ROUND 7

TOSS-UP

1) Biology – *Short Answer* Which of the following four statements are true of cytoplasmic determinants during embryogenesis?

1) They are encoded solely by maternal genes
2) They are found in the cytoplasm of all germ cells
3) They are homogenous in the cytoplasm
4) They regulate gene expression and differentiation

ANSWER: 1 AND 4

BONUS

1) Biology – *Short Answer* Beginning with a 2n zygote, order the following four stages of the fungal life cycle.

1) Germination
2) Karyogamy
3) Meiosis
4) Plasmogamy

ANSWER: MEIOSIS, KARYOGAMY, GERMINATION, PLASMOGAMY (3, 2, 1, 4)

TOSS-UP

2) Math – *Short Answer* Find the area of the region bounded by the curves y equals x squared and y equals 4 times x.

ANSWER: 32/3

BONUS

2) Math – *Multiple Choice* Which of the following matrix operations is equivalent to transposing a matrix and then taking its conjugate?
W) Inverse

X) Adjoint
Y) Rotation
Z) Eigenvalue

ANSWER: X) Adjoint

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TOSS-UP

3) Physics – *Short Answer* Identify all of the following four charge distributions that have an electric potential function that is inversely proportional to the distance from the center: 1) A point charge, 2) An infinite line of charge, 3) An infinite plate of charge, 4) Inside a conducting sphere

ANSWER: 1 ONLY

BONUS

3) Physics – *Short Answer* An infinitely long rod with a charge density of 4 Coulombs per meter. If the rod is moving at 3 meters per second, what is the magnitude of the magnetic field 6 meters away from the wire, in nanoteslas?

ANSWER: 400, 400 nanoteslas

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TOSS-UP

4) Chemistry – *Multiple Choice* Which of the following compounds readily form highly reactive free radical species that initiate a polymerization reaction?

W) Ketones
X) Peroxides
Y) Alcohols
Z) Aldehydes

Answer: X) Peroxides

BONUS

4) Chemistry -- *Multiple Choice* Which of the following is closest to the pKa of an alpha hydrogen of a beta diketone?

W) 5

X) 9
Y) 13
Z) 17

ANSWER: X) 9

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TOSS-UP

5) Earth and Space – *Short Answer* Order the following four layers of an ophiolite from shallowest to deepest: 1) Sheeted Dikes; 2) Gabbro; 3) Pillow Lavas; 4) Peridotite;

ANSWER: 3, 1, 4, 2 [SP]

BONUS

5) Earth and Space – *Short Answer* What is the redshift of a star that is moving away from a viewer at 0.75c in radical form?

ANSWER: $\sqrt{7} - 1$ [SP]

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TOSS-UP

6) Earth and Space – *Multiple Choice* The earth experiences glacial maximums consistently almost every 100,000 years. Which of the following changes are the major contributing factor to this phenomenon?

W) Axial Precesssion
X) Axial Obliquity
Y) Sunspot Cycle
Z) Eccentricity

ANSWER: Z) ECCENTRICITY [SP]

BONUS

6) Earth and Space – *Short Answer* If the environmental lapse rate is greater than the dry adiabatic lapse rate, what atmospheric condition has occurred?

ANSWER: ABSOLUTE INSTABILITY [SP]

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TOSS-UP

7) Physics – *Multiple Choice* The bright point in the center of a circular object's shadow is called the Arago spot. This effect occurs due to what physical phenomenon?

W) Refraction
X) Reflection
Y) Diffraction
Z) Dispersion

ANSWER: Y) Diffraction

BONUS

7) Physics – *Short Answer* For a circuit consisting of an initially charged capacitor and an inductor, charge oscillates between the capacitor and the inductor. If the capacitor has capacitance 4 pi milli Farads and the inductor has inductance 16 pi milli Henries, what is the period of the oscillation of charge between the capacitor and inductor, to the nearest hundredth of a second?

ANSWER: 0.16, 0.16 seconds

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TOSS-UP

8) Chemistry – *Short Answer* Which rule conveys that no two electrons can have the same set of quantum numbers in an atom?

