LEDERBERG 2: DAUGHTER CELL
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PACKET 1 – HOTHEAD

1. The prothrombin G20210A mutation is almost exclusively found in this ethnic group, and the most common hypercoagulability disorder among these people is caused by a mutation in a protein ordinarily cleaved by activated protein C. One notable phenotype carried by these people is partly caused by an alanine to threonine mutation at position 111 of SLC24A5. Around 1% of these people have two copies of CCR5 delta 32, which confers resistance to (*) HIV. One genetic disease most common in this ethnic group is caused by a deletion of a phenylalanine codon at position 508, and is caused by a mutation in a conduction channel leading to a buildup of mucus in the lungs. The first whole genome sequenced by 454 sequencing and published online belonged to an individual of this ethnic group; that man is James Watson. For 10 points, name this ethnic group, between 1 and 25 and 1 in 30 of whom have the privilege of being cystic fibrosis carriers.
ANSWER: **white** people [accept **Europeans**, **Caucasians**, **crackers**, **ranch-dressing-lovers**, etc]

2. Valentine and Xiang developed a three-dimensional structure with this property based on a cascaded fishnet structure of silver and magnesium fluoride, and Donhee Ham's group achieved this property by taking a two-dimensional electron gas and cooling it so it undergoes kinetic inductance. One paper posited that a slab with this property would be able to focus all radiative and non-radiative Fourier components of a 2D image, creating a (*) superlens. This property was originally postulated in a paper by Veselago, and was realized using a bunch of square copper split ring resonators by Shelby, Smith, and Schultz. Materials with this property are sometimes called "left-handed", and materials with this property have permittivity and permeability less than zero. Pendry's "invisibility cloak" and many metamaterials notably possess, for 10 points, what property, in which a dimensionless quantity appearing in Snell's Law is less than zero?
ANSWER: **negative index of refraction** [prompt on "metamaterials", accept **left-handed** before mention]

3. Silicones with this functionality are the ligands in Karstedt's catalyst, which catalyzes a reaction between Si-H groups and compounds of this type in a hydrosilylation reaction. Molecules of this type can be formed from benzothiazol-2-yl sulfones and aldehydes in a one-step base catalyzed reaction. That one-step reaction gives high stereoselectivity and avoids the need for a second step using sodium amalgam which produces a freely rotating planar radical. In the food industry, molecules containing this group are reacted with a (*) nickel catalyst with hydrogen gas under heat and pressure in order to create margarine and shortening from oils. For 10 points name this functional group produced in a reaction named for Julia and whose stereochemistry differentiates unsaturated fats into cis and trans types.
Answer: **Alkene**

4. Finding the quadrupole-to-monopole ratio of the correlation function of the space named for *this quantity* is used to find its namesake distortion parameter, symbolized beta. Mattig's formula is a particular instance of the relation between this quantity and angular size. Because the Sunyaev-Zeldovich effect is independent of this quantity, said effect is used to map galaxy clusters that have high values of *it*. The K correction is employed in surveys that use this quantity, which include DEEP2, 2dF, and CfA. One method of calculating this quantity involves finding the ratio of the scale factor in the (*) past to the current scale factor, and distortions in it include the Kaiser effect and the "Fingers of God". It is equal to 1089 for the CMB, which corresponds to reionization. This value, symbolized z, is negative for M81 because M81 is moving towards us. For 10 points, name this quantity found by dividing the difference between the observed and emitted wavelength and dividing by the emitted wavelength, which is a change in the observed wavelength from an object moving away from the observer.
ANSWER: **redshift** [or **z** before mention; prompt on "distance", prompt on "Doppler shift"]

5. In quantum field theory, the partition function is equal to an integral of e to the power of quantity (an integral plus *this* quantity). In QED, the invariance of this quantity, along with the electric and magnetic fields, under gauge transformation is an easy way to derive charge conservation. In a scalar field theory, considering an extremum of this quantity leads to an equation identical to the Klein-Gordon equation. One version of this quantity is equal to a constant times the integral of the Ricci curvature tensor times the square root of the negative determinant of the metric tensor. Another version of this quantity is defined in terms of derivatives with respect to both the spacelike and timelike worldsheet (*) coordinates. For a classical orbit of a system in oscillating motion, this quantity is equal to the area enclosed by said orbit in phase space. Besides the Einstein-Hilbert, Nambu-Goto, and Polyakov versions of this quantity, this quantity times i over h-bar, all exponentiated, gives the probability amplitude of a given path in the Feynman formulation. Hamilton's principal function is equal to this quantity, which is stationary in the path followed by a physical system. For 10 points, name this quantity equal to the integral of the Lagrangian.
ANSWER: **action**

