

Lederberg 3: Trinity

Brugada my heart, four-chambered God.

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1. This situation can be minimized by finding a "maximal set of subcubes" for a series of hypercubes in a parallel computing system. Kim and Lee tried to avoid "cold data" in a paper describing minimizing this. SQLite's ("S-Q-lights") "Journaling of Journal" anomaly can increase this situation. It's not "loss" or "deletion", but this situation can be reversed without metadata using a carving algorithm. The fsck ("f-suck") utility's output of "non contiguous i-nodes" can help diagnose this situation. The buddy algorithm reduces one instance of this problem, but creates its (*) internal form by allocating blocks with power-of-2 sizes. which notably occurs less in $e \cdot x \cdot t \cdot 4$ systems than N·T·F·S. Bin-packing heuristics can alleviate this problem by finding best-fit or first-fit holes. This phenomenon occurs externally when blocks of free memory are separated by smaller used blocks. For 10 points, name this inefficient use of computing storage space in which files are stored non-continuously.

ANSWER: file system fragmentation [prompt on file corruption or hard drive corruption]

<Computer Science, Jaimie Carlson>

2. Indeterminate zones are graphical regions where stochastic processes impact this phenomenon. This phenomenon is studied using associative and substitutive experiments on "associate" and "focal" species. One model of this phenomenon divides the parameter $B_{sub\ i}$ to the power of theta over the sum of parameters $B_{sub\ j}$ to that same power. A parameter equal to death rate over consumption rate determines the outcome of this phenomenon, and is referred to as "R star." Coefficients quantifying this phenomenon are symbolized alpha and calculated as the ratio of two (*) carrying capacities. In the size asymmetric form of this phenomenon, the ratio of organism size to resource amount varies for each organism involved. Gause's Law states that niche-sharing species are either driven to extinction or a change in niche via this process. Intraspecific and interspecific are types of, for ten points, what phenomenon where multiple organisms seek a common resource?

ANSWER: competition [or competitive exclusion or interspecific competition or intraspecific competition]

<Biology, Akshay Govindan>

3. One method of measuring this quantity involves measuring a bridge imbalance output voltage, dividing by concentration, and taking the limit as concentration goes to zero. That method uses two thermistors, each with a drop of solution. Another method uses a capillary tube with a regenerated cellulose membrane in its "static" version. In theta solvents, this quantity is raised to the 0.5 power in an equation that relates it to intrinsic viscosity. It is plotted on the y axis against volume in a technique which uses thyroglobulin, aprotinin, and blue dextran as standards for this quantity; in that technique, the (*) void volume is measured to create a calibration curve. The Mark-Houwink equation is used to calculate this quantity, which is measured using membrane osmometry and gel filtration chromatography. The distribution of this quantity is the dispersity index, and it is measured in kilodaltons. For 10 points, name this quantity equal to the sum of atomic masses in a molecule.

ANSWER: molecular weight [or molar mass; or molecular mass; or number-average molecular weight; or weight-average molecular weight; or Z-average molecular weight; or mass-average molecular weight; or molecular weight distribution; or number-average molar mass; or weight-average molar mass; or Z-average molar mass; or mass-average molar mass; or molar mass distribution; or number-average molecular mass; or weight-average molecular mass; or Z-average molecular mass or mass-average molecular mass; or molecular mass distribution; prompt on M; prompt on mass; prompt on weight; prompt on size; prompt on length]

<Chemistry, Eric Mukherjee>

4. When an equation for this quantity is linearized, the perturbation term in an expression for this quantity has a gauge freedom analogous to the gauge freedom of the magnetic vector potential. In one case, calculating this quantity involves integrating the equation “negative $d r$ over r equals $d V$ over quantity V times quantity V minus one,” where V is one of four functions introduced to simplify solving for this quantity. One half of this quantity times a sum of three partial derivatives of this quantity gives the (*) Christoffel (“CHRIS-toe-fell”) symbol of the second kind. The stress-energy tensor is proportional to the Ricci (“ree-chee”) curvature tensor minus one half the scalar curvature times this quantity, according to the Einstein field equations. Minkowski’s (“min-COW-skeez”) version of this tensor corresponds to flat spacetime. For 10 points, name this tensor that describes the geometry of spacetime in general relativity.