Answer: Pauli Exclusion Principle

BONUS

8) Chemistry -- *Short Answer* In a Jablonski diagram, what radiationless transition occurs between electronic states of the same spin multiplicity?

ANSWER: INTERNAL CONVERSION

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TOSS-UP
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9) Biology – *Short Answer* Keshav pickaxed a fetus with a gestational age of 20 weeks, spilling blood everywhere. Which hematopoietic organ most likely produced this spilled blood?

ANSWER: LIVER (ACCEPT: SPLEEN)

BONUS

9) Biology – *Multiple Choice* Which of the following diseases is most likely caused due to neural crest cells failing to migrate completely during fetal development?

W) Thalassemia, which is caused by body not producing sufficient hemoglobin
X) Hirschsprung disease, which is caused by missing enterochromaffin cells in the gut
Y) Spina bifida, which is caused by incomplete closure of the neural tube
Z) Cerebral palsy, which is cause by abnormal brain development, often before birth

ANSWER: X) HIRSCHSPRUNG DISEASE, WHICH IS CAUSED BY MISSING ENTEROCHROMAFFIN CELLS IN THE GUT

TOSS-UP

10) Math – *Multiple Choice* Which of the following theorems permit interchanging the order of integration for double integrals over a region?
W) Green's Theorem
X) Stokes' Theorem
Y) Fubini's Theorem
Z) Taylor's Theorem

ANSWER: Y) Fubini's Theorem

BONUS

10) Math – *Short Answer* How many binary sequences of length 10 have no two consecutive zeroes?

ANSWER: 144

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TOSS-UP
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11) Earth and Space – *Multiple Choice* In which of the following time frames does Venus appear the brightest to us?

W) When its phase is full
X) When it is at superior conjunction
Y) About a month before or after inferior conjunction
Z) When it is at opposition

ANSWER: Y) ABOUT A MONTH BEFORE OF AFTER INFERIOR CONJUNCTION [SP]

BONUS

11) Earth and Space – *Multiple Choice* Which of the following is the only other object in the solar system apart from Earth known to harbor hydrothermal activity?

W) Io
X) Callisto
Y) Enceladus
Z) Triton

ANSWER: Y) ENCELADUS [SP]

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TOSS-UP

12) Math – *Multiple Choice* A student wants to conduct a hypothesis test to compare two fertilizers. Specifically, to see if either fertilizer is more effective than the other. Which of the following best describes her hypothesis test if she uses a 5% significance level?
W) One-tailed with 90% equivalent confidence
X) One-tailed with 95% equivalent confidence
Y) Two-tailed with 90% equivalent confidence
Z) Two-tailed with 95% equivalent confidence

ANSWER: Y) Two-tailed with 90% equivalent confidence

BONUS
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12) Math – *Short Answer* Identify all of the following three random variables that are Gaussian or nearly Gaussian:
1) The sum of two Gaussian random variables
2) The product of two Gaussian random variables
3) The sum of squares of two Gaussian random variables

ANSWER: 1 ONLY

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TOSS-UP

13) Chemistry – *Multiple Choice* Which of the following elements has a green flame test color?

W) Sodium
X) Barium
Y) Strontium
Z) Rubidium

Answer: X) Barium

BONUS

13) Chemistry -- *Multiple Choice* If Potassium Tertbutoxide is used as a reagent in the elimination of 2-bromo, 3-phenyl propane, what is the IUPAC name of the resulting major product

Answer: 3-phenyl, 1-propene

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TOSS-UP

14) Physics – *Multiple Choice* A circuit consisting of a charged capacitor, lightbulb, and an inductor is originally open. What could exactly describe the current going through the lightbulb after the circuit is closed?

W) Exponential Increase
X) Exponential Decrease
Y) Simple Harmonic Oscillation
Z) Constant

ANSWER: X) Exponential Decrease

BONUS

14) Physics – *Multiple Choice* Analogies are commonly seen when studying physics. In a circuit consisting of a resistor, inductor, and capacitor, the inductor is analogous to what element in a spring-mass-block system?

W) Spring Constant
X) Mass
Y) Displacement
Z) Damping Force

ANSWER: X) Mass

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TOSS-UP

15) Biology – *Multiple Choice* Which of the following statements is best supported by the ecological species concept?

