LEDERBERG 2: DAUGHTER CELL
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PACKET 8 – FLYING SAUCER
THE LAST TOSSUP YOU READ SHOULD HAVE BEEN ON ANSWER: **convex hull**

1. One team that discovered several of these entities is the namesake of a two-power-law to estimate surface brightness of galaxies. A rapidly growing one of these entities is found in the Phoenix Cluster. One method of measuring the mass of these entities sets mass equal to form factor times the radius of the broad-line region times the square of the root-mean-square velocity of gas near these objects all over G; that method is called reverberation mapping. Several of these entities were discovered by the Nuker collaboration, and these entities' mass is related to the 4th or 5th power of the velocity dispersion according to the (*) M-sigma relation. Bruce Balick and Robert Brown found a candidate for this kind of body in the Milky Way using the NRAO Green Bank interferometer; that object is Sagittarius A-star. These objects may accrete gas to become an active galactic nucleus. For 10 points, name these objects that are hundreds of thousands to billions of solar masses large and are found in the center of galaxies.
ANSWER: **supermassive black holes** [prompt on "black holes", "black holes at the center of galaxies" etc; accept **active galactic nuclei** or **galactic nuclei** until they're mentioned]

2. The SSURGO database contains digital maps of this substance. Alternating periods of formation and removal of this substance is the subject of the theory of bio-rhexi-stasy. The equation of state for the formation of this substance can be remembered by using the mnemonic "CLORPT", and that equation was derived by Hans Jenny. The Willamette valley contains a unique igneous-derived type of it called Jory. Illuvium is material displaced from one layer of this substance to another, which can create cutans. The layers of this substance can be subdivided by color and (*) texture into O-A-B-C-R horizons. The cation-exchange capacity of this substance, which is derived from so-called "parent materials", can be increased by increasing the amount of humus. Erosion can often remove the "top" type of this substance. For 10 points, name this substance which is created in the process of pedogenesis, a mixture of organic matter and minerals that supports plant life.
ANSWER: **soil**

3. A domain that contains a pair of these amino acids spaced 20 residues apart is called the rsp5-domain and binds to proline-rich motifs. This compounds namesake synthase contains tunnels between its alpha and beta active sites in a classic example of substrate channelling. In mammalian mitochondria, the UGA codon isn't a stop codon, but codes for this amino acid. This amino acid has the strongest absorbance at 280 nm, which is why that absorbance is used to track protein folding. This amino acid is unusually only encoded by one codon, (*) UGG. The cluster of genes synthesizing this compound is activated by a stall in the synthesis of a leader peptide and contains A through E structural genes; that mechanism is attenuation. It serves as the precursor to niacin and serotonin, the latter through its namesake hydroxylase. For 10 points, name this amino acid with an indole side chain and one-letter symbol W.
ANSWER: **tryptophan** [or **trp** or W]

4. It's not the Claisen rearrangement, but Overmann and Watson reported the ability of this reaction to diastereoselectively create contiguous quaternary carbon centers. A variant of this reaction that uses diazonium salts is named for Matsuda. A version of this reaction in which the reactants are refluxed with acetic acid is named for Fujiwara and Moritani. It is performed it on ethylene and a naphthalene derivative to synthesize naproxen. A variant of it in which one reactant has an OH group creates furan rings and is called an oxy-arylation. Another variation of this reaction immobilizes the catalyst and BMIM-F6 in silica gel; that variation of this reaction allows it to be performed without a (*) phosphorous-containing ligand and uses an ionic liquid. This reaction's catalyst is regenerated to its zero oxidation state using potassium carbonate in the final reductive elimination step, and like the Wacker process this reaction lacks a transmetallation step. One American namesake of this reaction won the 2010 Nobel Prize with two Japanese chemists. For 10 points, name this palladium-catalyzed coupling reaction between alkyl halides and alkenes, named for an American chemist.
ANSWER: Mizoroki-**Heck** reaction

5. An efficient algorithm for doing this based on the convolution theorem uses a Fast Fourier Transform and an inverse Fast Fourier Transform before a combination step; that algorithm was slightly improved by Martin Furer. The "big-Oh of n to the log base 2 of 3" running time of one method for doing this task made it faster than the "big-Oh of n squared" naive approach since it reduced four operations to three. Algorithms that do this include the (*) Schonhage-Strassen algorithm and the Karatsuba algorithm, which is asymptotically slower than the more general Toom-Cook algorithm. In two's complement, this operation can be done by sign extending to 2n length to avoid overflow errors, and this operation with a 2 in binary is equivalent to shifting left once. For 10 points, name this operation whose identity is 1 and that is unfortunately explained as repeated addition.
ANSWER: **multiplication** [accept word forms]