6. David Tilman's Markov models of this process rely on the resource-ratio theory, and two other researches divided instances of this process into ones that follow the Facilitation, Inhibition, or Tolerance models. The Clements deterministic model of this process contrasts with the individualistic model of Gleason, which emphasizes traits like abiotic tolerance and (*) dispersal ability. The primary stage of this process results in pedogenesis after an initial growth of fungi or lichens. This process occurs through a series of sere, and begins with pioneer species and ends with the creation of a climax community. For 10 points, name this ecological process that occurs after a forest fire or the creation of an island, in which life colonizes a new habitat.
ANSWER: ecological **succession**

7. A boolean ternary operator that holds if and only if its arguments are an encoding of a program, an input, and a halting computation of that program on that input is named for this man; that T-predicate named for this non-Chomsky person is used to develop his "normal form." This man is the alphabetically first author of a paper that recreates the Richard paradox titled "The inconsistency of certain formal logics" which earned an identically titled response from (*) Haskell Curry; that paper coauthored by this man introduced a paradox he co-names with J. B. Rosser. A state with an epsilon transition and a self-loop that consumes a character can be used to represent a unary operator named for this man that indicates zero or more of a string. For 10 points, identify this namesake of a recursion theorem as well as the regular-expression operator known as his "star."
ANSWER: Stephen Cole **Kleene**

8. These cells' surfaces contain homodimers of CD94 and CD159a as an activating receptor and they require the transcription factor NFIL3 for their development. A precursor of these cells are RORC- and CD127-double-positive and control the organogenesis of lymph nodes; those are LTi cells. In the placenta, these cells are down-regulated by HLA-E, which is selectively expressed by trophoblasts. The mouse cytomegalovirus can invade these cells via the Ly49H receptor, and they express the surface receptors CD16 and CD56. These cells, which are an evolutionary bridge between the (*) adaptive and innate immune systems, do not require the presence of MHC class I in order to destroy their targets. These cells are responsible for attacking tumors and virus-infected cells, and like cytotoxic T cells have granules containing perforin and granzyme. For 10 points, name these immune cells named for their innate ability to attack non-self cells.
ANSWER: **Natural Killer** cells or **NK** cells

9. This metal is used to catalyze a process discovered by Rochow in which methyl chloride is reacted with silicon metal to produce chlorosilanes. It is complexed with tetramethyl ethylenediamine and reoxidized with oxygen gas in one of multiple reactions that produce 1,3-diynes using this metal as a catalyst. It is also used in a catalyst for industrial methanol production, and that same catalyst is used for the low-temperature portion of the water-gas shift reaction. In biochemistry, this metal is found with zinc in a (*) superoxide dismutase, and two hemes and two sites containing this metal are found in cytochrome C oxidase. This metal is consumed in a reaction where aryl halides are converted to symmetrical biaryl compounds as developed by Ullmann. For 10 points, name this transition metal whose iodide can be reacted with organolithium compounds to form Gilman reagents.
Answer: **Copper**

10. This character says "Hurry up! Get out before you meet yourself coming in!" in one amusement park appearance. He complains about selling out to a "mercenary clown" in his cameo in *The Simpsons Ride*, a reference to it replacing an earlier ride featuring this character at Universal Studios. This man has dogs named Copernicus and Einstein, while his children will eventually be named Jules and Verne. In his third film appearance, he marries a woman named Clara Clayton who lives in Hill Valley, circa (*) 1885. This scientist, who is at one point shot by Libyan terrorists, notes when a certain object hits 88 miles per hour, you're going to see some serious shit. He invents the flux capacitor which he places in a DeLorean to create a time machine. For 10 points, name this eccentric, Christopher Lloyd played scientist who helps Marty McFly in the *Back to the Future* movies.
ANSWER: Doc **Emmett Brown** [accept either part]

