(E) Science Bee Finals

Regulation Tossups

(1) **When photons from this specific phenomenon enter galactic clusters, they undergo inverse Compton scattering. The WMAP (+) and COBE probes studied the anisotropies of this phenomenon, which was discovered at Bell Labs and has a temperature of about 2.7 Kelvin. Evidence for the Big (*)** Bang is given by, for the points, what black-body radiation that permeates the whole universe and has a frequency between radio and infrared?

ANSWER: **Cosmic Microwave Background** Radiation (or **CMB**; or **CMB**R; accept **Relic Radiation**; prompt on partial answers)

(2) **This protein is transported to the nucleus by importin-9, and this protein is anchored by vinculin to the cell membrane. This protein comes in globular (+) and filamentous types, and this protein, under the sliding filament theory, makes up thin filaments along with tropomyosin and troponin. In cell adhesion, (*)** cadherins link to, for the points, what protein which is the primary component of microfilaments and is paired with myosin to facilitate muscle contraction?

ANSWER: **Actin** (accept G-**Actin**; or F-**Actin**)

(3) **This substance is found in specialized capillaries called lacteals. Lipid particles called chylomicrons [[kye-LOH-mee-krons]] transport fats from the intestines to the body using this substance, which drains into the left subclavian (+) vein from the thoracic duct. This clear to white substance consists mainly of interstitial fluid and cells such as T cells (*)** and B cells. For the points, name this fluid found in namesake nodes in the head and neck that swell during infection.

ANSWER: **lymph** (accept **lymph**atic fluid; accept **chyle**)

(4) **The Venice System uses this quantity to classify bodies of water, whose global average is 35 parts per thousand. This quantity and temperature drive (+) thermohaline flows, and this quantity increases from the tidal limit of a river to the mouth of an estuary. In comparision to freshwater, brackish (*)** water has a higher value of, for the points, what quantity that measures the concentration of sodium and chloride ions in water?

ANSWER: **Salinity** (accept **Salt Concentration**; accept descriptive answers like the **amount of salt** in water)

(5) **When constructed, the Yakutsk TV Tower was the tallest structure built on this surface, which can be found in patterns such as palsas and pingos. This material extended south to New (+) Jersey during the last Ice Age. This surface, whose erosion in Siberia led scientists to worry about vast carbon dioxide releases into the air, is common in the (*)** tundra. For the points, name this type of ground that remains below the freezing point for two or more years.

ANSWER: **Permafrost** (prompt on descriptive answers; prompt on "ice" or "frost")

(6) **This man ran a museum in Monaco that is blamed for releasing the invasive species *Caulerpa taxifolia* [[kuh-LUR-puh TAX-ih-FOH-lee-uh]]. Loël (+) Guinness leased this man a vessel with a "false nose" that sank in Singapore in 1996, the year before his death. This man, who often wore a red cap, is featured in the documentary (*)** *The Silent World*. The *Calypso* was the research ship used by, for the points, what French oceanographer who co-invented a breathing device called the Aqua-lung?

ANSWER: Jacques **Cousteau** [[zhahk koo-STOH]] (or Jacques-Yves **Cousteau**)

(7) **A form of this event that glows red in the dark is called *nuée ardente*. A variation of this event occurred on Mount Unzen in Japan, killing Harry Glicken alongside Katia and Maurice (+) Krafft. That type of variation occurs when this event is composed of more rock than gas. This natural disaster is often caused by fountain collapses, which prompted this type of event's destruction of (*)** Herculaneum. For the points, name this fast-moving current of hot gas and volcanic matter, collectively known as tephra, that destroyed the ancient city of Pompeii.

ANSWER: **Pyroclastic flow** (or **Pyroclastic density current** or **Pyroclastic cloud**)

(8) **The discovery that this entity is a supermassive compact object was the subject of the 2020 Nobel Prize in Physics. The non-alphanumeric (+) character in this entity's name was attached because it was "exciting." This entity is near the constellations Scorpius and another constellation it shares a name with, which is named for an (*)** archer. For the points, name this supermassive black hole at the center of the Milky Way.

ANSWER: **Sagittarius A*** [["star"]] (prompt on "Sagittarius" or "Sagittarius A", prompt on descriptions like "black hole at the center of the Milky Way" by asking "is known by what name?")

(9) **According to Andrei Linde, this process in part occurs due to a "slow roll" (+) parameter. This process, which was proposed by Alan Guth, explains the horizon, flatness, and magnetic monopole problems. This process took place 10-to-the-negative-36 seconds after the Big (*)** Bang. For the points, name this theory that proposes a brief period of rapid expansion of the early universe.

