LEDERBERG 2: DAUGHTER CELL
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PACKET 5 – HORTA
THE LAST TOSSUP YOU READ SHOULD HAVE BEEN ON ANSWER: **21 cm line**

1. The Hirvonen function is used alongside the Least Squares Collocation method for computing this construct locally. Transforming from real space to Helmert space is a key step in Vanicek's method of computing this entity precisely. Data from the GRACE satellite has computed this entity to 2159 orders, and another model of this entity has combination solutions to 70 orders of harmonics, and blocks diagonal and quadrature solutions to the remaining orders up to 360; that is the EGM96 model. The difference between the height of this entity and the height of the reference ellipsoid is equal to the disturbing potential over gamma according to the Bruns formula; that quantity is known as its namesake (*) undulation. The plumb line is always perpendicular to this entity, which can be constructed approximately using the Stokes integral. This construct is depressed by mantle thickening and elevated in orogenic regions. For 10 points, name this shape that corresponds to the shape which gives the mean sea level of a water-covered earth.
ANSWER: **geoid** [prompt on "Earth's gravitational field" or similar answers]

2. An extension to these statements was posited by Wick, Wightman, and Wigner to include local fluctuations, and those extensions to these can be used to divide infinite magnetic systems into namesake sectors. These statements are used to distinguish the dotted lines from the solid lines in a Tanabe-Sugano diagram. The derivation of one example of these depends on whether the dipole, quadrupole, or other multiple approximation is used. A general method for deriving these statements is to find where the integral of psi-sub-one-star times mu times psi-sub-two is nonzero. These statements can help find the relative intensities of peaks in (*) UV/vis spectroscopy. Vibrionic coupling and the Jahn-Teller effect allows for the violation of one of these which applies to processes that alter the symmetry around an inversion center. Another one of these states that triplet states and singlet states don't mix. For the rigid rotor, one of these states that the rotational quantum number can only change by 1, and forbidden mechanisms have a low probability because they violate these. For 10 points, name these statements from quantum mechanics that disallow certain electronic transitions.
ANSWER: **selection** rule [accept **superselection** rule, prompt on "rule"]

3. Inhibitors of this protein include the naphthalene-sulfonamide derivative W-13. Along with protein A and a tobacco etch virus protease site, a peptide that binds to this protein helps comprise a Tandem Affinity Purification tag. A phosphatase whose catalytic subunit binds to *this protein* triggers nuclear import of NFAT, and that phosphatase is inhibited by cyclosporine and tacrolimus. One protein that is activated by this protein auto-phosporylates at threonine 286, which is thought to be important in long-term potentiation. This protein activates myosin light chain kinase. This protein contains four canonical examples of a motif also found in (*) Annexins, called the EF hand. This protein takes an analogous role to troponin in smooth muscle, and it's not cyclin but this protein binds to a namesake dependent protein kinase. For 10 points, name this signaling molecule that binds calcium.
ANSWER: **calmodulin**

4. Note: we are looking for the best possible big-Oh bound as a function of the size of the input, n. The maximum subsequence sum problem can be solved in this time using an algorithm developed by Kadane. By looping from "n over 2" to 1 and sinking keys down, building a binary heap from an unsorted array can be shown to take this much time. From the master theorem, this is the running time of a program described by the recurrence T(n) = 4T(n/4) + 1 ["T of n equals 4 T of n over 4 plus 1"]. This is the running time of the conquer step of (*) merge sort and, contrary to popular belief, this is actually the worst-case time for a lookup in a hash map. This is the worst-case time to search for an element in a standard binary search tree, and this is the best case bound for any sorting algorithm. For 10 points, give the time needed to search for a specific element in an array.
ANSWER: O(**n**) [or big-Oh of **n** or **linear** time; accept big-Oh of **[any linear function of n]**; accept big-Theta of **n** or of **[any linear function of n]**; do not accept any "little-Oh", "little-Omega", or "big-Omega" answers]

5. Plotting the baryon density on the x-axis against the ratio of one isotope of this element to hydrogen shows a minimum between 10 to the negative 10th and 10 to the negative 9th. The Spite plateau helps constrain the amount of this element in the early universe, which is inferred by measuring its abundance in old halo stars. Absorption lines of this element are characteristic in T Tauri stars. Neutrino production in the second branch of the proton-proton chain is accompanied by the production of this element. Standard theories of the big bang nucleosynthesis predict that this element appears as the universe cools below 100 KeV, though BBN significantly (*) overestimates the amount of this element. In stellar cores, this element is rapidly destroyed by reacting with a proton, creating a beryllium atom that then degenerates into two alpha particles. The spectral lines of this element are used to distinguish brown dwarves from low-mass stars. For 10 points, name this element, which is produced after hydrogen and helium and is the lightest element that counts for metallicity measurements of stars.
ANSWER: __lithium__