W) *E. Coli* and *D. immitis* are different species since they usually infect different hosts
X) *Canis lupus* and *Homo sapiens* are different species since they have different morphologies
Y) *E. Coli* and *D. immitis* are different species since they cannot produce viable offspring
Z) *Canis lupus* and *Homo sapiens* are in the same domain since they are in the same kingdom

ANSWER: W) *E. COLI* AND *D. IMMITIS* ARE DIFFERENT SPECIES SINCE THEY USUALLY INFECT DIFFERENT HOSTS

BONUS

15) Biology – *Multiple Choice* Which of the following best exemplifies an example of an exaptation?

W) Darwin's finches adapted different beaks, but their structure depended on their diet
X) Owls eyes evolved larger concentration of rods to help with nocturnal hunting
Y) Feathers evolved for insulation, but over time co-opted for flight
Z) Cavefish evolved eyes, but they evolved to subsequently degenerate after development

ANSWER: Y) FEATHERS EVOLVED FOR INSULATION, BUT OVER TIME CO-OPTED FOR FLIGHT
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TOSS-UP

16) Biology – *Short Answer* Which subgroup of proteobacteria lives in close association with eukaryotes and includes *Rhizobium* and *Agrobacterium*?

ANSWER: ALPHAPROTEOBACTERIA (ACCEPT: ALPHA)

BONUS

16) Biology – *Multiple Choice* Which of the following culture media is characterized by containing natural compounds of which precise chemical compositions aren't known, and may vary between batches, thus affecting the process reproducibility?

W) Defined media
X) Differential media
Y) Selective media
Z) Complex media

ANSWER: Z) COMPLEX MEDIA

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TOSS-UP

17) Earth and Space – *Multiple Choice* Which of the following types of rock are the Lunar Highlands primarily composed of?

W) Basalt
X) Gabbro
Y) Anorthosite
Z) Migmatite

ANSWER: Y) ANORTHOSITE [SP]

BONUS

17) Earth and Space – *Short Answer* What type of melting occurs due to the upward movement of mantle and the rapid decrease in pressure caused by it?

ANSWER: DECOMPRESSION MELTING [SP]

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TOSS-UP

18) Chemistry – *Multiple Choice* When compared to insulators, what is the the band gap in semiconductors

W) The band gap in semiconductors is smaller than that in insulators
X) The band gap in insulators is smaller than that in semiconductors
Y) The band gap difference depends on the element
Z) The band gap in semiconductors and insulators is the same

Answer: W) The band gap in semiconductors is smaller than those in insulators

18) Chemistry -- *Multiple Choice* What is not one of the differences between p-type and n-type semiconductors

W) The number of free electrons available
X) Conductivity level
Y) Size of band gap
Z) None of the above

Answer: Z) None of the above

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TOSS-UP

19) Physics – *Multiple Choice* An infinite conducting plate and a point charge are placed 5 meters apart. At a point 10,000 meters away on the perpendicular line connecting the plate and the charge, the electric field is proportional to what power of distance to the plate?

ANSWER: -3

BONUS

19) Physics – *Short Answer* A solid sphere has a moment of inertia about its central axis of 10 kg m^2 (Read: kilogram times meters squared). If the radius of this sphere is tripled while keeping its density constant, what will be the new moment of inertia of the sphere, in kg m^2 (Read: kilogram times meters squared)?

ANSWER: 2430, 2430 kg m^2
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TOSS-UP

20) Math – *Short Answer* Determine all of the following three pairs of vectors that are linearly independent:

1) open bracket, 2 comma 3, close bracket and open bracket, 3 comma -2, close bracket
2) open bracket, 3 comma 5, close bracket and open bracket, 6 comma 10, close bracket
3) open bracket, 4 comma 6, close bracket and open bracket, 2 comma 3, close bracket

ANSWER: 1 ONLY

BONUS

20) Math – *Short Answer* Sequence *a* is defined by a sub n equals 1 over open parenthesis, n squared plus n, close parenthesis for n greater than 0. What is the sum of the first 100 terms of this sequence?

ANSWER: 100/101

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