

Science Monstrosity II: Science of the Lambs

Irene Ying and Jordan Boyd-Graber

July 9, 2004

Tossups

1. Belonging to the Bunyaviridae family, it can only infect specific rodent hosts, and its main carrier in the U.S. is the deer mouse. Its hallmark is an abnormally large increase in the white blood cell count, and the cardiopulmonary phase of the disease it causes brings rapid lung failure. The Korean strain of this virus causes kidney failure and may be combated with ribavirin, but no cure for the diseases it causes exists, and when it broke out in the Four Corners region, more than half of those infected died. FTP, name this virus whose strains include the Sin Nombre and the Scandinavian Puumala viruses, and which is named after the Hantaan River.

Answer: **Hantavirus**

2. Its largest crater is the 27km wide Mazomba, and its surface is defined by maculae and cryovolcanic flows such as Rauch Planitia. It has an odd orbit; it was the first satellite to be observed with a retrograde orbit, and the latitude where the Sun is directly overhead can change from far north to far south over several decades, alternately melting and freezing half of its surface. Had it not been captured, it probably would have been called a planet since it is larger and usually closer to the sun than Pluto. FTP, identify this discovery of William Lassell, the largest moon of Neptune.

Answer: **Triton**

3. Because polarization of light is inherently binary, using light beams with this property would make quantum encryption easier since there are practically an infinite number of possible states. Photons with this property can be generated using Laguerre-Gaussian lasers, and torque is defined as the derivative of this quantity with respect to time. Quantum-mechanically, it is the generator of infinitesimal rotation, and is defined as the position vector crossed by $\hbar \nabla$ over i . Conserved in planetary motion according to Kepler's second law, FTP, identify this vector quantity whose classical form is the cross product of position and linear momentum.

Answer:(Orbital) **Angular Momentum**

4. It was first proposed by Francis Guthrie in 1852, and incorrectly proved by Alfred Kempe in 1879, who erroneously asserted that any normal map contained some region with fewer than six adjacent regions. The correct 1979 proof uses Heesch's discharging method to find an unavoidable set of reducible configurations, which had to be analyzed using a computer program. The Heawood conjecture informed its proof by giving an upper bound for, which was wrong for the Klein bottle. FTP, what theorem proved by Wolfgang Haken and Kenneth Appel says that all maps of contiguous regions are colorable by certain number of colors?

Answer: **Four-Color** Theorem

5. The incorporation of benzene rings into these compounds led to the development of calixarenes. The first one was discovered in 1967 by Charles Pederson and contained six oxygen atoms. The interior of these

molecules is water-like, while the exterior is hydrocarbon-like, and they can participate in "host-guest" chemistry, usually with cations. They are often used to dissolve inorganic salts such as potassium permanganate into organic solutions and they also possess the ability to extract metallic salts from solutions. FTP, name these molecules where each oxygen atom is bound between two carbon atoms, arranged in a ring, and fit for a king to wear.

Answer: Crown Ethers (prompt on "ether")

6. There are 308 species of this near-passerine animal, and their family is the only one in their order that is still extant, the family *Raphidae* being extinct. Their use in wirelessly transmitting IP datagrams was specified by RFC 1149, which was implemented for the first time in 2001 with a ping response time of 6 times ten to the six seconds. Their superposition principle relates the association of events with rewards, as described by B.F. Skinner, who trained them to pilot bombs and play ping pong, which prompted Google to use them to rank webpages. Close relatives of the dodo and belonging to the family *Columbidae*, FTP, identify these rats of the air beloved by Bert and poisoned by Georg Kreisler and Tom Lehrer.

Answer: Pigeons (or doves)

7. They can be predicted using the Inex or Saros cycles, and one happens about every eighteen months. They cannot last for over seven minutes and forty seconds, but only about ten every millennium that last over seven minutes; the last time this happened was June 30, 1973. Eddington traveled to South America to observe one in 1919, since it would then be possible to observe the deflection of a star's light by gravity, and they are the only time the sun's corona is visible. FTP, identify these events when the moon occludes the sun.

Answer: Total solar eclipse (prompt on occlusion or eclipse, accept eclipse of the sun)

8. An important example of this phenomenon is the keto-enol type, with the keto form the more stable due to the greater strength of a carbonyl double bond. These molecules have the same formula but not the same structure, and cannot be independently isolated. All four DNA bases exist in these forms, and enol ones of guanine can lead to mutations and GT pairings. They also explain why pure enols generally don't exist. FTP, name these rapidly interconverting isomers that differ only in the placement of p-electrons and hydrogen.