ANSWER: Cosmic **inflation** (accept cosmological **inflation**)

(10) **Eighty-six of these structures were published by Robert Wiedersheim in the book *The Structure of Man: An Index to His Past History*, in which he mistakenly included the pineal gland, since melatonin had not yet been discovered. Douglas (+) Futuyma [[foo-TOY-muh]] argued that these structures are evidence of evolution, and some examples of them include the eyes of cave fish and the pelvic bones of snakes and whales. The wisdom teeth and tailbone (*)** of humans are classic examples of, for the points, what "obsolete" parts of the body that no longer serve a purpose in its present form?

ANSWER: **Vestigial** Structures (or **Vestigial** Organs; accept **Vestigial**ity; prompt on answers synonymous to "non-functioning body parts")

(11) **The approximate distance to this location can be found by adding one to the object's orbital eccentricity and multiplying the solution by its (+) semi-major axis. The date when this location is reached by the Earth is approximately fourteen days after the June solstice when solar (*)** radiation is at its lowest. For the points, name this point in a satellite's orbit where the body is furthest from the Sun.

ANSWER: **Apogee** (accept **Aphelion**; accept **Apsis**)

(12) **The middle layer of this structure houses Purkinje [[per-KIN-jee]] cells, and the first model to explicitly state this structure's anatomy and function was based on a "teaching (+) signal" sent by a climbing fiber. Impairments to this region of the central nervous system can cause Huntington's disease, as well as several forms of ataxia. Located underneath the (*)** occipital and temporal lobes, this is, for the points, what region of the brain that is responsible for one's motor learning and maintenance of balance?

ANSWER: **Cerebellum** (accept **Cerebellar Cortex**; prompt on "Brain"; prompt on "Little Brain")

(13) **Under special relativity, this law is implied by the general form of the first law of thermodynamics and Albert Einstein's formula "E equals m c squared." With (+) the laws of definite and multiple proportions, this law underlies the principles of stoichiometry [[stoy-kee-YAH-meh-tree]], which is used to balance chemical reactions. Antoine (*)** Lavoisier discovered, for the points, what law that states that matter can neither be created nor destroyed?

ANSWER: Law of **Conservation** of **Mass** (or Law of **Conservation** of **Matter**)

(14) **In collaboration with Starling Burgess and Isamu Noguchi, this person designed and built prototypes of the Dymaxion Car. Biologists have drawn on this person's architectural designs to explain the (+) icosahedral shape of many viruses. This man helped to popularize the concept of "Spaceship Earth" and established a field he called "synergetics." A carbon (*)** allotrope that comes in ball, tube, and onion varieties is named for this person. For the points, name this architect remembered for his geodesic domes.

ANSWER: Buckminster **Fuller** (or R(ichard) Buckminster "Bucky" **Fuller**; accept Buckminster **Fuller**ine)

(15) **ITU-R 468 weighting and A-weighting are commonly used to measure a type of this phenomenon. The thermal excitation of (+) electrons causes a type of this phenomenon known as its Johnson-Nyquist variety. A type of this phenomenon is given as the ratio of signal power to its power and adds error to electronic signals. A constant (*)** power spectral density defines the "white" type of, for the points, what unwanted disturbance of an electrical signal.

ANSWER: **Noise** (accept Johnson-Nyquist **Noise**; or Thermal **Noise**; accept White **Noise**)

(16) **This man listed 800 medical substances and outlined methods of "Special Pathology" in a book that summarized Galen's work titled (+) *The Canon of Medicine*. A book by this man, which introduced the "floating man" theory, incorporates early psychology and chemistry to cure the ignorance of the soul, titled *The Book* (*) *of Healing***. For the points, name this 11th-century Persian Islamic Golden Age polymath.

ANSWER: **Avicenna** (accept **Ibn Sina**)

(17) **The lack of this construct differentiates a pseudo-ring from a ring. For matrices, the multiplicative type of this construct consists of a square (+) matrix with 1's on the main diagonal and 0's elsewhere. For addition on the real numbers, this construct equals 0, and for multiplication, it equals 1 except for the (*)** zero case. For the points, what construct for a binary operation does not change the element it acts on?

ANSWER: **Identity** (accept Multiplicative **Identity**; or Additive **Identity**)

(18) **These cells were essential in the research of Harald zur Hausen in linking human papillomavirus 18 with cervical cancer, for which he won the Nobel Prize in Physiology and Medicine in 2008. These (+) cells were also essential in the development of the polio vaccine, as scientists found that the poliovirus was able to (*)** replicate in these cells. For the points, name these "immortal" cells used in medical research whose name derived from a cancer patient named Henrietta Lacks.

