

(MS) Science Bee Quarterfinals

Regulation Tossups

(1) **In the G protein-coupled signal transduction pathway, this molecule is used by adenylyl cyclase to synthesize secondary messenger (+) cAMP. Large amounts of this molecule are synthesized during oxidative phosphorylation via a namesake synthase enzyme located in the (*) mitochondria.** For the points, name this "energy currency" of the cell, a molecule consisting of adenine, ribose sugar, and three phosphate groups.

ANSWER: **ATP** (or **Adenosine Triphosphate**)

(2) **Recovery is one of the two options after this effect occurs, which was exhibited by the American bison after its population size grew from an estimated 750 in 1890 to about 360,000 by the year 2000. The (+) Toba catastrophe theory suggests that humans faced this effect 75,000 years ago after the eruption of a supervolcano in Indonesia. Environmental disasters, habitat destruction, and (*) overhunting can result in,** for the points, what form of genetic drift, which occurs when a drastic reduction of a population size changes its gene pool?

ANSWER: **Bottleneck** Effect (or Population **Bottleneck**; or Genetic **Bottleneck**; prompt on "Genetic Drift" before mentioned)

(3) **A supernova remnant in this constellation, formally known as 3C 10, is also referred to as "Tycho Supernova Remnant" since the astronomer discovered the object in 1572. The five brightest (+) stars of this constellation — Segin, Ruchbah, Gamma Cas, Schedar, and Caph — make up its most prominent feature, which resembles a queen sitting on her (*) throne.** For the points, name this constellation that can be recognized by the naked eye in the shapes of an "M" or "W", named after a mythological queen of Ethiopia.

ANSWER: **Cassiopeia** (or **Cassiopeiae**)

(4) **This structure is sometimes referred to as Palade granules, which are composed of RNA and ribonucleoprotein. Tetracycline blocks the aminoacyl-tRNA and (+) peptidyl-tRNA during a process that takes place in this structure. This structure is comprised of two subunits denoted as 30S in prokaryotes and 40S in eukaryotes. Translation (*) occurs in,** for the points, what protein-synthesizing organelle that resides in the nucleus and nucleolus and gives a form of endoplasmic reticulum its "rough" appearance?

ANSWER: **Ribosomes** (accept **Palade granules** before mentioned)

(5) **Proteins are "displayed" on the surface of the M13 class of these agents in a common method for directed evolution. The T2 (+) type of these agents was labelled with radioactive sulfur and phosphorus in the Hershey-Chase experiment that proved DNA is genetic material. When reproducing, these agents can switch from the lysogenic to the lytic cycle, which destroys their (*) host cell. For the points, name these viruses that infect bacteria.**

ANSWER: **bacteriophages** (or **phages**; accept **phage** display; prompt on "virus")

(6) **According to Emery's rule, the social form of this behavior is seen between two closely related organisms, which is exhibited when the larvae of large blue butterflies employ ant mimicry. Great (+) frigate birds stealing the prey of another seabird and cuckoo bees laying in the nests of other bees exhibit the klepto- form of this behavior. The presence of tapeworms (*) inside a human's intestines is a prime example of, for the points, what type of symbiotic relationship in which one organism benefits at the expense of another?**

ANSWER: **Parasitism** (accept other word forms; accept Social **Parasitism**; accept Klepto**parasitism**; accept Brood **Parasitism**; accept Adelpho**parasitism**; prompt on "Symbiosis" before mentioned)

(7) **Ninety percent of the bacteria that live in this location come from the phyla Firmicutes and Bacteroidetes. Microorganisms that live in this habitat form a biochemical signaling axis with the (+) brain. Barry Marshall found that ulcers can be caused by H. pylori bacteria living in this habitat, whose collective organismal community is called the flora or microbiota. The colon (*) contains the highest concentration of bacteria living in, for the points, what body system?**

ANSWER: **digestive** system (accept **digestive** tract; accept **gut**; accept **gastrointestinal** tract; accept **GI** tract; accept **stomach**; accept **small intestines**; accept **large intestines**; accept **intestines**; accept **colon** before mention; prompt on "body" or "human body")