6. Applying this model to spin-waves in a ferromagnet gives a quantity proportional to the zeta function of 2.5, and only requires considering one polarization mode instead of three. This model can be modified with a quantity equal to the volume times the derivative of pressure with respect to energy at a given volume. The derivation of the energy in this model requires taking an integral whose limit is pi to the fourth over 15; that integral is the quantity x cubed over the quantity e to the power x minus 1, which gives its namesake's third number. In the original derivation of this model, an eighth of a sphere containing the one-third power of the quantity six over pi times N summands replaces a cube containing a similar number. One quantity considered in this model becomes zero at (*) van Hove singularities; that quantity is derived from the linear dispersion relation used in this model and is the density of states. At low temperatures, this model is sometimes modified by adding a linear contribution from electrons. This model recapitulates the Dulong-Petit law at high temperature, and considers the object in question as a collection of harmonic oscillators that oscillate together. In this model, the heat capacity takes on a temperature-cubed dependence, unlike the Einstein model. For 10 points, name this model of solids named for a Scottish physicist.
ANSWER: **Debye** model

7. In one scene in this film, the protagonist blows up the car of the villainous Chuck and Froggy, and he later destroys a *Star Wars* billboard. A showing of this film features wrap-around segments featuring the annoying robot Monad and a man dressed like Captain Janeway. That showing continually features a joke about a sheriff's deputy saying the line "ARE YOU READY FOR SOME FOOTBALL?" This film's plot is about Billy Duncan discovering a metallic pendant and using it to destroy bullies. In a television showing of this film, a "host segment" ends with the Satellite of Love reaching the edge of the universe and Dr. Forrester turning into a (*) baby. For 10 points, name this terrible film about a teenager who discovers an alien weapon and becomes a monster, perhaps better remembered as the final Comedy Central episode of *Mystery Science Theater 3000.*
ANSWER: *__Laserblast__*

8. This statement was extended to include polarization by HG Booker, and its vectorial form assumes the surface in question is very thin and perfectly conducting and states that E equals c times B prime sub c. This statement is usually formulated for scalar fields using Kirchhoff's approximation. This statement can be stated as the sum of two amplitudes being equal to the undisturbed amplitude, which can be derived using the Sommerfeld condition. This statement is often used in (*) antenna engineering to determine the size of slots to create in waveguides. The vectorial form of this statement holds when the radius of curvature is much larger than the aperture radius. This statement can be used to show that a sphere produces the same pattern as a hole in a plate. For 10 points, name this principle from electrodynamics and optics, which states that the diffraction pattern produced by a screen is the same as the one produced by its complementary screen.
ANSWER: **Babinet**'s principle

9. One algorithm using these functions to compute four-body integrals is partly named for Warren Hehre, and another algorithm for computing integrals over them involves 20 different paths from shell-quartet parameters and is called PRISM. Multicenter integrals over these functions are often calculated using the Boys function. Diffuse functions and polarization functions are often used to modify groups of them, and "primitive" ones are multiplied by contraction coefficients. These functions follow a namesake rule stating that a product of two of them is the sum of them centered along the line connecting the cores of the first two, which allows the reduction of four-center integrals to two-center integrals. These constructs, n of which make up one of Pople's STO-nG (*) basis sets, have a radial component that drops off as e to the power negative r-squared, in contrast with their counterparts, which drop off as e to the negative r. These constructs can be linearly combined into Slater-type orbitals. For 10 points, name this type of orbitals commonly used in quantum chemistry, which look like normal distributions.
ANSWER: **Gaussian** orbitals [or **Gaussian** basis sets; accept **basis sets** before mention since basically all basis sets consist of Gaussian orbitals, etc; prompt on "orbitals"]

10. This process precedes degeneration and complementation in a model of sub-functionalization developed by Force et al. One of these events can be detected by a step-like elevation in the Log-R ratio in an array CGH experiment. Susumu Ohno pioneered the view that this process, followed by neo-functionalization, is a central process of evolution. In breast cancer, the extent to which this process has occurred to HER2 is a common (*) prognostic indicator, and this process commonly occurs to N-myc in neuroblastoma. This process is a common one that produces isozymes. Paralogs are products of this genetic process, which occurred repeatedly in the beta-globin locus. The tandem version of this process is usually the result of an unequal crossover. This process results in an increase in copy number, unlike a deletion. For 10 points, name this genetic change in which a segment of DNA is copied.
ANSWER: gene **duplication** [prompt on, but do NOT accept, common-language equivalents]