Answer: Tautomers (prompt on "isomers", do not accept "stereoisomers" or "enantiomers")

9. Its derivatives include pigment cells, facial cartilage, the adrenal medulla, and the entire peripheral nervous system. Its differentiation takes place under the regulation of a defined set of paracrine and juxtacrine factors, and in the embryonic neuroectoderm, this tissue forms when high levels of bone morphogenetic protein and Wnt6 ("wint six") meet. Defects in its cranial functional region results in such syndromes as Robin and DiGeorge, and it also contains the trunk, vagal, sacral, and cardiac functional regions, which migrate to the appropriate parts of the body and begin differentiation. Consisting of pluripotent cells, FTP, name this transient tissue that arises from the neural fold.

Answer: neural crest

10. Depending on whether they it is iron rich or magnesium rich, a mineral in this category is known as either a fayalite or a forsterite. It is found in heavy igneous rocks and minerals in this category have high melting points. Of its two varieties, forsterite crystallizes first, with fayalite following just as pyroxenes are beginning to form. An orthosilicate of magnesia, it is semiprecious and its formation temperature of about 1400 degrees places it at the top of the discontinuous branch of Bowen's reaction series. Name the class of minerals whose gem is peridot, and, FTP, is named for a color resembling an oily fruit.

Answer: olivine

11. While a researcher at McGill University, he blew smoke from a cigar and observed the effect on an ionization chamber, thus laying the foundation for future smoke detectors. Assisted by Harriet Brookes, he discovered Radon, and he was the first to name the alpha, beta, and gamma forms of radiation. For his determination that an alpha particle was equivalent to the atom of a Helium nucleus, he won the 1908 Nobel in Chemistry, prompting him to say that the fastest transformation he knew of was his transformation from a physicist to a chemist. FTP, identify this physicist perhaps best known for his gold foil experiment.

Answer: Lord Ernest **Rutherford** of Nelson

12. Less than a megabyte in size, this program was developed at Rife Bible College, and it is sometimes called "Reality." It is derived from a Nam-shub, an older virus developed by Enki. It is delivered through a variety of means, but usually through an individual logged into public access terminals. The first victim was Da5id Meier, who developed the Metaverse protocol and owns the Black Sun. For ten points, identify this titular neurobiological and computer virus of a Neal Stephenson book.

Answer: **Snow Crash** Accept "Reality" or "Nam-shub of Enki" (before it's mentioned)

13. This molecule with formula C₆H₁₂O₆ is found in dairy products and sugar beets and is poisonous if not metabolized. Babies who cannot break it down develop cataracts, and its D form has the same configuration at the penultimate carbon as D-glyceraldehyde. It is converted into glucose for metabolism, but in certain females, glucose is converted into it and then linked to another glucose. Hydrolyzed by lactase, FTP, name the monosaccharide, the inability to process which is known as a certain type of intolerance, and which with glucose forms lactose.

Answer: **Galactose**

14. A monument to this organism was erected in Enterprise, Alabama in 1919. They spend the fall and winter living in ground trash, and they are hampered by the fact that they can reproduce only in one kind of plant. Known for spurred femurs and having long snouts, their snouts are used to puncture the boils protecting the fibers of their preferred nesting site to lay their eggs. They belong to class Insecta, and up to five generations can remain in the "square" of their preferred habitat of the genus Gossypium. FTP, name this most destructive of North American cotton pests.

Answer: **boll weevil** (accept "Anthonomus grandis")

15. Cast in the Euclidean style of the Mathematical Principles, eight definitions and eight Axioms precede the three Books. It anticipated Einstein's equivalence of matter and energy in Query 30: "why may not Nature change bodies into light, and light into bodies?" Through investigations of Iceland spar, it introduced the idea of polarization. The author investigates the interference of corpuscles by placing a convex lens on a table, producing a pattern still named for this work's author. FTP, identify this investigation of the nature and interactions of light by Isaac Newton.

Answer: **Opticks** (make sure they pronounce the "k")

16. Life without Death, an automaton rule which generates the symbol on the New Mexico flag, is a complete problem in it. Both the problem of finding the best move in Go or Chess and deciding a statement in Pressburger arithmetic are not in it, but the Ziv-Lempel, Linear Programming, Convex Hull, and Circuit Value problems are. It was recently shown that PRIMES was also in this complexity class, although it is believed that SAT is not. Defined as the class of decision problems solvable by a Turing machine in a time dependant in a specific way on the input size, FTP, identify this complexity calls which may or may not be equal to NP.