(8) **These structures were found to have eighty shapes according to a classification system devised by Ching Woo Lee and Choji Magono. Another classification of these structures is outlined in the (+) Nakaya diagram, which suggests that its various formations are dependent on supersaturation and temperature. Formed through the Wegener-Bergeron-Findeisen (*) process, these are, for the points, what single ice crystals that come in columns, dendrites, and needles varieties, in which a common adage says that "no two are alike"?**

ANSWER: **Snowflakes** (accept **Ice Crystals** or **Snow Crystals** before "crystals" is mentioned; prompt on "Crystals" before mentioned)

(9) **These events occur when the sun and moon are separated by ninety degrees as viewed from Earth. These events are predicted by measuring the rise of (+) sea levels, and a small range of heights indicates these events whereas a large range indicates the spring type. Sometimes referred to as a quadrature (*) tide, for the points, what is this tide that occurs when there's a difference between high and low water?**

ANSWER: **Neap** Tide (or **Quadrature** Tide before mentioned; prompt on "Tide")

(10) **One of these places called Sudbury Basin was formed after the Nuna supercontinent was hit by a bolide. These places, the largest of which is the (+) Vredefort in South Africa, include one underneath Mexico's Yucatan Peninsula called Chicxulub [[chik-ZHOO-loob]]. These places typically have raised rims and floors lower in elevation than the surrounding (*) terrain. For the points, name these places created when meteorites hit the Earth's surface.**

ANSWER: Impact **craters** (accept **Astroblemes**)

(11) **This person ended his Nobel Prize lecture by stating "Beauty is the splendor of truth." An observatory named for this scientist includes the ACIS, or Advanced CCD Imaging (+) Spectrometer, and is NASA's flagship X-ray telescope. A value named for this man is about 1.4 solar masses and is the maximum mass that a stable white (*) dwarf can have. For the points, name this Indian-American astrophysicist who spent most of his professional career as a professor at the University of Chicago.**

ANSWER: Subrahmanyam **Chandrasekhar** (accept **Chandrasekhar** limit; prompt on "Chandra" or "Chandra X-ray Observatory")

(12) **This mountain is home to the Pangboche Crater near its summit and formed during the Noachian Period. This mountain is associated with the Tharsis (+) Montes chain, and has a surface area larger than Hungary. Of known peaks, this mountain is only possibly surpassed by Rheasilvia on Vesta, standing at a height of (*) 72,000 feet. For the points, name this volcano, the highest of Mars and the Solar System.**

ANSWER: **Olympus Mons** (accept **Nix Olympica**)

(13) **A body part that allows some animals to perform this ability is the called the melon, which is an area of the head made of adipose tissue. Although this ability is primarily produced through the mouth, the (+) horseshoe variety of one species perform this ability through their nostrils. Porpoises can evade orcas due to this ability, which is produced at around 130 kilohertz. Produced at the same (*) frequencies as an ultrasound, this is, for the points, what sensory ability used by bats and whales to help them navigate by sound?**

ANSWER: **Echolocation** (prompt on "Sound Waves"; prompt on "Sonar")

(14) **A population's standard deviation is divided by the square root of this quantity to give the standard error of the mean. The distribution of sample means approaches a (+) normal distribution as this quantity increases according to the central limit theorem. The mean of a set equals the sum of the values (*) divided by this quantity. For the points, name this quantity symbolized n, which is the number of data points in a set.**

ANSWER: sample **size** (or population **size**; accept **n** before mention; prompt on answers such as "how many there are" or "the number of values there are")

(15) **A precursor to this technique produces a Taylor cone from a sample that is dispersed by electrospray. The "tandem" form of this technique is used to sequence proteins. Gas (+) chromatography is often paired with this technique, which produces sizable M and M+2 isotope peaks when the sample contains bromine or chlorine. The m-to-z (*) ratio is measured by, for the points, what spectroscopic technique that separates ions by their weight?**

ANSWER: **mass spectrometry** (or **mass spectroscopy**; or **MS**; accept tandem **mass spectrometry**; accept GC-**MS**)

(16) **This element was the metal constituent in a chemical which was involved in a 1990 explosion at a Russian military plant in Utika. Another (+) compound containing this metal has the lowest dispersive power for a solid. Isotopes of this element break into two alpha particles. The alkaline earth (*) metal with the lowest mass, for the points, what element has atomic number 4 and symbol Be?**