11. Over finite-dimensional Hilbert spaces, they can be generated using PPB-truncation or LT-truncation. In one system, the eigenvalue expansion of one of these has coefficients of alpha to the n over the square root of n factorial times exponent of negative mod alpha-squared over 2. The quasiprobability distribution with observables written in normal order is one in which the density matrix is diagonal over the basis of these; that is the (*) Glauber-Sudarshan P representation. They form an overcomplete set and are not necessarily orthogonal. Applying the displacement operator to the ground state generates one of these, and these states are more generally the eigenstates of the annihilation operator. These states have real and imaginary parts proportional to the average position and momentum, and they have the minimal amount of uncertainty allowed by the Heisenberg uncertainty principle. For 10 points, name these quantum states which approximate the corresponding classical state.
ANSWER: **coherent** state

12. An ongoing debate concerns whether the outermost shell of this layer contains an anomalous ultra low-velocity zone. The boundary between this layer and the layer above it is home to a whispering-gallery mode called the SmKS mode. PKNP waves with N equals four and seven are multiply reflected when bouncing around this layer. The boundary between this layer and the layer above it refracts PKIKP waves. When they enter this layer, SKS and SKKS waves convert to P waves, and P-wave velocity increases smoothly with depth in this region. S wave velocity (*) drops to zero in this region, which lies immediately underneath the d-double prime layer of another region. Convection currents in which are the drivers in the dynamo theory of the Earth's magnetic field. For 10 points, name this 1400-mile thick layer of the earth bound from above by the Gutenberg discontinuity, which consisting of liquid iron and nickel.
ANSWER: **outer core**

13. The solution to this problem can be "oriented" to one group or the other, which implies that each agent in the suboptimal group has the worst possible outcome out of all possible solutions to this problem. When solving this problem, once a passive agent is no longer free, it can never again be free. The original algorithm to solve this problem runs iterative rounds whereby one set of agents can trade up while agents in the other set are tasked with making offers to the best available candidate; that algorithm by (*) Gale and Shapley first proved that this problem is always solvable. Each agent ranks its preferences before a solution tries to eliminate blocking pairs in which two agents prefer to be paired with each other rather than their current partners. For 10 points, name this problem of finding a pairing of men and women such that no pairs want to switch partners.
ANSWER: **stable marriage** problem [or **stable matching** problem; prompt on partial answers]

14. Daschous and Fat are atypical examples of these proteins, the latter of which is an upstream regulator of the Hippo signalling pathway. A paper by Crespi et al hypothesizes that the expression of three of these proteins in the placenta is an example of an evolutionary "red queen with a green beard". Flamingo proteins have homology to both GPCRs and these proteins. An autoimmune disease that targets these proteins shows a positive Nikolsky sign. The cytoplasmic face of these proteins can bind to plakoglobin in order to influence the actin cytoskeleton or bind to beta-catenin to influence gene expression. One family of these proteins is the autoantigen in (*) pemphigus foliaceus and pemphigus vulgaris. These proteins contain a series of Ig-like domains on their extracellular face which mediate homophilic binding. This protein comes in E-, N-, and P- types, which allows "like" tissues to find each other during development. For 10 points, name these calcium binding cell adhesion molecules, some of which localize to desmosomes.
ANSWER: **cadherin** [accept **desmoglein** before mention; prompt on "cell adhesion proteins" or anything like that, prompt on "desmosomes"]

15. Chen et al. used a dimeric boron species and a rhodium catalyst to form terminal organoboranes by reacting a bond between these two atoms. Periana et al. used sulfuric acid and a platinum II catalyst to react this type of bond and produce methyl bisulphate. That reaction was an improvement on one using stoichiometric platinum IV to react a bond between these two atoms and produce methanol as developed by Shilov. In a fraud case at Columbia University, falsified NMR spectra supposedly showed reactions involving this type of bond in papers by Bengu Sezen, who had worked in the lab of Dalibor Sames. When present in a ligand, this type of bond can interact with the metal atom in an (*) agostic interaction. Along with a carbon-nitrogen bond, a bond between these two atoms is broken in a reaction which uses aqueous silver oxide and methyl iodide to form a tertiary amine leaving group, as developed by Hofmann. A bond of this type on an aromatic ring is replaced as the net result of a Friedel-Crafts alkylation, and bonds of this type are formed when using Raney Nickel to react an alkene. For 10 points, name this type of bond formed when converting unsaturated to saturated fats, the only type of bond found in methane.
Answer: **C-H** bond [or **carbon-hydrogen** bond. Order does not matter. Prompt on "sigma" bond, "single" bond, etc]

