

Round 7

1. A feature of cells that are going through this process is the presence of such molecules as annexin A1, calreticulin, and phosphatidylserine. TNF is the major extrinsic mediator of this, with TNF receptors are involved in both major theories of the initiation of this in mammals. In some cases of vitiligo, two varieties of a type of protease that plays an important role in this process are overexpressed. Carl Vogt was the first to describe the mechanism of this, which he did in 1842. Caspases play essential roles in this process. Identify this process which causes blebbing, cell shrinking, and nuclear fragmentation, the process of programmed cell death.

ANSWER: apoptosis <AL>

2. Removing water through a Dean-Stark apparatus or using a dehydrating agent improves the yield of the Steglich type of this reaction. The trans-version of this reaction is usually used in the degradation of triglycerides. Diazomethane can prompt this reaction in carboxylic acids. Saponification, another type of these reactions, is the basis of the creation of soap. Refluxing a carboxylic acid and an alcohol in the presence of an acid catalyst is the basis of a version of this reaction named for Fischer. Name this type of reaction between two compounds, usually an alcohol and an acid, that produces the namesake fruity-smelling compound.

ANSWER: esterification <BJ>

3. In power generation, this term indicates a constant frequency of electricity, and in horology, clocks that are unaffected by changes in the driving force are this. In dynamic system theory, any oscillator for which frequency is independent of amplitude can be called this, and this is a type of data flow for the Universal Serial Bus for computers. The division of time into equal parts by a language, usually for rhythm, is this in linguistics. This type of cyclotron adjusts its field strength to balance out relativistic increases in mass. Because the period of a pendulum is constant regardless of mass and angle, the path of the pendulum can be described by this word. Identify this term constructed from the Greek roots for “same” and “time.”

ANSWER: isochronous <AK>

4. One carcinoma of this organ shows characteristic Little Orphan Annie nuclei and psammoma bodies. One condition that affects this organ is treated using a pair of drugs that carry a high risk of depleting all granulocytes, called methimazole or propylthiouracil. When one product of this organ is under-produced, mucopolysaccharides are deposited in the skin, causing myxedema. C cells in this organ produce a substance that opposes PTH called calcitonin, and diseases that affect this organ include Graves’ disease and Hashimoto’s disease. This organ is acted upon by TSH, and it secretes T3 and T4. Name this organ, found below the Adam’s apple that can form goiters due to iodine deficiency.

ANSWER: thyroid gland [do not accept or prompt on “parathyroid gland”] <SV>

5. This property is changed by the Walden inversion. Changing only this property for an alcohol involves using tosyl chloride and pyridine, then adding sodium acetate and THF, and finally adding potassium hydroxide and water. This property is not possessed by meso compounds, and it can be visualized using Fischer projections. Pasteur found this property in tartaric acid, and glycine is the only amino acid lacking it. A mixture of products with this property is said to be racemic. Molecules with this property are designated R or S in the CIP system. Name this concept of a compound's “handedness,” which describes compounds with a non-superimposable mirror image.

ANSWER: chirality [prompt on optical isomers or enantiomers, but nothing else]

6. Massive O and B stars may produce bubbles named after this phenomenon, filling huge cavities in the interstellar medium. Radiation pressure on condensing dust may cause this phenomenon in stars near the end of their lives. Wolf-Rayet stars have very strong ones of these, which causes them to lose relatively large amounts of their mass. The one produced by and named for the Sun is responsible for creating the overall shape of the Earth’s magnetosphere and the auroras. Identify this phenomenon in which is a stream of particles released from the atmosphere of a star.

ANSWER: stellar wind [anti-prompt on “solar wind”] <AL>

7. The box count method of a type of dimension analysis named after these objects is being researched as a possible tool for the prognosis of cancer. The Menger sponge, in addition to being a super-object for all compact one-dimensional objects, is a three-dimensional one of these. Another one of these has a Hausdorff dimension of 3 and is known as the dragon curve. The Pythagoras tree is a shape-replacement example of these. More famous examples include the Julia sets, which occur in the one of these known as the Mandelbrot set. Name these infinitely self-similar patterns, exemplified by the Sierpiński triangle and the Koch snowflake.