ANSWER: **Beryllium** (accept **Be** before mentioned; accept **Beryllium** oxide or **Beryllium** fluoride)

(17) **This man names a rule for differentiating under the integral sign. The alternating series test in series (+) convergence is alternately named for this mathematician. This man, whose philosophical works include *Discourse on Metaphysics*, also published a text which presented a formulation of a subject that another mathematician explained with (*) fluxions. For the points, name this mathematician who invented calculus independently of Isaac Newton.**

ANSWER: Gottfried **Leibniz** (or Gottfried Wilhelm von **Leibniz**)

(18) **In H Two regions, Bok globules are extremely cold locations where this process may occur. This process, which occurs at high rates in starburst galaxies, leads to the formation of a protoplanetary (+) disk. The photograph *The Pillars of Creation* shows this process, which starts after the collapse of a giant (*) molecular cloud. For the points, name this process that occurs in stellar nurseries, forming objects like the Sun.**

ANSWER: **Star formation** (accept reasonable equivalents like **stars being created**)

(19) **After this scientist became the first to isolate benzene, he became the first Fullarian Professor of Chemistry at the Royal (+) Institution. With his ice pail experiment, this chemist and physicist developed an enclosure wherein electromagnetic fields (*) are blocked.** For the points, name this inventor of the homopolar generator who developed a namesake law on electromagnetic induction.

ANSWER: Michael **Faraday** (accept **Faraday's** Law of Induction; accept **Faraday's** Cage)

(20) **In Tierra del Fuego, these structures have resulted in major losses in fauna life. These structures are often designed to protect shelters called (+) lodges using moats. These structures, which often result in excess nutrient removal, are anchored by branches pointing (*) upstream, making the animals that make them keystone species.** For the points, name these structures created on streams by large rodents.

ANSWER: **Beaver dams** (accept **Beaver ponds**; prompt on "Dams")

(21) **The trailing suction method of this task involves filling hoppers with material and unloading it once full, while another method involves use of a suction device and a specialized augur. Leonardo (+) Da Vinci developed a schematic for a "drag" tool to perform this task, which was done in ancient times to construct harbors along the Eastern Mediterranean. Sometimes used to recycle sand for "beach (*) nourishment,"** for the points, what is the term for excavating material from beneath the water?

ANSWER: **dredging** (or **dredge**; prompt on "excavation"; prompt on descriptions like "digging underneath water" before mentioned)

(22) **To use this method on larger problems, it is often useful to implement a "tail call" to optimize memory use and avoid stack (+) overflows. Common implementations of this concept in programming are calculating factorials, greatest common divisor, binary search, and the Towers of (*) Hanoi problem.** For the points, what is this non-iterative method of solving computational problems, where functions call themselves from within their own code.

ANSWER: **Recursion** (accept **Recursive** algorithm/program; accept Tail **Recursion**)

(23) **This phenomenon can be applied to current meters to measure water current velocities. In medicine, this effect can help assess the direction of blood flow and the velocity of blood and cardiac tissue in an (+) echo-cardiogram, and when applied to astronomy, the relativistic form of this effect can utilize electromagnetic waves to detect the rotational speed of stars and (*) galaxies.** For the points, name this effect, the change in the frequency of waves in relation to an observer.

ANSWER: **Doppler** Effect (or **Doppler** Shift)

(24) **Gauss's law can be proven from this equation if the superposition principle is fulfilled. A constant in this inverse-square law is equal to one over four pi times the permittivity of (+) free space. That constant used in this law is approximately equal to 8.988×10^9 . The electrostatic interaction between two point (*) charges can be described by, for the points, what law that relates force to the product of k , q_1 , and q_2 all over r -squared, named after a French physicist?**

ANSWER: **Coulomb**'s Law (or **Coulomb**'s Inverse-Square Law)

(25) **One of the first references to this term for a type of computer program was in the first UNIX manual in 1971. This term was popularized by Ken (+) Thompson in his 1983 Turing Award lecture "Reflections on Trusting Trust". These entities differentiate themselves from a virus by not injecting themselves into other (*) files. For the points, name this type of malware that misleads users of its purpose, whose name derives from an Ancient Greek story of deception.**