16. Improving an argument of Robin Moser, Messner and Thierauf used a construct named for this mathematician to give a constructive proof of the Lovasz local lemma. A result named for him can be used to show that there is a critical density in bond percolation; that result is his zero-one law. An equation co-named for this non-English mathematician can be used to compute n-step transition probabilities in Markov chains; that equation is also named for (*) Chapman. This man is the first namesake of a theorem that deals with the preservation of quasiperiodic motion under small perturbations. His namesake complexity measure is used to prove Chaitin's incompleteness theorem and is sometimes called "descriptive complexity." The standard axiomatization of probability theory is due to, for 10 points, what Russian mathematician who names a theorem with Arnold and Moser?
ANSWER: Andrey (Nikolaevich) **Kolmogorov** [accept Gregory **Chaitin** before "critical density", since he sometimes co-names Kolmogorov complexity]

17. One instrument on this craft was adapted for use in the Archeops mission, which was used to prototype part of the cryogenic chain cooling system of this craft. This instrument was the first to get a full-sky Sunyaev-Zeldovich catalogue of galaxy clusters. This instrument was launched with a common service module as the Herschel observatory. Originally called COBRAS/SAMBA, this satellite has a low-frequency instrument and a high-frequency instrument, and takes measurements across nine bands. This experiment confirmed the existence of a hemispheric power asymmetry at a (*) multipole moment up to 1500, as well as a previously-characterized cold spot. This satellite constrains the amount of dark energy down to 68.3% of the overall mass of the universe. This experiment has a resolution of around 10 arc-minutes, which is around three times better than its predecessor, WMAP. For 10 points, name this ESA satellite that mapped anisotropies in the cosmic microwave background, named for a German physicist.
ANSWER: **Planck** satellite

18. This quantity can be calculated using the BCFW recursion. In the planar limit of N = 4 supersymmetric Yang-Mills theory, this quantity is equal to the volume of the polytope in which the Grassmanian is positive in momentum twistor space. These values can be calculated from time-ordered correlation functions via the LSZ reduction formula. This quantity for any given order is often found by iteratively calculating the transition operator via the Lippman-Schwinger equation. The first-order version of this quantity is equal to negative 2 m over four pi h-bar squared times the Fourier transform of the potential according to the first-order (*) Born approximation. The imaginary part of this value at an angle of zero, times four pi over k, is equal to sigma-sub-total according to the optical theorem. The magnitude of this quantity, squared, gives the angular dependence of the differential cross section. In the partial wave expansion, this value, symbolized f of theta, multiplies the spherical wave term, and in general this value gives the probability of a particle bouncing off a potential and travelling in a given direction. For 10 points, give this value, which is the "height" of the outgoing spherical wave of a scattering event.
ANSWER: scattering **amplitude** [or probability **amplitude**; accept **f** before "f of theta", prompt after]

19. A particularly annoying side effect of this procedure can be alleviated using a blood patch or intravenous caffeine. When performing this procedure it is important to feel the "give" of moving past the ligamentum flavum, and the instrument used in this procedure commonly has a Quincke point. The opening pressure measured by this procedure is elevated in IIH and cryptococcosis. Samples obtained by this procedure can be subjected to the complement fixation test to find coccidioides fungus, to electrophoresis to find (*) oligoclonal bands, or to testing for 14-3-3 protein to diagnose CJD. This procedure is typically done with the subject in the fetal position, and xanthochromia in the substance collected by this procedure is the most sensitive test for subarachnoid hemorrhage. For 10 points, name this procedure commonly used to diagnose meningitis, in which a needle is slid into the back in order to collect cerebrospinal fluid.
ANSWER: **lumbar puncture** [or **LP**; accept **spinal tap**]

20. Hayashi, Matsui, and Takagi developed a three-detector method for use with this technique, which uses static LS, UV, and RI in line with it. This technique is commonly used in desalting and buffer exchange or to remove radiolabelled dNTPs from polymerized DNA. Sephadex and sephacryl are common matrices used in this technique, and this technique is an alternative to asymmetric field-flow fractionation. It is commonly combined with a multi-angle light scattering apparatus as a detector, and can be used to find the polydispersity index of a polymer. This technique is used in biology to separate (*) oligomeric protein complexes from monomers and unfolded proteins from folded ones, and uses dextran blue or thyroglobulin to establish the void volume. Analytes are assumed to not directly interact with the matrix in this technique. This technique uses porous beads to hinder smaller molecules in the pores while allowing larger molecules to go around the pores and leave the column faster. For 10 points, name this form of chromatography which separates analytes by their hydrodynamic radius or molar mass.
ANSWER: **size exclusion** chromatography [or **gel permeation** chromatography or **gel filtration** chromatography; prompt on "chromatography" or "column chromatography"]