ANSWER: metric tensor [prompt on metric or tensor; accept metric after “tensor”]

<Physics, Justin French>

5. During the development of these cells, D·P·Y·19·L·2 is required for localization for the SPAG·4·L domain within the nuclear envelope. A·KAP·3 and A·KAP·4 are almost exclusively expressed in these cells. A sulfated version of a protein in these cells is used to increase the duration of therapeutic insulin and to reverse heparin overdose. A tri-peptide called F·P·P triggers the removal of sterols from the membranes of these cells; that removal and the subsequent influx of calcium ions through CATSPER (“CAT-spurr”) channels occur during (*) capacitation. Protamines (“PRO-tuh-meenz”) are used in place of histones (“HISS-tones”) in these cells, which modify glyco-proteins on another cell’s zona pellucida (“puh-LEW-sid-uh”) with hydrolases in their acrosomes. Sertoli (“ser-TOE-lee”) cells nourish these cells during development, and they are initially linked by cytoplasmic bridges during meiosis (“my-OH-sis”). For 10 points, name these male gametes.

ANSWER: sperm cells [accept spermatid, spermatozoa, spermatogonia, primary spermatocytes, secondary spermatocytes]

<Biology, Abhinav Godavarthi>

6. Louis Esperet (“ess-pair-ay”) et al proved an exponential lower bound for the number of perfect matchings in bridgeless graphs of this type, proving an earlier conjecture by Lovász (“low-voss”) and Plummer. Tait’s conjecture about 3-connected planar graphs with this property having a Hamiltonian cycle was proven false via a counterexample due to Tutte, who also analyzed symmetries of these graphs and classified them by minimal symmetric oriented path length. Tait proved that a certain set of simple, connected, bridgeless graphs of this type being nonplanar is equivalent to the (*) four-color theorem; those graphs satisfy a particular requirement on chromatic index and are known as snarks. Every graph of this type that is also bridgeless contains a perfect matching according to Petersen’s Theorem, and a famous graph also named for Petersen has this property. For 10 points, identify this type of graph in which every vertex is of degree three.

ANSWER: cubic graph [accept 3-regular graph or trivalent graph or bicubic graph; prompt on regular] <SRS>

<Math, Steven Silverman>

7. To rank approaches to this task, Hendrickson introduced the external-path-length and total weight metrics. One method of performing this task successively builds layers off a T·G·T node, creating an E·X·T·G·T tree. Wipke helped develop the O·C·S·S program for this task, which evolved into LHASA (“luh-HASSA”). This task can either aim for S- and T-goals or employ a topological strategy. E.J. Sorensen and K.C. Nicolaou write a textbook on “classics in” this task, which in Steve Hanessian’s “Chiron approach” begins with finding substructures with C·2 symmetry. One approach for task involves using a series of disconnections to create idealized (*) synthons; E.J. Corey developed that approach, which involves working backwards from the target. For 10 points, name this task in organic chemistry involving creating a complex product from simple, commercially available precursors.

ANSWER: planning a total synthesis [or retrosynthesis or retrosynthetic analysis; prompt on natural product synthesis, chemical synthesis, organic synthesis, stereoselective synthesis]

<Chemistry, Eric Mukherjee>

8. In several models of these events, the natural log of the ratio of S-sub-zero to S-sub-infinity gives the “final size relation”. Catalytic models of these events are used to estimate a parameter symbolized lambda, call the F·O·I. The Reed-Frost and Greenwood models of these events are special cases of a general chain-binomial model. When modelling these events, the serial interval is the time between primary and secondary onsets. The ratio of beta to gamma in one model of these events gives a variable denoted R-sub-zero, which is less than one for (*) self-limiting examples of them; that number is the basic reproduction number. The often-extended S·I·R model of these events includes compartments for susceptible and recovered populations. Forcing terms are added to model seasonal examples of these events like the flu. For 10 points, name these outbreaks of infectious disease