Answer: **P**olynomial Time

17. This effect is seen when molecules separated by an optical lattice in a Bose-Einstein condensate can

tunnel from one part of the condensate to another but retain their coherency. It allows for a measurement of e over h because it produces, given a supplied DC current, an AC current with frequency of two e times the voltage divided by Plank's constant. It is the voltage produced by the current in this effect that allows the measurement of minute magnetic fields, and its British discoverer won the Nobel Prize in 1973. FTP, identify this effect describing how Cooper pairs travel between superconductors separated by a thin insulator.

Answer: Josephson effect

18. A cheaper form of this reaction also bears the name of Horner, and uses a phosphite ester instead of a phosphine. Triphenylphosphines tend to give the cis isomer, while trialkylphosphines, or any presence of groups that stabilize the ylide give the trans isomer. During its first step, the nucleophilic carbon from the ylide reagent adds to the electrophilic carbon in the polar carbonyl group, while the second step involves the decomposition of the intermediate carbon-phosphorus bond. FTP, identify this organic reaction, useful for producing alkenes.

Answer: Wittig reaction

19. A Wieferich one is a number n such that n squared is congruent to one mod two to the quantity n minus one. A Wilson one is a number n such that n minus one factorial is congruent to negative one mod n squared. A Fermat one is a number n such that n is equal to two to the two to the m all plus one where m is a non-negative integer, and a Mersenne one is a number n such that n is equal to two to the m minus one, where m is, again, a non-negative integer. For ten points, identify these special cases of numbers that are divisible only by one and themselves.

Answer: prime numbers

20. They make mistakes 1 in 20,000 times. Type I repairs damage and sometimes synthesizes molecules. Type II is involved only in repair, and is relatively inactive. Type III is composed of three subunits, and dimerizes to form two functional ends. All types can only work 5' to 3' (five prime to three prime). For ten points, name the enzymes that replicate DNA.

Answer: DNA Polymerases or DNA Replicases

Bonuses

1. Most quizbowl questions test your theoretical biology. Let's see how proficient you are in the lab by identifying these lab techniques for ten points each.

[10 points] You run an SDS gel, transfer it onto nitrocellulose, probe with antibodies, and expose the nitrocellulose onto film.

Answer: **Western** blot

[10 points] You make four tubes of dNTPs, add a different ddNTP into each tube, and put some of the same DNA into each tube. You take the resulting DNA and run it on a gel.

Answer: Nucleotide or Base **Sequencing** (accept equivalents)

[10 points] You mix Coomassie Blue with ethanol and acid. You add the result to various extracts that are thought to contain protein. As you do so, the reagent goes from greenish-brown to brilliant blue. Those mixes are put into a spectrophotometer to check for absorbance at 595 nanometers.

Answer: **Bradford** assay

2. Chemistry questions for ten points each.

[10 points] This famous chemist dreamed of a snake biting its own tail, thus coming up with the ring structure of benzene.

Answer: Friedrich August **Kekule** von Stradonitz

[10 points] This rule states that in elimination reactions, the major product is the alkene with the more highly substituted double bond.

Answer: **Zaitsev's** rule

[10 points] Fischer invented a synthesis of this type of heteroatomic, heterocyclic aromatic compound, also known as benzopyrrole.

Answer: **Indoles**

3. Identify these impact sites for ten points each.

[10 points] One of the best preserved is this 1.2 km diameter site near Flagstaff, Arizona formed 50,000 years ago.

Answer: **Meteor** Crater

[10 points] This impact structure in Quebec has a central peak of shock-metamorphosed rock surrounded by frozen impact melt and a ring-shaped reservoir carved by glaciers from the soft sedimentary rock.

Answer: **Manicouagan** Crater

[10 points] This is not a crater because this asteroid exploded 6km above the ground in western Siberia in 1908, downing trees over several thousand square kilometers.

Answer: **Tunguska**

4. Identify these counterintuitive results from measure theory made possible by that crazy axiom of choice for ten points each.

[10 points] The most well known is this theorem, which states that sphere can be divided into finitely many pieces and rearranged into a sphere of double the volume.