ANSWER: **HeLa** [[HEE-la]] Cells (accept **He**nrietta **La**ck Cells before mentioned)

(19) **During World War Two, this scientist developed vaccines for diseases such as sleeping sickness and dengue [[DEN-geh]] fever. This man suggested that a (+) certain virus cultivated in human intestines before attacking the central nervous system, based on his observation of the bodies of polio victims. Developing a "live" vaccine that rivaled the "dead" vaccine developed by Jonas (*)** Salk, this is, for the points, what Polish-American scientist who developed the oral polio vaccine, effectively eradicating the disease?

ANSWER: Albert **Sabin** (or Albert Bruce **Sabin**)

(20) **This operation's epsilon-delta definition was first formulated by Cauchy [[koh-SHEE]]. This operation can be evaluated by L'Hopital's [[loh-pee-TAHLS] rule. (+) The formal definition of a derivative is this operation applied to a difference quotient. The two-sided type of this operation does not exist at jump discontinuities. (*)** For the points, name this operation of finding where a function "approaches" as an input goes toward a value.

ANSWER: **Limit**

(21) **The term for this computing technique was coined by David Michie in 1968. Related to caching [["CASH"-ing]], this technique is often used in compilers (+) for functional programming languages, where a "call by name" strategy is employed. With the goal of "turning a function into something to be (*)** remembered," for the points, what is this computing technique that stores the results of function calls to be returned from a cache at a later time, also called tabling?

ANSWER: **Memoization** [["memo"-"EYE"-zay-shun]] (accept **Tabling** before mentioned; prompt on "Memo" or "Memorandum"; prompt on "Caching" before mentioned)

(22) **Tin hydride or PTOC thiol are used to calibrate clocks named for these species, and AIBN is heated to serve to initiate production of these species. A form of polymerization (+) using these species experiences steps of initiation via homolytic cleavage, propagation, and termination. Mechanisms containing these species are drawn using fishhook arrows, and they are thwarted by (*)** antioxidants. For the points, name these chemical species with an unpaired electron.

ANSWER: **Free Radicals** (prompt on "radical")

(23) **This phenomenon was corroborated by the Vines-Matthew-Morley hypothesis, where a series of magnetic stripes were observed. Convection (+) currents in the asthenosphere cause this phenomenon, which was first proposed by Harry Hess. Basaltic crust is created at (*)** mid-ocean ridges as a result of this process. For the points, name this process where new oceanic crust is formed as a result of older crust moving apart.

ANSWER: **Seafloor spread**ing

(24) **A theorem named for this man states that the order of any element of a group divides the order of that group. This man names (+) "multipliers" which are used to find local maxima and minima of a function under equality constraints. This mathematician names "points" in which the centrifugal force balances (*)** gravity. For the points, name this Italian-French mathematician known for his contributions to number theory.

ANSWER: Joseph-Louis **Lagrange** (accept **Lagrange** Multipliers; accept **Lagrange** Points)

(25) **In 2020, scientists witnessed a star undergoing this phenomenon, in what some astronomers call a tidal disruption event. The difference in acceleration between the head and feet of a human (+) causes this effect, although it is theorized that humans may not experience this phenomenon in supermassive black holes since its tidal force is less than what is experienced on (*)** Earth. For the points, name this phenomenon that is caused by vertical stretching and horizontal compression, also called the noodle effect?

ANSWER: **Spaghettification** (accept **Noodle Effect** before mentioned)

Extra Questions

(1) **The process of forming one of these substances is described by the COSMO model and the Born equation. The K-sp (+) value quantifies an equilibrium observed in these substances. Molality is often used to measure the concentration of these substances, which can form a solid precipitate if they are (*)** supersaturated. For the points, name these homogeneous mixtures that consist of a solute dissolved in a solvent.

ANSWER: **solution** (accept **solvation**; prompt on "mixtures")

(2) **Certain organisms use organs called halteres to assist in this phenomenon. A behavior called WAIR, or inclined running, may explain the evolution of this phenomenon. (+) *Archaeopteryx* was likely capable of this phenomenon, as was *Quetzalcoatlus*. This phenomenon is divided into unpowered and powered forms, and the only (*)** mammal to use this mode of locomotion are bats. For the points, name this behavior found in pterosaurs and birds.

ANSWER: **Flight** (or **Fly**ing; prompt on "throw[ing] yourself at the ground and miss[ing]")

(3) **Gerard de Lairesse was a congenital sufferer of this disease, symptoms of which include Hutchinson's teeth and saddle nose. John Charles Cutler orchestrated an unethical study of this disease on human test subjects in Guatemala, (+) and he directed another study of this disease that led to the creation of the Office for Human Research Protections. Caused by *Treponema pallidum* and possibly the only major disease brought from the (*)** Americas to Europe is, for the points, what sexually-transmitted disease which the Tuskegee Study victims were left untreated for?

ANSWER: **Syphilis**