ANSWER: epidemics [or pandemic; prompt on outbreak or infection or infectious disease or similar answers]

<Data Science/Stats/Applied Math, Eric Mukherjee>

9. Tyson et al made the first measurement of this phenomenon on the Victor Blanco Telescope at C·T·I·O in 1990. It isn't the C·M·B or clustering, but the Limber and flat-sky approximations are often applied to measurements of this phenomenon. The meta-calibration method uses simulated image-level effects to enable measurements of this phenomenon without needing intrinsic properties or using large simulations. Direct reconstructions and inversion methods are two ways of analyzing this phenomenon developed by (*) Kaiser and Squires. The intrinsic alignment of galaxies and their intrinsic ellipticity are the two biggest systematics when measuring this phenomenon. This phenomenon cannot be measured from a single galaxy, and is rather obtained from statistical measurements of convergence and shear. For 10 points, name this effect which occurs at large distances from massive sources and therefore doesn't produce Einstein Rings.

ANSWER: weak gravitational lensing [prompt on partial answer; do NOT accept or prompt on “strong lensing” or “microlensing”]

<Astronomy, James Lasker>

10. The binding of this amino acid to CASTOR·1 disrupts its heterodimer with GATOR·2, which inhibits ribophagy through the action of m·TORC·1 (“em-tork-one”). P·A·D proteins substitute one functional group in this amino acid with a carbonyl. The asymmetric di-methyl form of this amino acid is a marker of cardiovascular health. An enzyme which targets this amino acid comes in endothelial (“endo-THEE-lee-uh”), neuronal, and inducible isoforms; that enzyme oxidizes this amino acid to (*) N·O·H·L·A in the biosynthesis of a common vasodilator (“VASE-oh-DIE-later”). This molecule and water are converted to ornithine (“ORN-uh-teen”) in the last step of the urea cycle, and this molecule is often converted to citrulline (“SIT-true-lean”) as a byproduct of nitric oxide synthesis. For ten points, name this amino acid with abbreviation R.

ANSWER: arginine

<Biology, Akshay Govindan>

11. If the modes of this process are statistically independent, then Lusser's law applies. This process occurs when the sum of little n sub i over big N sub i is equal to 1, according to Miner's rule. The annualized rate of this process is approximately equal to 8766 over the mean time between these events, which is equal to one over lambda. The rate of this process appears on the y-axis of the bathtub curve, which has regions of decreasing, constant, and increasing rates of it. “Burn-in” is used to move objects past the initial high rate of this process, while work hardening is used to decrease its incidence. The x-axis of an S-N curve is the logarithm of the number of cycles to this event in (*) cyclic loading experiments. In ductile materials, this process can be preceded by necking, while in brittle materials, it occurs at the ultimate point on a stress-strain diagram. The reliability is one minus the probability of this event. Fatigue, creep, fracture, and buckling are all modes of achieving this event. For 10 points, name this event in which an engineered structure can no longer can perform its function.

ANSWER: failure [prompt on specific failure modes like fatigue, creep, fracture, buckling, cracking with “what do these things lead to?”]

<Physics, Eric Mukherjee>

12. Repeated cycling of a lamellar/inverse-hexagonal transition can induce formation of these structures with bi-continuous cubic phases. A thin film hydration method for synthesizing these structures named for Bangham suffers from low trapping efficiency. Adding P·E·G to these structures allows them to evade macrophage uptake. Both doxorubicin (“DOCK-so-ROO-buh-sin”) and amphotericin (“AM-fo-TEAR-uh-sin”) B are prepared with these structures to decrease organ damage. A popular cationic (“cat-eye-on-ick”) (*) transfection reagent produced by Invitrogen (“in-VEE-tro-jen”) that forms these structures is prepared in reduced serum media such as OPTI-MEM. Extrusion is often used to prepare multi-lamellar (“luh-MELL-ar”) examples of these structures, while sonication can be used to prepare their unilamellar type from a mixture of amphipathic molecules, like phospholipids. For 10 points, name these structures similar to micelles that possess at least one lipid bilayer on their exteriors.