6. The Filipino film *Terror is a Man* is basically set in this location. A film titled for this location resulted in angry director John Frankenheimer's one-liner "Will Rogers never met Val Kilmer." In another appearance, the protagonist meets the servant M'ling and after being left here, ends up staying with a man named Montgomery. A movie about this location featured an UN negotiator arriving here and meeting the title character, played by Marlon Brando. In a novel, Edward (*) Prendick ends up at this location, where he meets the Sayer of the Law and a man who had been disgraced for running vivisection experiments in London. For 10 points, name this island run by a namesake scientist who creates human-like beings from animals, a fictional place created by H.G. Wells.
ANSWER: The Island of Doctor __Moreau__ [or __Noble's__ Isle, or Island of __Lost Souls__]

7. Reactions of this type are responsible for rearrangements of the Mariano compound and the Pratt diene. The decolorization of santonin is an early example of this type of reaction. A reaction of this type that synthesizes oxetane is the Paterno-Buchi reaction. Another reaction of this type has its stereochemistry determined by the degree of intersystem crossing; that reaction is named for Norrish. Electrocyclic reactions of this type on molecules with an even number of conjugated pi bonds are disrotatory and on those with an odd number of conjugated pi bonds are conrotatory according to the Woodward-Hoffmann rules, which contrast this type of control with (*) thermal control. Other reactions of this type include the dimerization of ethylene, the closure of 1,3-butadiene to cyclobutadiene, and the formation of halogen radicals from CFCs in the atmosphere. For 10 points, name this type of reaction in which activation energy is provided by photons.
ANSWER: __photochemical__ reactions [accept __light__-catalyzed reactions, __photon__-catalyzed reactions before mention, anything with the prefix "__photo__" in it, etc]

8. One method of illustrating this theorem involves deriving a balance equation by considering a series of square Q-molecules that bounce smaller P-molecules at 45-degree angles. The derivation of this statement relies on finding the time derivative of the probability of being in a given state, which is the sum over all states of the transition probability times the difference in probability between two states. The value central to this theorem is equal to the energy distribution function times the log of a function of the energy distribution function, all integrated from t = 0 to infinity, and the theorem states that said quantity (*) decreases until it reaches a minimum. This theorem was criticized by Zermelo via its contradiction of Poincare's recurrence theorem, while another criticism of this theorem is the fact that the molecular chaos assumption is time-symmetric, though this theorem describes irreversible processes; that is Loschmidt's paradox. For 10 points, name this theorem that complements the second law of thermodynamics which states that an irreversible system has a non-decreasing entropy.
ANSWER: Boltzmann's __H__-theorem [prompt on "second law" or "second law of thermodynamics" until mention]

9. One type of these molecules is induced by STING acting on TBK1, which in turn activates IRF3. The release of this protein is assayed for in a test in which whole blood is mixed with the peptides EST-6 and CFP-10; that assay is a test for tuberculosis. This protein mediates downstream effects by activating protein kinase R. This compound triggers the phosphorylation of eIF2, which in turn stops translation. A SNP near the gene coding for the "lambda-3" one of these proteins is associated with treatment response to hepatitis C, which is treated with ribavirin and this other (*) compound. The alpha-2a and alpha-2b forms of this compound are conjugated to polyethylene glycol in pharmaceutical formulations. The secretion of these compounds is triggered by activation of TLRs in response to foreign double-stranded RNA, and these signaling molecules up-regulate the presentation of peptides on MHC I and II, which in turn activates helper and cytotoxic T cells. For 10 points, name these glycoproteins secreted by infected host cells, that get their name from their ability to slow down viral replication.
ANSWER: **Interferon** [prompt on "cytokines" and "interleukins"]

