER: W) MASS-TO-CHARGE RATIO OF IONS

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BONUS

14) Chemistry – *Short Answer* If an imaginary element ScienceBowlium has two main isotopes: ScienceBowlium-20 and ScienceBowlium-21, and ScienceBowlium-20 has abundance of 20%, what is the average atomic mass of ScienceBowlium?

ANSWER: 20.8 (ACCEPT: 104/5, 20 ⅘; DO NOT ACCEPT: 20 8/10)

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TOSS-UP

15) Physics – *Multiple Choice* Which of the following fundamental forces has yet to be rigorously described by quantum mechanics?

W) Gravity
X) Electromagnetic force
Y) Strong nuclear force
Z) Weak nuclear force

ANSWER: W) Gravity

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BONUS

15) Physics – *Short Answer* Newton's Law of Universal Gravitation states that the force of gravity is proportional to what power of the distance between two masses?

ANSWER: -2

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TOSS-UP

16) Earth and Space – *Multiple Choice* Which of the following best describes when an eclipse can occur?

W) When the sun is near one of the antinodes of the moon's orbit
X) When the sun is near one of the nodes of the moon's orbit
Y) When the moon is near one of the antinodes of the sun's orbit
Z) When the moon is near one of the nodes of the sun's orbit
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ANSWER: X) WHEN THE SUN IS NEAR ONE OF THE NODES OF THE MOON'S ORBIT

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BONUS

16) Earth and Space – *Short Answer* What term describes the cycle after which the pattern of eclipses repeats?

ANSWER: SAROS CYCLE

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TOSS-UP

17) Math – *Short Answer* What is the exact value of $\tan(15°)$?

ANSWER: $2 - \sqrt{3}$

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BONUS

17) Math – *Short Answer* Expressing the answer as $\frac{\sqrt{a}+\sqrt{b}}{c}$(read: **fraction with numerator square root of A plus square root of B, and denominator C**), what is the exact value of $\sin(75°)$?

ANSWER: $\frac{\sqrt{2}+\sqrt{6}}{4}$ (ACCEPT: $\frac{\sqrt{6}+\sqrt{2}}{4}$)

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TOSS-UP

18) Energy – *Multiple Choice* Scientists at Fermi National Accelerator Laboratory are studying high-energy interactions using a particle accelerator. Which of the following best describes how particles are accelerated and directed, respectively, within accelerators?

W) Electric Fields; Magnetic Fields
X) Magnetic Fields; Electric Fields
Y) Electric Fields; Electric Fields
Z) Combustion; Electric Fields

ANSWER: W) ELECTRIC FIELDS; MAGNETIC FIELDS

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BONUS

18) Energy – *Multiple Choice* Scientists at Fermi National Accelerator Laboratory are studying the properties of neutrinos, including whether they violate certain symmetries. Which of the following symmetries has never been observed to be violated?

W) C Symmetry
X) P Symmetry
Y) CP Symmetry
Z) CPT Symmetry

ANSWER: Z) CPT SYMMETRY

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TOSS-UP

19) Biology – *Multiple Choice* Jonah is a young scientist trying to treat his father's Type II diabetes. He wants to express the inuslin gene in E.coli using a plasmid vector, which he will transform into the cells. Identify ALL of the following elements required to express the insulin gene:

I. Selectable Marker
II. Promoter
III. Polyadenylation Signal

ANSWER: ALL

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BONUS

19) Biology – *Short Answer* Now that Jonah knows how to construct a plasmid for expressing insulin, he has to run the experiment. In order to be an honest scientist, how many different E.coli aliquots should he grow to have an accurate representation of the results?

ANSWER: 3 (NEGATIVE CONTROL, POSITIVE CONTROL, AND EXPERIMENTAL)

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TOSS-UP

20) Chemistry – *Multiple Choice* Which of the following periodic table trends is true?

W) Atomic radius INCREASES across periods and INCREASES down groups
X) Atomic radius INCREASES across periods and DECREASES down groups
Y) Atomic radius DECREASES across periods and DECREASES down groups
Z) Atomic radius DECREASES across periods and INCREASES down groups

ANSWER: Z) ATOMIC RADIUS DECREASES ACROSS PERIODS AND INCREASES DOWN GROUPS

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BONUS

20) Chemistry – *Multiple Choice* Which of the following types of reactions is ALWAYS spontaneous?

W) An ENDOTHERMIC reaction with SOLID reactants and GAS products
X) An ENDOTHERMIC reaction with GAS reactants and SOLID products
Y) An EXOTHERMIC reaction with SOLID reactants and GAS products
Z) An EXOTHERMIC reaction with GAS reactants and SOLID products

ANSWER: Y) AN EXOTHERMIC REACTION WITH SOLID REACTANTS AND GAS PRODUCTS

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TOSS-UP

21) Physics – *Multiple Choice* Which of the following is closest to the period, in seconds, of a pendulum in simple harmonic motion with a length of 10 meters and a hanging mass of 10 kg?

W) 0.314
X) 0.628
Y) 3.14
Z) 6.28

ANSWER: Z) 6.28

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BONUS

21) Physics – *Short Answer* What is the maximum velocity of a spring in simple harmonic motion with an angular frequency of 1 rad/s and an amplitude of 5 meters?
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ANSWER: 5 m/s (ACCEPT: 5)

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TOSS-UP

22) Earth and Space – *Short Answer* What process is predominantly used by the Sun to make its energy?

ANSWER: PROTON-PROTON CHAIN (ACCEPT: P-P CHAIN, DO NOT ACCEPT: FUSION)

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BONUS

22) Earth and Space – *Short Answer* In a binary system, the period is 2 years and the average separation is 4 AU. What is the total mass, in solar masses, of this binary system?

ANSWER: 16 ($M_A + M_B = \frac{a^3}{P^2}$)

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TOSS-UP

23) Math – *Multiple Choice* Which of the following is NOT true about normal distributions?

W) About 68% of values are within one standard deviation
X) About 89% of values are within two standard deviations
Y) They are symmetric about the mean
Z) The mean, median, and mode are always equal

ANSWER: X) ABOUT 89% OF VALUES ARE WITHIN TWO STANDARD DEVIATIONS

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BONUS

23) Math – *Short Answer* Order the following central tendencies from least to greatest for the set {2,8,2,0,6,7} (read: **open brackets 2 8 2 0 6 7 close brackets**):

I. Mean
II. Median
III. Mode

ANSWER: III, II, I

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