ANSWER: **Trojan** (accept **Trojan** Horse)

(26) **A model generalizing this phenomenon was solved in two dimensions by Lars Onsager as a lattice of interacting plus-one and minus-one spins; that model is the (+) Ising model. This property persists even after a change in the applied field due to its hysteresis. Materials lose this property if heated past the Curie (*) temperature. For the points, name this form of magnetism exhibited by nickel, cobalt, and its namesake, iron.**

ANSWER: **ferromagnet**ism (prompt on "magnet(ism)"; do not accept or prompt on "paramagnetism")

(27) **This man pioneered the method of infinite descent in proofs and frequently applied that method to Diophantine [[dee-oh-FAHN-teen]] (+) equations. This mathematician proved that a prime number must be $1 \pmod{4}$ to be the sum of two perfect squares, and his "Little Theorem" is one of the pillars of (*) number theory. For the points, name this French mathematician whose "Last Theorem" was proved by Andrew Wiles in 1995.**

ANSWER: Pierre de **Fermat** [[fehr-MAH]]

(28) **This structure consists of various gyri [[JYE-RYE]], including the non-functional gyrus rectus located in this structure's lateral portion. The functions of this structure are measured by Wisconsin (+) Card Sorting and Token Tests, which examine response inhibition and language, respectively. Injury to this lobe may lead to personality changes, as seen in Phineas (*) Gage after an iron rod severed this area of the brain. For the points, name this the largest lobe of the brain associated with problem-solving?**

ANSWER: **Frontal** Lobe (prompt on "Cerebrum", "Prefrontal Cortex", "Frontal Cortex", or "Cerebral Cortex"; prompt on "Brain" before mentioned)

(29) **These mixtures, one of the three primary types, have particles ranging between one and one thousand nanometers in diameter. Crystals (+) formed according to the principles of these type of mixtures are capable of self-assembly, and categories of these types of mixtures include emulsions and (*) foams.** For the points, name this type of discrete or continuous mixture that can be created by mixing, for example, Jell-O powder and water.

ANSWER: **Colloids** (accept Hydro**colloids**)

(30) **Because this substance stores as much as ten times more carbon dioxide than other ecosystems, scientists consider it the most efficient natural carbon sink on earth. The (+) Tollund Man was preserved in an ecosystem containing this substance, which makes up fens. Sphagnum moss makes up most of this substance, which is made of decayed (*) plant matter.** For the points, name this substance that can accumulate in bogs.

ANSWER: **Peat** (accept **Peat** moss; accept **Turf**)

Extra Questions

(1) **This compound is industrially produced in the anthra-quinone [[an-thrah-KWY-nohn]] process. A solution of ferrous iron and this compound is used to treat drinking water as (+) Fenton's reagent. Within eukaryotic [[yoo-"care"-ee-AH-tik]] cells, specialized vacuoles use catalase [[KAT-ah-"lace"]] to break down this compound into water and (*) oxygen. For the points, name this compound with formula H₂O₂ which, like isopropyl alcohol, is commonly used as a first aid antiseptic.**

ANSWER: **Hydrogen Peroxide** (accept **H₂O₂** before mentioned; prompt on "peroxide")

(2) **One form of this law is joined with Faraday's law to give an induction equation for ideal MHD. Another form of this law states that current density equals sigma times electric (+) field. At low forward bias, this law does not apply to diodes, and the drops calculated by this law add to zero, according to (*) Kirchhoff's loop rule. For the points, name this law that states voltage equals current times resistance.**

ANSWER: **Ohm's Law**

(3) **Methods that measure this quantity include the concentric cylinder geometry, which consists of a spindle, inner bob, and an outer cup and a similar apparatus that consists of a spindle, (+) cone, and plate. Air has the lowest value of the absolute type of this quantity while glass has the highest value. Glycerol has the value of (*) 1 Newton-second per square meter in, for the points, what quantity that comes in the dynamic and kinematic types and describes a fluid's resistance to flow?**

ANSWER: **Viscosity** (accept Absolute **Viscosity**; accept Dynamic **Viscosity**; accept Kinematic **Viscosity**)