ANSWER: liposomes [or nanoliposomes, or cubosomes, or vesicles; prompt on membrane or lamellae]

<Chemistry, Paul Lee>

13. Dysthe added a fourth-order term to the standard cubic nonlinear Schrodinger equation used to model these phenomena. Simulations of these phenomena are usually based on a second-order P·D·E of the free surface elevation “eta,” an equation named for Boussinesq (“BOO-sin-esk”). If c is the speed, irregular solutions to another equation that models these phenomena take the form of [read slowly] “negative one half c times hyperbolic cosecant squared of the square root of c over two times the difference between x and c t;” that equation governing these phenomena sets u - t plus 6 u - x plus u - xxx equal to zero. The (*) dispersion relation for these phenomena sets the angular frequency squared equal to gk times the hyperbolic tangent of $h \cdot k$. Airy developed a linear theory of these phenomena that works for any depth. The radius of circular particle paths along these phenomena decreases exponentially with depth. For 10 points, name these oscillations of fluids whose restoring force comes from a massive object like Earth.

ANSWER: gravity waves [do NOT accept “gravitational waves”; accept surface gravity waves; accept capillary-gravity waves; accept deep water waves; accept shallow water waves; accept solitons; prompt on waves by asking “what medium are the waves in”; do NOT accept “wind wave”]

<Physics, Jonathen Settle>

14. Hirschfeld and Chase developed a chevron-configuration dielectric filter for use with this technique. The density of defects in graphite is given by the ratio of the D and G bands in this technique. Notation in this technique uses the letters X, Y, and Z with parentheses to designate direction of propagation. Molecules with silent modes can be probed using one form of this technique which creates second harmonic photons. The value of the ratio of two intensities notated ρ is compared to three-fourths to determine (*) polarized or depolarized bands in this technique. Modes active in this technique possess gerade symmetry, therefore excluding those modes from being active in infrared spectroscopy. This technique uses a continuous-wave laser to induce inelastic scattering. For 10 points, name this form of spectroscopy which relies on excited particles undergoing Stokes or anti-Stokes shifts.

ANSWER: Raman spectroscopy

<Chemistry, Akshay Govindan>

15. A quality check on these studies compares the observed median to the expected median to find the inflation factor λ . Price’s EIGENSTRAT (“EYE-gun-stratt”) method uses principal component analysis to remove bias due to hidden structure in these studies. One program used for these studies uses P·E·D and M·A·P files. A step in these studies pre-phases the data and then uses imputation to fill in gaps. PLINK (“plink”) is a package used for these studies, which usually uses a discovery and replication set. These studies graph position on the X axis and negative $\log P$ on the Y axis in a (*) Manhattan plot. The first of these studies linked the Y·402·H variant of complement factor H with macular degeneration. These studies typically discover common variants with low penetrance from whole-exome (“ECKS-ohm”) sequencing or SNP (“snip”) arrays. For 10 points, name these studies which tie genetic variants to traits or diseases.

ANSWER: GWAS (“GEE-wass”) [or genome-wide association studies, or whole-genome association studies, or GWA studies, or WGA studies]

<Biology, Eric Mukherjee>

16. Maps of constant rank can always be locally represented in a simple canonical form in the rank theorem on these spaces. On these spaces, an isomorphism between de Rham groups and singular cohomology groups is induced by integrating over simplices. Involutive distributions on these objects are connected to foliations by the Global Frobenius (“fro-BEN-ee-us”) theorem. The 2-form associated with one type of these spaces is expressible as the sum over dx_i wedge dy_i , where x_i and y_i are Darboux (“dar-BOW”) coordinates. Sard’s (*) theorem is used to show that a generic projection from one of these spaces to $\mathbf{R}P^{n-1}$ (“r-p-n-minus-1”) is injective in the proof that every one of these spaces of dimension n with or without boundary admits a proper smooth embedding into \mathbf{R}^{2n+1} (“r-two-n-minus-1”). The Whitney Embedding Theorem concerns the properties of these space that are considered smooth when any two charts in their atlas are smoothly compatible with each other. For 10 points, name these spaces that locally look like Euclidean space.

