LEDERBERG 2: DAUGHTER CELL
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PACKET 9 – FULL AS A TICK
THE LAST TOSSUP YOU READ SHOULD HAVE BEEN ON ANSWER: <u>size exclusion chromatography</u>

1. Goldreich showed that the physical phenomena predicted by this theory are subject to Swing amplification, and those phenomena can also be amplified by the WASER mechanism. Bertin and Lowe modified the dispersion relation predicted by this theory, which showed that the critical wavenumber is equal to kappa-squared over 2 pi G sigma sub naught. The originators of this theory explained it using the analogy of a traffic jam, in which cars can move in and out of the jam but the jam itself moves slowly. This theory states that stability occurs between the inner and outer Lindblad resonances, which are defined via the (*) global pattern speed. One prediction of this theory is H I clouds and dust bands on inner edges. This theory was derived by assuming tight winding, allowing the use of the WKB approximation. This theory predicts the existence of regions with 10-20% greater mass than their surroundings, and purported to solve the winding problem. For 10 points, name this doubly-eponymous theory that explains spiral galaxy structure via stationary overdense regions.
ANSWER: **<u>Lin-Shu</u> <u>density wave</u>** theory [either underlined portion acceptable]

2. One tool used for this procedure is defined as a 2-D square lattice with spin one-half particles on its edges but may find anyons at its vertices or plaquettes. Those "toric" tools, as well as the "CSS" ones arose from the stabilizer theory of this procedure for quantum computing. After constructing a polynomial over a finite field, interpolation can be used for this procedure, or it can use syndrome decoding. This procedure often uses cyclic (*) Reed-Solomon codes or Hamming codes. The "forward" type of this procedure is proactive and sometimes relies on horizontal or vertical redundancies. A source can confirm the number of set bits by using a parity bit, which is a specific type of tool used for this procedure known as a checksum. For 10 points, name this procedure by which the source data can be verified or reconstructed after faulty transmission.
ANSWER: **<u>error correction</u>** [accept word forms; accept **<u>error detection</u>**]

3. A coherent form of this phenomenon is impossible in media with a refractive index of unity, ruling out masers based on it in a vacuum. When the ratio of energy loss via inverse Compton emission to energy loss via this phenomenon is greater than 1, it results in the "inverse Compton catastrophe", which puts a brightness limit on stationary sources of it. This phenomenon undergoes self-absorption past the peak of its spectrum, which occurs at point two nine times the critical frequency. In an astrophysical plasma whose plasma frequency is greater than this phenomenon's frequency divided by gamma, this phenomenon is suppressed in the (*) Razin effect. The degree of polarization of this phenomenon is equal to the spectral index plus 1 over the spectral index plus 5/3. This phenomenon typically displays a steep negative spectral index. This phenomenon displays beaming in a cone of width of one over gamma, and follows a continuous power-law distribution across a broad range of frequencies. Jet emissions from active galactic nuclei are believed to be *this*, because said emissions are highly linearly polarized, as opposed to thermal emission. For 10 points, name this relativistic analogue of cyclotron radiation.
ANSWER: **<u>synchrotron</u>** radiation

4. One set of molecules that localize to these structures are targeted here by CAB box motifs and often have composite H/ACA and C/D box motifs. The localization of SMN complex to these structures is disrupted by mutations in SOD1. Telomerase RNA requires these structures for localization to telomeres, and the primary component of these structures uses its C-terminus to interact with Sm proteins. P80, or coilin, uniquely localizes to these structures. They are responsible for directing the assembly and maturation of snRNPs (snurps), which are components of the (*) splicing machinery. These structures are between one-half and one micrometer in diameter and are found in the same compartment as paraspeckles, GEMS, and PML bodies. In nondividing cells, these structures are often found near the nucleolus. For 10 points, name these densely staining organelles found in the nucleus, which are often named for a Spanish neurologist.
ANSWER: **<u>Cajal</u>** bodies [or **<u>coiled bodies</u>**, prompt on "nuclear bodies"]

5. Thrusters commonly use this metal mixed with aluminum oxide to decompose hydrazine. Complexes of this metal are commonly used in phosphorescent organic light-emitting diodes. A photo-activate-able piano stool compound containing this metal was characterized by both Graham et al and Bergman et al and was used to catalyze C-H bond activation. One catalyst containing this metal has it coordinated to tris-cyclohexylphosphine, 1,5-cyclo-octa-diene, and pyridine, and is bonded to a PF-6 counter-anion; that complex is more effective at heterogeneously catalyzing alkene hydrogenation than the (*) rhodium-containing Wilkinson's catalyst. One complex containing this element is a square-planar yellow powder with two tri-phenyl-phosphine groups that can reversibly bind O2. This element is at the center of a catalyst in a reaction that has supplanted the Monsanto process; that catalyst triggers the carbonylation of methanol and catalyzes the Cativa process. For 10 points, name this element central to Crabtree's catalyst and Vaska's complex, which is also present in abundance at the K-T boundary.
ANSWER: **Iridium** [or **Ir**]