ANSWER: fractals <AL>

8. For a thermal system, this quantity equals density times specific heat times volume over the heat transfer constant times surface area. The open-circuit method named after this quantity is used to determine the corner frequency for complex circuits. In simple circuits, the corner frequency is equal to one over 2π times this quantity. This quantity is equal to the inductance over the resistance in an RL circuit, and it is equal to resistance times capacitance in an RC circuit. Half-life is equal to this quantity times the natural log of two. Name this quantity, which equals the amount of time it takes for a system to reach $(1 - 1/e)$ of its final value, a common constant used in circuit analysis.

ANSWER: time constant [prompt on “tau”] <SV>

9. One function denoted by this letter, when taken of n , multiplied by q to the n , and summed over all integers greater than 1, gives the Dedekind eta function to the 24th power; that function is named for Ramanujan. One particle with this name can generate “double-bang” and “lollipop” events and was detected in Fermilab’s DONUT collaboration. A statistic named for this letter is calculated by finding the difference between concordant and discordant pairs of ranks, and is also named for Kendall. This letter denotes proper time, and a subatomic particle known by this Greek letter is the heaviest lepton yet discovered. It is not MAP2, but a defective protein of this name can lead to neurofibrillary tangles in Alzheimer’s disease. It is also used in physics to denote the time constant and torque. Identify this Greek letter analogous to the letter T.

ANSWER: tau <AL>

10. An equation named for this man and Kramers gives the cross section for the inelastic scattering of a photon by an electron. Wavefunctions are time-independent while operators acquire time dependence in this man’s picture of quantum mechanics. This man used the exchange interaction in his Hamiltonian modeling ferromagnetism, and along with Born and Jordan, he developed the matrix formulation of quantum mechanics. This man’s most famous accomplishment states the product of two standard deviations is greater than or equal to \hbar over 2. Name this German physicist, who stated that position and momentum cannot simultaneously be known in his uncertainty principle.

ANSWER: Werner Heisenberg <AK><ed. BB>

11. When cells of this structure do not fully develop, lesions called Tornwaldt’s cysts can form. During embryonic development, this structure produces a morphogen important in organ differentiation named after Sonic the Hedgehog. It is composed of a glycoprotein core surrounded by two collagen helices, and it served as a backbone in *Haikouichthys*. Though it is a defining feature of the phylum Chordata, most chordates do not retain this structure into adulthood, though tunicates and lancelets notably do. Identify this structure that is the precursor to the intervertebral disk, a structure found in the embryos of all chordates.

ANSWER: notochord [do not accept or prompt on “dorsal nerve chord”] <SV>

12. It’s not the Sun, but rapid changes in the magnetic field surrounding its central object are a very probable cause for its recent flares. Radiation from this object was used to map the Sun’s corona and measure the thickness of Titan. Jan Oort was able to determine that the polarized light from this object was a product of synchrotron radiation. At its center, this object contains a pulsar with a period of 33 milliseconds which is one of the brightest gamma ray sources in the sky. SN 1054, the supernova responsible for what the Chinese called a “guest star”, produced this object. Identify this supernova remnant, the first entry in the Messier catalogue.

ANSWER: Crab Nebula <AL> [accept M1 until mentioned]

13. He helped determine the chemical composition of cacodyl, which was some of the first work in organometallic chemistry. This man invented a battery with a carbon electrode which Henri Moisson used to isolate fluorine; that is his namesake cell. Sulfur dioxide, iodine, and water react to form sulfuric acid and hydrogen iodide in his namesake reaction. Henry Roscoe and this man worked together to study the formation of hydrogen chloride from its constituent gases. He discovered the elements caesium and rubidium with Gustav Kirchoff. Name this man, whose namesake “burner” is a mainstay in chemistry classes.

Answer: Robert **Bunsen** <BJ>

14. Divisions of this time period include the Cisuralian, Guadalupian, and Lopingian epochs. The continent of Cimmeria separated from Gondwana during this period, which resulted in the shrinking of the Paleo-Tethys sea and the formation of the Tethys sea to its south. Modern trees like conifers and ginkos first appeared in this period, whose dry conditions favored the growth of gymnosperms. This period was dominated by synapsids such as pelycosaurs, dinocephalia, and gorgonopsians. Preceded by the Carboniferous Period, it was first introduced in 1841 by Roderick Murchison. Name this geological period in which 95 percent of the extant species were wiped out by its namesake P-T extinction event.