11. An enzyme called LynF attaches prenyl groups to tyrosine via an intermediate that spontaneously undergoes this reaction. That aromatic version of this reaction is then followed by re-aromatization, in this case reforming the tyrosine hydroxyl group. This reaction also occurs in the first committed step in synthesis of tyrosine and phenylalanine, the conversion of chorismate to prephenate. Electron donating groups on the (*) vinyl C-1 increase the reaction rate, which led to variations co-named for Eschenmoser and Ireland. This reaction typically passes through a chair transition state, and the presence of a bulky substituent at C-4 leads to formation of *E* alkenes. This typically non-catalyzed reaction follows a similar mechanism to the Cope rearrangement, and both are [3,3]-sigmatropic reactions. For 10 points, name this reaction that produces an unsaturated carbonyl compound from an allyl vinyl ether.
Answer: **Claisen Rearrangement**

12. Mutations in Sog delay certain aspects of this process, and it occurs in a "twisted" fashion in Tsg mutants. The cerebrus protein is expressed during the early stages of this process. A group of cells important to inducing this process is activated by the Siamois transcription factor, and that group of cells was discovered using cap transplantation assays. In Xenopus, this process begins when the edge of the DIMZ rolls and bottle cells from the gray crescent invaginate to form a dorsal lip, as directed by beta-catenin and TGF-beta induced transcription of chordin and noggin in the (*) Spemann-Mangold organizer. In humans, this occurs when cells from the epiblast migrate through the primitive streak. This process forms a primitive pouch called the archenteron, which opens to the outside via the blastophore. For 10 points, name this process that occurs in the early embryo, in which the blastula cleaves into three germ layers.
ANSWER: **gastrulation**

13. The effect of these entities on their environment can be quantified using the Hjulström-Sundborg diagram, and aggradation caused by these entities can be modelled by the Exner equation. The incision rates of these entities is calculated using Playfair's law. One method of classifying these entities was used by Gleyzer and Salingar to create a recursive algorithm based on GIS measurements; that method assigns the highest index to the main stem and is based on the (*) Strahler number. Rejuvenation in these entities can cause the terraces they form to be paired. These systems can form cut points when they exceed their capacity, after which they can braid. When they interact with glaciers, they form eskers. Those in forested areas can form riparian buffers, and they leave behind deposits called alluvium. For 10 points, name these entities that can form oxbow lakes when they cut off a meander, and which can also form namesake deltas.
ANSWER: **river**

14. An improvement on this result contains a denominator equal to the chi-square divergence of the probability density function of theta plus delta with respect to the pdf of theta; that improvement is named for Robbins, Chapman, and Hammersley. The single-parameter version of this result can be proven by taking the covariance of a test statistic with the score, using the chain rule, then applying the Cauchy-Schwartz inequality. This result can be used to prove that the maximum likelihood estimator is asymptotically (*) unbiased. Applying this result to a multivariate normal distribution gives a result of sigma-squared over N, and this statement can be used to find the unbiased estimator with the lowest mean-squared error. For 10 points, name this inequality that states that the variance of an unbiased estimator is at least as high as the inverse of the Fisher information, named for two statisticians.
ANSWER: **Cramer-Rao** bound [or the **information** inequality]

15. In the embryo, these structures develop when a Wnt4-induced vesicle elongates into a comma-shaped body, followed by an S-shaped stage. One section of these structures produces the Tamm-Horsfall glycoprotein. People with interuterine growth restriction have fewer of these at birth and a higher chance of hypertension later in life. Barter and Gitelman's syndromes are caused by mutations in proteins found here. Mutations in PKD1 cause cysts to appear throughout these structures. NKCC2 localizes to one part of this structure, which is acted upon by furosemide. One section of this structure that feeds back onto a previous section is the (*) macula densa, and peritubular capillaries surround it. One section of this structure dips into the medulla, uses a countercurrent multiplier mechanism, and is surrounded by the vasa recta. Ultrafiltration occurs in its vascular pole, which forces filtrate into Bowman's capsule. For 10 points, name these structures which contain the glomerulus and Loop of Henle, the functional unit of the kidney.
ANSWER: **nephron** [prompt on "kidney", anti-prompt on more specific parts of the nephron like glomerulus, Bowman's capsule, proximal convoluted tubule, Loop of Henle, etc]