10. This quantity is equal for two species at the isobestic point, and for a protein, this quantity can be calculated using the Edelhoch method. The maximum value of this quantity is equal to 1.74 times 10^4 times n according to a rule partly named for Kuhn. 3298.2 times the difference of the left-polarized and right-polarized version of this quantity is equal to the molar ellipticity in circular dichroism spectroscopy. The x-coordinate of the maxima of this quantity is shifted 60 nanometers rightward by a secondary amine and 30 nanometers rightward by extending conjugation according to the (*) Woodward-Fieser rules. This quantity is equal to the mass attenuation coefficient times the molar mass. The product of this quantity with the path length and the concentration is equal to absorbance according to the Beer-Lambert law. For 10 points, name this value symbolized epsilon, which is a measure of how strongly a molecule absorbs light at a certain wavelength per mole.
ANSWER: molar **absorptivity** [or molar **extinction** coefficient or molar **absorption** coefficient; accept "absorbance" before mention, prompt after; prompt on "epsilon"]

11. Cortical cells that process this sense can be arranged into blobs and anti-blobs by cytochrome oxidase staining. Hubel and Weisel proposed that the main cortex of this sense is organized into repeating units of dominance and orientation columns in an ice-cube arrangement. Milner and Goodale posited that signals carrying this sense are split into ones traveling to area MT and those travelling ventrally; that is the (*) two-streams hypothesis. The magnocellular and parvocellular pathways carrying this sense connect to M and P cells in the Lateral Geniculate nucleus. The nerve that carries this sense crosses over in a structure located underneath the pituitary, called the chiasm. For 10 points, name this sense that is processed in the occipital lobe, which receives signals from the ganglion cells of the retina.
ANSWER: **vision** [or **sight**; accept reasonable equivalents, the player pointing to their eyes, etc.]

12. The "fuzzball theory" posits that a bunch of strings replace these entities in one location. One theorem about the existence of these entities was challenged by considering a rotating plane of dust by Shapiro and Teukolsky, and two-dimensional versions of them are called domain walls. One of these can be shown to exist by showing that the derivative of the reciprocal of the expansion with respect to proper time is greater than or equal to one-third using Raychaudhuri's equation. They can occur in a ring in the Kerr solution, and one of these things can be found by noting the points at which both the metric tensor and the determinant of the Riemann tensor (*) blow up. Both spacelike and timelike ones have geodesic incompleteness according to one set of theorems. One of these arises when considering the Robertson-Walker metric backwards in time, while another occurs at r equals zero of the Schwarzchild solution. Naked ones don't exist according to the cosmic censorship hypothesis. For 10 points, name these things supposedly found within black holes, regions of space which have zero volume and infinite density.
ANSWER: **singularity**

13. The length of segments of these entities is inversely proportional to the total length of these entities according to the Richardson effect. The Ballantine scale rates the exposure level of these entities. Machairs can be found near emergent examples of these entities. Cuspate forelands can be created by certain drift processes happening near these entities, one type of which has ridges separating several rias. Tombolos are outcroppings of these structures, and the action of refracted wavefronts on these entities results in mass transport towards (*) headlands. The concordant type of them are divided into Haff and Dalmatian types. This structure is immediately adjacent to the littoral zone, which were described as a fractal in a paper by Benoit Mandelbrot asking about the length of the one belonging to Britain. For 10 points, name these regions whose landforms include capes, bays, and coves, regions in which a body of water meets land.
ANSWER: **shore** [or **coast** or **shoreline** or **coastline** or **beach**; prompt on "cliffs", accept answers like "seaside cliffs"]

14. This man is the first namesake of a diagram which plots specific resistance against velocity to determine the efficiency of different modes of transport; he co-names that with Gabrielli. A method of measuring variations in boundary layer thickness by integrating the momentum equation is dubbed this man's momentum integral approach. One phenomenon named for this man has a frequency partly governed by the Strouhal number, and occurs when a fluid moves past a (*) cylindrical body; that is his namesake vortex street. This man is the second namesake of a set of boundary conditions that, when plugged into Schrodinger's equation, gives Bloch's theorem; that set of conditions states that psi of r plus some translation vector is equal to psi of r and is named for Born and this scientist. One construct named for this man can be found by finding the altitude at which the air density is such that a vehicle would have to travel faster than orbital velocity to support itself. For 10 points, name this scientist who names the line dividing the atmosphere from space.
ANSWER: Theodore von **Karman**

15. A substitution creating a bond between this element and a ligand is used to determine the Tolman electronic parameter. This element's acetylacetonate is used to prepare a complex in which it is bound to two cyclo-octa-diene molecules, which serve as donors of its "zero" form. Using this metal as a catalyst in the Fischer-Tropsch process tends to favor the formation of methane. It's not titanium or aluminum, but during the development of Ziegler-Natta catalysts it was discovered that impurities of this element stopped the reaction at 1-butene. The process used to purify this element creates its tetracarbonyl by adding a bunch of (*) carbon monoxide in one step. It's not palladium, but several catalysts for the Negishi and Kumada couplings use this element. The Mozingo process is catalyzed by this element, and that process involves the removal of a thioketal group after protecting a carbonyl. A catalyst containing an alloy of it and aluminum is activated by sodium hydroxide; that catalyst is used for hydrogenation and named for Raney. For 10 points, name this transition metal.
ANSWER: **nickel**