Answer: **Banach-Tarski** Theorem

[10 points] The Banach-Tarski "paradox" is an extension of this man's odd result that finitely many divisions of the unit interval can be translated into an interval of length two. His name is also attached to spaces where any two points have disjoint neighborhoods.

Answer: **Hausdorff** Paradox

[10 points] Tarski also posed this challenge, not to be confused with squaring the circle, which was proved by Miklos Laczkovich in 1990. He described a way to cut up a circle and rearrange the pieces into a square using only translations.

Answer: Tarski's **Circle-Squaring** Problem

5. You know what it is, but do you know what it means? Find out for ten points each.

[10 points] This term covers synthetic materials whose essential components are inorganic, nonmetallic elements.

Answer: **Ceramics**

[10 points] Under that definition, glass is actually a ceramic. One method of strengthening glass is to heat it to near its softening point, maintaining that temperature for a time, and then slowly allowing the glass to cool. Name this process, which can also be used on metals.

Answer: **Annealing**

[10 points] Firing a ceramic causes the fine particles in the paste to merge together under the high temperatures. This process shrinks the volume and is called by this name.

Answer: **Sintering**

6. Imagine you have a hollow spherical shell of mass M and radius R . For ten points each,

[10 points] What is its moment of inertia about its center in terms of M - R - squared?

Answer: **$\frac{2}{3}$**

[10 points] Now suppose that there is a charge q on the sphere. What is the magnitude of the electric field in terms one over four pi epsilon naught inside the sphere?

Answer: **0**

[10 points] What is the magnitude of the electric field outside the sphere in terms one over four pi epsilon naught?

Answer: **q over R squared**

7. The bigger, the better, right? Answer questions on polymer chemistry FTPE.

[10 points] Many polymers form by processes involving radicals. In that case, the chemical used to start the reaction is called by this term, often a peroxide.

Answer: **Initiator**

[10 points] If the monomers involved have three or more reactive sites, this process can occur such that non-linear materials like sheets or networks form.

Answer: **Cross-linking**

[10 points] Dissolve cellulose in concentrated ammonia containing cuprammonium. Pour that solution into sulfuric acid. Now you can string up some polymer threads of this synthetic fiber, which used to be called "artificial silk", and was later perfected by DuPont.

Answer: **Rayon**

8. You know how to hit a buzzer, but how do your muscles know? Answer these questions for ten points each.

[10 points] These are bundles of neuron nuclei deep in the white matter of the cerebral cortex, and, like the cerebellum, they control your movement. They are damaged in Parkinson's disease.

Answer: **Basal ganglia**

[10 points] Motor neurons will zap a signal into your muscle cells, causing them to release this cation which will trigger contractions.

Answer: **Calcium 2+**

[10 points] The calcium ions are stored in the sarcoplasmic reticulum, guarded by these release channels.

Answer: **Ryanodine** receptors

9. Answer these questions on a theory developed by David Politzer for ten points each.

[10 points] The fundamental symmetry in the equations of this gauge invariant theory is the special unitary group in three dimensions.

Answer: Quantum Chromodynamics

[10 points] The theory of QCD describes the interactions between quarks and what mediator of the strong nuclear force?

Answer: gluon

[10 points] Imagine you have a proton, and you pull off one of the quarks. Because of color conservation predicted by QCD, you're left with a proton and what other type of particle?

Answer: meson

10. Answer these related questions from geology for the stated number of points each.

[5 points] For five, this is the general term for rock embedded in glaciers deposited after a glacier melts.

Answer: moraine

[5 points each] Identify the three major types of moraine, which identify where the rock was in the glacier before it melted.

Answer: Lateral, Medial, and Terminal

[10 points] For ten points, a moraine may form a natural dam below this type of lake that is carved out by the action of a glacier.

Answer: Tarn

11. Identify these classic problems from concurrent computation for fifteen points each.

[15 points] Perhaps the best known problem is this Dijkstra's, where you must assign four forks to five hungry thinkers in such a way that nobody starves to death and nobody can hold onto a fork forever.

Answer: Dining Philosophers

[15 points] This problem, devised by Parnas, was originally thought to be unsolvable with semaphores. In it, three addicts have an infinite supply of one material, but must get the other two from an agent.

Answer: Cigarette Smoker's Problem

12. The C programming language and C++ have quite a bit in common, but there are some differences. Given a feature of a programming language, state whether it is in C, C++, both, or neither for five points each and a bonus five for all correct.