ANSWER: manifolds [accept smooth manifolds; accept symplectic manifolds]

<Math, Jonathen Settle>

17. In 2010, Yaghjian proved the correctness of an equation conjectured by Caldirola that in the point limit converges to an equation governing these particles. The infinite self energy of these particle is eliminated when starting with the non-linear Lagrangian proposed by Born and Infeld. The difference by a factor of four-thirds in two calculations for the mass of these particles is eliminated by introducing Poincaré (“pwan-cuh-RAY”) stresses. The total magnetic moment of these particles in a weak field is equal to the negative (*) Lande-g factor times the Bohr magneton over h -bar times J . The shift in wavelength after x-rays collide with these particles was found to depend on one minus the cosine of the scattering angle by Compton. For 10 points, name this particle whose interactions with photons are studied in $Q \cdot E \cdot D$.

ANSWER: electrons

<Physics, Jonathen Settle>

18. In 2005, observations with the CHARA array revealed that this star's polar temperature is about 2000 Kelvin greater than its equatorial temperature, a result of the fact it is rotating at 90% of its break-up angular velocity. While not Fomalhaut, in 2013, a team at the University of Arizona determined that this star had an inner asteroid belt-like debris and an outer Kuiper (“KAI-purr”) belt-like debris belt. This star is the prototype of stars which display an infrared excess as a result of thermal emission from a circumstellar dust disk. The Johnson photometric system was frequently standardized so that this A0 main sequence star had (*) 0 color in all bands. After about 12,000 years, this star will become the pole star as a result of the Earth's axial precession. For 10 points, name this second brightest star in the Northern Hemisphere and brightest star in Lyra, which, along with Altair and Deneb, is part of the Summer Triangle.

ANSWER: Vega [or alpha Lyrae until Lyra is mentioned]

<Astronomy, Geoffrey Chen>

19. The OpenAI library Gym is a Python platform for testing these types of algorithms. Gu et al performed cooperative robotic manipulation via these algorithms, which can use a normalized advantage function or deterministic policy gradient. Sutton and Barto wrote the standard textbook for these algorithms and created one called SARSA. These algorithms may be “myopic” if they have a small discount factor; that limitation of these algorithms can occur in a paradigm which maximizes the expected value of a metric of action quality, called (*) Q-learning. Some of these algorithms involve an actor and a critic, and they try to balance exploration with exploitation of existing resources. These algorithms often operate on Markov decision processes and feature an agent moving through an environment with a given policy. For 10 points, name these learning algorithms which maximize reward, named after a psychology technique studied by Skinner and Pavlov.

ANSWER: reinforcement learning [or deep reinforcement learning; prompt on machine learning; prompt on deep learning; anti-prompt on Q-learning before mention or temporal difference learning]

<Computer Science, Jaimie Carlson>

20. It's not radiation, but in the Atlantic and Indian Oceans, the time-mean "forcing" of this quantity has a magnitude two to three times greater than that of eddy-driven forcing. The Sverdrup ("sfair-droop") relation can be derived by integrating the equation which gives the conditions for balance of this quantity across the entire height of a water column. In oceanography, the "absolute" value of this quantity is given by the sum of its "relative" and "planetary" components, the latter of which is maximal at the poles and zero at the equator. That "absolute" value of this quantity is divided by water column height to give its so-called (*) "potential" form, which is conserved by fluid parcels as the result of Kelvin's theorem. By Stokes' theorem, the integral of this quantity around a loop gives the enclosed circulation. The curl of the velocity field is, for 10 points, what quantity which measures a field's local rotation?