16. Antibodies to these cells are found in Susac's syndrome. Precursors to these cells are marked by the ID1 gene. A signalling peptide named for these cells has receptors inhibited by Bosentan and Ambrisentan, which are used to treat pulmonary hypertension. These cells uniquely express VE-cadherin and CD141 on their surface. They contain storage granules called Weibel-Palade bodies, which contain P-selectin and von Willebrand factor. Those found in the (*) liver sinusoids are separated by fenestrae. These cells help comprise the tunica intima, and Furchgott originally discovered nitric oxide as a "relaxing factor" derived from them. The space underneath these cells is filled with lipids in atherosclerosis. For 10 points, name these cells which regulate vascular tone and are found on the inner surface of blood vessels.
ANSWER: **endothelial** cells

17. A 2013 update to this standard includes a method where compounds are mixed with cellulose and the result is compared to mixtures of cellulose with calcium peroxide as a test for oxidizing potential. Unlike the IARC, this standard classifies only two categories of carcinogens, broken into known and suspected. An upside-down fish next to a leafless tree and a flame over a circle are used in this system to designate aquatic toxicity and oxidizers. Those (*) pictograms can be paired with the words "danger" or "warning." Ratings in this system are the inverse of those on the NFPA 704 diamond, meaning that low-hazard materials score a 4 in this system. For 10 points, name this system created by the UN for classification and labelling of chemicals that was incorporated into the Hazard Communication Standard in 2012, with final US implementation planned for 2015.
ANSWER: **Globally Harmonized** System [or **GHS**]

18. A corollary of the separating hyperplane theorem known as Farkas's lemma is used with the KKT conditions to prove a "strong" theorem in this field. While a popular algorithm and its variants are all thought to be exponential, the leading term is only raised to the 3.5th power in a polynomial time algorithm in this field that uses the interior point method and improved upon the ellipsoid method. Methods in this field rely on the correspondence between the (*) primal and dual forms of a problem; those methods find a solution within a convex space known as the feasible region. A popular algorithm in this field converts inequalities to equalities using slack variables. Two popular algorithms of this type are Karmarkar's algorithm and the simplex method. For 10 points, name this method of optimization that uses constraints to maximize a first order objective function.
ANSWER: **linear programming** [prompt on partial answers; prompt on "optimization" or "linear optimization"]

19. In a book about "using" this theorem, Jiri Matousek presents Alon's proof of the necklace theorem which makes use of it. Tucker's lemma is a combinatorial analog of this theorem, which Barany and Greene used to give tight lower bounds on the chromatic number of Kneser graphs. Corollaries of this theorem include the Lyusternik-Shnirel'man theorem, as well as the fact that any three solid figures in three-space can be simultaneously bisected, known as the ham sandwich theorem. This theorem implies the Brouwer fixed-point theorem, and it is often illustrated by claiming that there are two antipodal points on the Earth's surface with equal temperature and barometric pressure. For 10 points, what is this theorem, whose second namesake is better known for a chaos theory experiment with Fermi and Pasta and for helping Edward (*) Teller design thermonuclear weapons?
ANSWER: **Borsuk-Ulam** theorem [accept **ham sandwich** theorem before mention, even though no one's gonna say it]

20. One piece of evidence for the existence of this feature was found by Jakobsen et al, who found a dropoff in the UV spectrum of Q0302-003. Rorai, Hennawi, and White found a method to measure the Jeans scale of this region using quasar pairs. Somewhere under 75% of the gamma ray background of the universe is purportedly caused by shockwaves hitting this region during structure formation. Tracers for this region include oxygen-7 and oxygen-8 absorption lines. This region's ionization state is maintained by a diffuse background of UV photons. Cen and Ostriker claim that its warm-hot phase may contain between 30-50% of the (*) baryonic matter in the universe. The presence of neutral hydrogen in this region causes a suppression of wavelengths less than the Lyman-alpha emission line in quasar spectra; that feature, which helps determine the time at which this substance reionized, is called the Gunn-Peterson trough. For 10 points, name this filamentous web of gas and plasma that occupies the space between galaxies.
ANSWER: **intergalactic medium** [or **IGM**]