16. The amplitude of Zitterbewegung oscillations is equal to this value. Considering an object for which this parameter is equal to the Schwarzschild radius is the first step in the derivation of the Planck mass. The square of the inverse of the reduced form of this quantity multiplies the wavefunction in one term of the Klein-Gordon equation. Vacuum polarization occurs over a region defined by this quantity, and therefore this quantity gives the scale over which quantum field theory is applicable. This quantity multiplied by the fine structure constant gives the classical electron (*) radius. Computing this value for the W boson gives the length scale over which the weak force can act. This quantity is equal to h over mc and is the region of space over which a particle can be localized. For 10 points, name this quantity which is multiplied by quantity one minus cosine theta to determine the shift when photons bounce off electrons in a namesake type of scattering.
ANSWER: **Compton wavelength**

17. Disconnectivity graphs can be created by looking at "superbasins" in these structures. Conical intersections between two of these entities correspond to places where states of the same symmetry meet and are called diabolic points. Stability on these constructs is indicated by points where the Hessian has all positive eigenvalues, and these constructs can be visualized using Z-matrix coordinates. Some features of these mathematical constructs can be found using the SQTN method, which is a modification of the synchronous transit approach. These constructs are often generated using the improved (*) Lennard-Jones function and are usually drawn using the Born-Oppenheimer approximation. The Dunham coefficients can be calculated using the minima of these constructs, and taking a one-dimensional path along these constructs can be used to create a reaction coordinate diagram. Saddle points on these constructs correspond to transition states. For 10 points, name these hypothetical many-dimensional constructs used to model the energy of an atom, molecule, or set of molecules.
ANSWER: potential **energy surface** [or P**ES**, or potential **energy function** or potential **energy hypersurface**, or potential **energy landscape**; prompt on "reaction diagram" or "reaction coordinate diagram", don't need "energy" after it's mentioned]

18. Lawrence Krauss and Frank Wilczek recently argued that the background of these phenomena is proportional to h-bar squared. Schutz pointed out that sources of these entities called "standard sirens" can be used to construct high-redshift distance scales. These phenomena are often studied using a gauge in which h-bar sub alpha-beta is equal to h sub alpha-beta and reduces 10 polarizations to two, called the transverse-traceless gauge. Primordial examples of these phenomena can be inferred from measuring B-mode polarizations in the CMB. These entities must arise from (*) quadrupole or higher multipole sources. The loss of energy of a system named for Hulse and Taylor is indirect evidence for their existence. Methods of detecting them include Weber bars and laser interferometry. Thorne, Drever, and Weiss developed the LIGO detector to search for these entities, which are predicted by general relativity but have not yet been directly observed. For 10 points, name these propagating "ripples" in spacetime, a form of radiation linked to the weakest of four forces.
ANSWER: **gravitational waves** [accept **gravitons** since wave-particle duality and all that]

19. One study that attempted to model the rate of this non-economics-related process measured the Gini coefficient and the M-20 of several bodies in the Extended Groth Strip; that study was performed by Jennifer Lotz. When this process occurs repeatedly in some locations, it leaves behind an x-ray halo in a formation called a "fossil group". Products of this process can rapidly move towards a Maxwell-Boltzmann equilibrium state according to Lynden-Bell's "Violent Relaxation" mechanism. Dynamical friction is a key driver of this process, during which the (*) star formation rate can increase to 100 solar masses per year. These events can be major or minor depending on the mass distribution, and this process can generate tidal tails in the first pass. For participants of approximately equal mass it results in the formation of an elliptical body from spiral ones. For 10 points, name these cosmic events, which in four billion years will occur to the Andromeda and Milky Way as they rush towards each other.
ANSWER: **galactic mergers** [or **galactic collisions**; accept common-language equivalents for either of these things; prompt on "galaxy formation"]

20. The MSI protocol is used to mark the state of these components in distributed systems in order to preserve "coherence." Under high load, a "stampede" can occur when many concurrent processes access one of these structures. The optimal algorithm to control these components is known as Belady's algorithm, but more practical choices include LRU and MRU. A map from virtual addresses is contained in a specialized one of these components known as a TLB. Compiler (*) optimizations like loop-tiling make use of these components. These components can mark elements as "dirty," which indicates that they must be copied if evicted in the "write-back" system of managing these components. These structures, which take advantage of temporal and spatial locality, usually measure performance through a "hit rate." For 10 points, name these small components that store data to be retrieved faster on subsequent requests, which have a hierarchy that includes the L1 and L2 types.
ANSWER: **cache** [prompt on "memory" or "buffer"; do not prompt on "RAM" or "hard drive" or "disk"]