ANSWER: **Permian** period <AK>

15. This element was used in Ionescu and Mihiu's precursor to the MASER, which itself was developed by Ramsey and Kleppner using a polarized form of this element for energy. This element was used instead of silver in Phipps and Taylor's followup to the Stern-Gerlach experiment. The Rydberg formula can be used to determine different spectral lines for this element, the most important of which are the Lyman, Balmer, and Paschen series. This element has isotopes known as deuterium and tritium, and the low density of ice and high boiling point of water arise because of its namesake bonds. Name this most abundant element in the universe, with atomic number 1.

ANSWER: **hydrogen** [accept **H** until mentioned] <BJ>

16. Lebesgue fixed some errors in a proof of one case of this by Lamé in 1840. Miyaoka produced an ultimately discredited proof of this by linking it to differential geometry. The final proof of this required the combination of Iwasawa theory and the Kolyvagin-Flach method. This is the most famous conundrum associated with the man called the “Prince of Amateurs” by E.T. Bell. Euler proved the $n = 3$ case of this through infinite descent. The final proof of this was completed by Richard Taylor and Andrew Wiles using the Taniyama-Shimura conjecture. Name this theorem that $a^n + b^n$ is never equal to c^n if “a”, “b”, “c”, and “n” are integers greater than two.

ANSWER: **Fermat's Last Theorem** <AL>

17. *This organism has been used by Baumgardner et. al. as a computer to solve a Hamiltonian path problem. The K12 strain of this organism is commonly used in laboratories. Richard Lenski discovered that some of these organisms could metabolize citric acid after several thousand generations of reproduction. The first example of DNA helicase was found on this organism's F plasmid. Meselson and Stahl proved the semiconservative nature of DNA replication in this organism, and Jacques and Monod studied the lac operon in this organism. It is targeted by the T4 bacteriophage and contains the restriction enzyme EcoRI [eco-r-one]. Name this bacterium, a model organism that produces lots of Vitamin K in the small intestine.

ANSWER: **Escherichia coli** <SV>

18. The wavefunctions for this system are proportional to the inverse square root of two to the n times n factorial times a Gaussian times a Hermite polynomial. The zero-point energy of this system is equal to $\frac{1}{2}$ times \hbar times omega. A particle in a potential minimum can be modeled using this system by Taylor expanding the potential and keeping the 2nd-order term. When this system's 2nd order differential equation is inhomogeneous, it is said to be “driven,” while when there is a nonzero first derivative term, damping occurs. In this kind of system, acceleration is linearly proportional to displacement. Name this kind of system exemplified by a mass attached to a spring.

ANSWER: **harmonic oscillator** [accept “simple” or “quantum” **harmonic oscillators**, accept word forms like **simple harmonic motion** and abbreviations like **QHO** or **SHM**]

<AK><ed.BB>

19. This language was the first to use the RAII idiom, which avoids deadlock by tying resource management directly to initialization and destruction". Like Leda, this programming language often shows the curiously recurring template pattern. Its creator asserted that "what you don't use, you don't pay for" in explaining its "zero overhead principle." Inspired by the computer language SIMULA, this language supports multiple inheritance, operator overloading, and pointer arithmetic, in which a pointer's address is changed by applying arithmetic operations. This programming language was developed by the Danish computer scientist Bjarne Stroustrup in 1979 at Bell Labs. Name this computer language, which was originally named C with Classes and was renamed in 1983.

ANSWER: C++ <AK>

[With special guest Rob Carson]

20. The BLITS satellite is a spherical module that tested the retro- variety of this phenomenon in space before it crashed with space debris. A Householder transformation matrix can be used to calculate the vector that represents this phenomenon. In rough surfaces, a model named for Oren and Nayar describes the diffuse variety of this phenomenon. The light that is subject to this phenomenon is fully polarized at Brewster's angle. Above the critical angle, the "total internal" variety of this phenomenon occurs. Name this optical phenomenon for which the angle of incidence is equal to the namesake angle, a phenomenon commonly contrasted with "refraction" that can commonly be observed in mirrors.

ANSWER: reflection [do not accept or prompt "refraction"] <SV>