6. One extension to this method defines a function Y in terms of two different values of t; that is the method of multiple scales. Weinberg developed the "chiral" version of this method to apply it to nucleon-nucleon interactions in QCD, where it can be used to construct an effective Lagrangian. This approach can be used to find the Rabi formula and the rate of spontaneous emission when applied to a forced two-level system. The interaction representation has to be used alongside this method to calculate the time-propagator when the system is time-dependent. When applying this method to a (*) degenerate state, a re-diagonalization of a certain operator in terms of degenerate states is required to solve the vanishing denominator problem; that method is used when this method is applied to the linear Stark effect. This method involves splitting the Hamiltonian into a "bare" Hamiltonian and another term, V, and then expanding in terms of a power series of some small parameter. For 10 points, name this method of approximating solutions to physical systems by considering the effects of a small namesake external force on the eigenvalues of the Hamiltonian.
ANSWER: **perturbation** theory

7. For pure materials, this process can be accomplished using the Bridgman and Czochralski techniques; the latter can accommodate volume expansion during this process. The kinetics of this process can be described using an exponential equation named for Avrami, and this process has been empirically observed to pass through multiple states of decreasing energy, known as Ostwald's step rule. When this process occurs in polymers, a maltese cross pattern can be visible in polarized light. During the initial step in this process, an (*) "embryo" must overcome a critical size determined by the Gibbs-Thomson effect. A theory predicting the rate of this process proposed by Burton, Cabrera, and Frank accounts for the small number of kink and step sites. That theory is based on the presence of screw dislocations and predicts that rate is proportional to the square of supersaturation for low supersaturations. For 10 points, name this process in which a solute or liquid transitions into an ordered solid.
ANSWER: **crystal growth** [accept **crystallization** or obvious equivalents, prompt on "precipitation," "solids formation," or similar answers.]

8. Alan Boss posited an "instability" mechanism for this process, which avoids the "meter-size barrier". One phase of this process has a rate that is proportional to to the Safronov number, which is an expression involving the ratio of the square of the escape velocity to the relative velocity. An early step in this process is the formation of a two-dimensional structure via the Goldreich-Ward mechanism. One theory of *this process* posits an initial "runaway" phase followed by a slower "oligarchic" phase. This process is posited to go through a transition at the isolation mass, which is calculated from the (*) Hill sphere. This process is posited to have been followed by a migration and rearrangement in the Nice model, which was used to explain the Late Heavy Bombardment. This process takes on the order of 10 million years and begins with a circumstellar disk according to the nebular hypothesis. For 10 points, name this process by which bodies like Mars and Jupiter form.
ANSWER: **planet formation** [or **solar system formation** or common-language equivalents; anti-prompt on the formation of specific planets or moons]

9. An artificial type of this protein generated by fusing an scFv to a transmembrane domain was used to cure Emma Whitehead of acute lymphocytic leukemia at Penn. The activation of this protein triggers the activation of the Lck kinase, which in turn phosphorylates the zeta chain and recruits ZAP70. A co-receptor for this protein is activated by CD80 and CD86. 95% of cells that have this protein have an alpha-beta heterodimer, but 5% have a gamma-delta heterodimer. This protein is directly activated by TSST-1 and other superantigens, and like (*) antibodies the components of this protein are created through an error-prone process of VJ and VDJ recombination. This receptor requires co-stimulation from CD28, CD4, and/or CD8. This protein binds to linear peptides presented by either MHC class I or class II. For 10 points, name this receptor protein found on a type of lymphocyte that matures in the thymus and comes in helper and cytotoxic varieties.
ANSWER: **TCR** [or **T-cell receptor**]

10. Bruce Campbell has a cameo in this movie as an antagonist known as the "Surgeon General." The protagonist is continually betrayed by the Steve Buscemi played "Map to the Stars" Eddie, who is a flunky of the Shining Path revolutionary Cuervo Jones. It ends with a character saying "welcome to the human race" after using the Sword of Damocles super weapon to destroy all electronics on the planet. The protagonist of this film is dispatched to an island to rescue the ultra-religious (*) President's daughter. The title location has become an island "city of sin" after an earthquake struck California in 2000. For 10 points, name this 1996 sci-fi sequel directed by John Carpenter, which further shows off Snake Plissken's adventures after *Escape from New York*.
ANSWER: *Escape from L.A.*