ANSWER: vorticity [accept relative vorticity or potential vorticity or vorticity balance]

<Earth Science, Will Alston>

21. One grading system for this disease is partly based on the number of intra-epithelial lymphocytes on biopsy. Patients with refractory iron or vitamin D deficiency should be tested for this disease, which is found in almost all sufferers of dermatitis herpetiformis ("derm-uh-TIGHT-is her-PET-uh-for-miss"). Oberhuber modified the Marsh Classification of this disease. Anti-D·G·P and anti-reticulon tests are part of the panel for this disease. An I·g·A level is usually obtained alongside (*) serology for this disease, which is associated with H·L·A·D·Q·2 and D·Q·8 polymorphisms. Endomysial ("en-doh-MISS-ee-ul"), anti-tissue trans·glu·tam·inase, and anti-gliadin ("GLEE-uh-din") antibodies are found in this disease, whose biopsy findings include crypt hyperplasia and villous ("VILL-us") blunting in the small intestine. For 10 points, name this autoimmune disease which causes gluten intolerance.

ANSWER: celiac disease [prompt on answers like gluten allergy or gluten intolerance before "gluten"]

<Biology, Eric Mukherjee>

22. In a 1977 paper, Stephen Hawking calculated the log of the partition function to be a linear combination of one of these functions and its derivative; that is a form of regularization named for these functions. For an operator A , one of these functions is given by the Mellin transform of the kernel of the heat equation " $d F d t$ plus $A F$ equals zero." Because the Bose-Einstein distribution resembles the integrand in a representation for one of these functions, that one of these functions appears in the formula for the (*) critical temperature of a Bose-Einstein condensate, evaluated at three halves. The factor of "negative one twelfth" in the one-dimensional Casimir ("cass-ee-mir") effect arises from summing the divergent series "one plus two plus three and so on" using these functions' namesake regularization. For 10 points, identify this class of complex-valued functions, the canonical example of which is named for Riemann ("REE-mahn").

ANSWER: zeta functions [accept spectral zeta functions or the Riemann zeta function]

<Physics, Justin French>

23. In a 1987 paper, Gary King criticized the use of models named for this scientist to model Supreme Court appointments, and later developed the G·E·C model to replace it. A construct named for this scientist was extended by Diane Lambert to account for zeroes. Clark and Evans name a formula for calculating nearest neighbor distances in a two-dimensional construct named for this scientist. Cox names a construct generated when replacing the intensity parameter in a model named for this man with a random measure. To account for overdispersion, negative binomial regression can replace a regression named for this scientist that is used when the dependent variable is (*) count data. A process with stationary increments used to model arrival times is named for this scientist; that process is based on a distribution characterized by a single parameter lambda for mean and variance. For 10 points, give this namesake of a distribution used to model rare events like horse kicks.

ANSWER: Simeon-Denis Poisson [accept Poisson process, Poisson point process, Poisson distribution]

<Data Science/Stats/Applied Math, Eric Mukherjee>

24. This element's (dap)₂ chloride was developed by the Reiser group as a visible light-driven photoredox catalyst for atom-transfer radical additions. This element is purified using the IsaKidd process, which uses a stainless steel cathode and a robotic stripping machine. A block of this element and nickel comprises a common diffusion couple. Alloys of this element with nickel are used in marine engineering due to their corrosion resistance. D·I·F·O is used to obviate the need for this cytotoxic metal in Bertozzi's version of the azide-alkyne ("AL-kine") cycloaddition. Three equivalents of sulfuric acid are added to this metal for leaching, which is then purified by (*) electro-winning. The iodide of this element is reacted with two equivalents of an organo-lithium reagent to produce Gilman reagents. This element, which has a full 3·d orbital and a half-filled 4·s orbital, glows bluish-green in the flame test. For 10 points, name this element which is alloys with tin to form bronze.

ANSWER: copper [or Cu]

<Chemistry, Eric Mukherjee>