[5 points] Polymorphic classes

Answer: C++

[5 points] Garbage Collection

Answer: Neither

[5 points] A built-in bool class for Boolean values.

Answer: C++

[5 points] Parameter passing only through pass-by-value.

Answer: C

[5 points] A built-in operator for bitwise or.

Answer: Both

13. Given an event, give the period of the Mesozoic that best fits for five points each and a bonus five for all correct.

[5 points] Central North America was home to the Sundance Sea, which covered Utah and Colorado.

Answer: Jurassic

[5 points] Fusulinid foraminifers, lacy bryozoans, rugose corals and trilobites disappear.

Answer: Triassic

[5 points] Modern crocodiles evolve, and Stegosauria were replaced by the heavily armored Ankylosauria.

Answer: Cretaceous

[5 points] The supercontinent of Pangea broke up into North America, Eurasia, and Gondwana.

Answer: **Jurassic**

[5 points] Modern grasses evolve at the end of this period, and modern trees such as the fig, sycamore, and magnolia emerge for the first time.

Answer: **Cretaceous**

14. Answer some questions about an interesting thermodynamic effect, FTPE.

[10 points] In non-ideal gases, this effect may be used to change the temperature of the gas by constricting the gas flow.

Answer: **Joule-Thomson** effect

[10 points] The Joule-Thomson effect is somewhat unusual because it takes place as this quantity is held constant.

Answer: **enthalpy**

[10 points] In order for the Joule-Thomson effect to work as a cooling effect, the initial temperature of the gas must be below the maximum temperature on this curve, which plots temperature against pressure for a given process.

Answer: **inversion** curve

15. Are you an IUPAC perfectionist? Give the common names of these molecules for ten points each.

[10 points] Acetylsalicylic acid

Answer: **Aspirin**

[10 points] 2-Propanone

Answer: **Acetone**

[10 points] (2R,3S,4R,5R)-2,3,4,5,6-pentahydroxyhexanol

Answer: D-(+)-**Glucose**

16. Blood is thicker than water ... and more complicated, too. Answer questions about blood on a 5-10-15 basis.

[5 points] Blood cells are ultimately derived from these pluripotent cells that give rise to different cell lines, usually in the bone marrow.

Answer: **Stem** cells

[10 points] The process of stem cells differentiating into different blood cells is called by this name.

Answer: **Hematopoiesis** (be lenient with pronunciation)

[15 points] When hematopoiesis is impaired or arrested, this type of anemia results.

Answer: **Aplastic** anemia

17. Answer some questions about superconductivity, FTSNOPE.

[5 points] These superconductors are all elemental and are governed by BCS theory.

Answer: **Type I**

[15 points] Named for the two men who devised it in 1952, this phenomenological equation describes the macroscopic and thermodynamic properties of superconductors.

Answer: **Ginzburg-Landau** equation (accept in either order)

[10 points] Type II superconductors have two critical temperatures. What is the term for the superconductor in that intermediate regime, which arises from the formation of the namesake structures?

Answer: **vortex** state

18. Do you see the benzene rings? Answer these questions about some compounds for ten points each. If you know where the opening line of this question comes from, it will be easier.

[10 points] If you can nitrate this compound three times, you'll get TNT.

Answer: **Toluene**

[10 points] Carboic acid and formaldehyde together form this synthetic plastic, which is also called phenolic resin, and was named after a Belgian scientist.

Answer: **Bakelite**

[10 points] These "dodgy" compounds, including methyl orange and FD&C Yellow number 6, are colored derivatives of azobenzene.

Answer: **Azo dyes**

19. Biology people can be creative. Identify two of the cuter gene names for 15 points each.

[15 points] This gene has two cousins, "Desert" and "Indian", which are actually named after real species. Drosophila who lose it look very bristly and spiky.

Answer: **Sonic Hedgehog**

[15 points] This gene, when missing, results in a Drosophila with no heart, and the resulting embryos are not viable.

Answer: **Tinman**

20. Identify the common three-letter acronym on a 30-20-10 basis.

[30 points] In chemistry, the chemical C_6Cl_5OH that is used as a wood preservative.

[20 points] In computer science, the Turing-complete system presented by Emil Post in 1947 and a complexity class that uses a random proof verifier.

[10 points] On the street, this one-time anesthetic is also called angel dust, ozone, wack, and rocket fuel.

Answer: **PCP**