11. Sikivie developed a method of detecting these particles using a resonant cavity, taking advantage of the fact that it decays into one real and one virtual photon. The "misalignment mechanism" is one method of producing these particles in the early universe, in which they take on a random mass before inflation fixes their mass. Two "invisible" forms of this particle can be distinguished by looking at the ratio of their electromagnetic and color anomalies, which is eight-thirds in the DFSZ model and 0 in the KSVZ model. One method of creating these particles involves firing a laser through a five tesla dipole magnet, called the "shining light through walls" method. In stars, this particle may be produced by a pair of photons interacting with an atomic nucleus via the (*) Primakoff effect. The ADMX experiment attempts to find this particle in the dark matter halo of the Milky Way, and the existence of this particle is posited to explain the low value of the theta parameter in the QCD Lagrangian. For 10 points, name these hypothetical particles that were posited by Peccei and Quinn to solve the strong-CP problem.
ANSWER: **axion**

12. This man formulated a Turing-complete triplet with initial words and production rules that generates a formal language, and the priority method of proof was developed when solving a question asked by him. Another problem posed by this man gives sigma with at least two symbols and two sequences of strings over sigma and asks whether there is some sequence of indices such that the two sequences of strings are equivalent over those indices. This namesake of a (*) "canonical system" also asked whether there exists a recursively enumerable set with Turing degree less than the degree of the halting problem. Determining whether a context-free grammar is ambiguous can easily be shown to be undecidable using a reduction from the most famous problem named for this man. For 10 points, name this computer scientist who posed an undecidable correspondence problem.
ANSWER: Emil Leon **Post**

13. **Several different instances of this phenomenon can be measured simultaneously using Dan Singleton's multiplexed high-field NMR method. The solvent-controlled version of this phenomenon is modelled by the Kresge-Gross-Butler equation, which is used to model experiments in which this thing arises from fractionation across various sites. The agostic interaction can cause this effect to be inverted in metal hydride clusters undergoing beta-elimination, and in general the strength of this phenomenon is given as the product of the ratio of symmetry numbers times a term encoding vibrational excitation times zero-point energy contributions. Parameters characterizing two different types of this phenomenon can be converted between using an exponent of 1.442 in the** (*) Swain equation. When a very large instance of this phenomenon is largely independent of temperature and cannot entirely be explained by differences in zero-point energy, then tunneling is considered. These phenomena can be divided into primary or secondary based on whether they directly involve the bond being broken in the rate-limiting step. For 10 points, name this effect important in studying reaction kinetics, in which replacing one atom with a heavier analogue affects the speed of a reaction.
ANSWER: kinetic **isotope effect**

14. **For a system containing stress-free surfaces, the critical value of this quantity is equal to twenty-seven over 4 times pi to the fourth power. For the Earth's mantle, this quantity is proportional to the product of the fifth power of the depth of the mantle and the radiogenic heat production. In one system, the critical value of this quantity is equal to 1708 at an eigenvalue of 3.2, above which the system forms Benard cells. In one system, this value is proportional to the difference between the surface temperature and the quiescent temperature, all times the cube of the** (*) characteristic length. This quantity is proportional to the expansion coefficient and inversely proportional to the thermal diffusivity, and this value is also equal to the product of the Grashof and Prandtl numbers. For 10 points, name this dimensionless constant from fluid dynamics which determines whether a fluid is undergoing conduction or convection.
ANSWER: **Rayleigh** number

15. **Mutations in parC and parE can confer resistance to this class of compounds, as can mutations in the QRDR region of another protein. These compounds are contraindicated in pregnancy because they can cause cartilage damage in the fetus, and in elderly people taking prednisone, these compounds can cause rupture of the Achilles tendon. Nalidixic acid was the first of these compounds on the market, and these compounds have a piperazine group ortho to the heteroatom that gives them part of their name. They are often given to CF patients as** (*) empirical treatment against Pseudomonas, and like macrolides, these antibiotics can cause prolongation of the QT interval. This class of compounds targets DNA gyrase and topoisomerase IV, and are commonly used to treat anthrax and urinary tract infections. For 10 points, name this class of antibiotics that include moxlifloxacin, ciprofloxacin, and levofloxacin.
ANSWER: **fluoroquinolones**

16. **PK Chattaraj posited one quantity important in this theory is minimized at the transition state and maximized at equilibrium. This theory can be used to derive a rule that says the more electronegative part of an ambident nucleophile reacts during SN1 reactions and vice versa for SN2. It's not frontier orbital or MO theory, but the "local" version of one quantity in this theory is found by multiplying it by the Fukui function. It's not Huckel theory, but Robert Parr made this theory quantitative by setting its central parameter equal to the second derivative of the energy with respect to the electron number. This theory corresponds to sorting species by the size of the gap between the** (*) LUMO and the HOMO. The enthalpy release of species that obey this theory can be calculated from the Drago-Weyland equation, and this theory also recapitulates Kornblum's rule. This theory predicts that ions with similar degrees of polarizabilities tend to form bonds together, and is used to predict which pairs of species tend to form ionic or covalent bonds. For 10 points, name this acid-base theory developed by Karl Pearson, that is important in transition metal chemistry.
ANSWER: **hard-soft** acid base theory [or **HS**AB; accept **Pearson**'s acid-base theory before mention]

17. The formation of three different types of this substance, including alkaline and tholeiite varieties, was the subject of a model by Kuno. The infinite onion and infinite leek models explain the rise of this substance from structures containing it. Assimilation, replenishment, and mixing are three of the FARM processes by which this substance differentiates. Cumulate rocks are created by the settling out of crystals from this substance, and (*) flow banding occurs when this substance leaves phenocrysts and xenoliths behind as it contacts a solid interface. The existence of rocks containing large quantities anorthosite of KREEP is used to posit an "ocean" of this substance on the moon. This substance can form sills, dikes, or other plutons upon intrusion, and its viscosity helps determine whether it forms andesite, rhyolite, or basalt upon cooling. For 10 points, name this mixture of molten rock that is called lava when extruded onto the surface of the earth.
ANSWER: **magma** [do NOT accept "lava" until "flow banding", accept it after]

18. PTF 11kx is an example of one of these events, which can be modelled using the CMAGIC relation. Some anomalous versions of these events may be explained by their having doubly-degenerate precursors. A cataloguing of 32 of these events in the Calan/Tololo survey gave an important relation describing them, which fits a curve using the delta-m-15 value. The Dark Energy Survey hopes to catalogue several thousand of these phenomena, which were used by Reiss, Perlmutter, and Schmidt to show that q is negative and the (*) expansion of the universe is accelerating. These events have a maximum absolute magnitude of 19.3, and the decay of cobalt-56 powers the near-infrared shoulder of their light curves, which are modelled by the Phillips relationship. These events, which have silicon II lines but no Balmer lines, occur when carbon detonation is triggered by accretion of a binary partner, and the fact that these events have a consistent peak luminosity allows their use as standard candles.. For 10 points, name this event in which a white dwarf collapses into a neutron star.
ANSWER: Type **Ia supernova** [prompt on partial answer]

19. In a 1999 paper, Vaughan Jones described how to associate an algebra described by *this* adjective to a bipartite graph. Bar-Natan used algebras of this type to describe how tangle composition acts on Khovanov homology, and one example of an algebra with this property is the Temperley-Lieb algebra. Algorithms for testing whether other mathematical objects have this property often use a criterion named for Fraysseix and Rosenstiehl. Whitney proved that certain objects have this property only if their associated matroid is (*) cographic. Paul Koebe showed that graphs have this property if and only if they are coin graphs; Steinitz's theorem states that polyhedral graphs are exactly 3-connected graphs with this property. One method of proving that an object has this property is to prove it doesn't have a subgraph isomorphic to K sub 5 or K sub 3-3. The best-known result about graphs with this property was popularized by De Morgan and proved by Appel and Haken with the aid of computers; that result is the four-color theorem. For 10 points, give this word which suggests that a graph can be drawn on a flat two-dimensional surface.
ANSWER: **planar** [accept word forms]

20. Wu and Ting found that the Odysseus gene in various Drosophila species can mediate this phenomenon, and genes that mediate this phenomenon can be found using introgression. One model for this phenomenon was partly supported by the work of Barbash, who found the interacting pair of genes Hmr and Lhr. In various Xiphophorus species, this phenomenon occurs by spots on the fins turning into tumors due to misregulation of the Xmrk-2 gene. Coyne and Orr were the first to map several factors that contribute to this phenomenon in three different lines of Drosophila. This phenomenon requires mutations in at least two genetic loci according to a model developed by (*) Dobzhansky and Muller. Haldane's rule states that this condition typically occurs in the heterogametic sex. This form of reproductive isolation occurs post-zygotically and affects male ligers and mules. For 10 points, name this phenomenon in which the offspring of two different species can't propagate.
ANSWER: hybrid **incompatibility** [accept hybrid **lethality** or hybrid **sterility**; accept answers like "**hybrids aren't viable**" or "**hybrids can't reproduce**"]