

PROTEINBOWL 2: what we talk about when we talk about fatty acid synthesis
Questions written by Geoffrey Chen
Thanks to Vishwa Shanmugam for “playtesting.”

1. Serine/threonine phosphorylation of interferon regulatory factor 3 causes it to form a complex with a protein named after binding to this protein. This transcription factor is regulated by phosphorylation at serine-133. Mutations in a protein that binds to this protein cause (-) Rubinstein-Taybi syndrome. The binding of this transcription factor to an enhancer controls (+) BDNF transcription. This protein can be made constitutively active by fusing it to the activation domain of VP16, which forms a common mouse cell line used to study late long-term potentiation. A protein which binds to this protein forms a complex with p300 that possesses histone acetyltransferase activity. Protein kinase (*) A affects enzyme activity by either directly phosphorylating them, or by phosphorylating this transcription factor, which then binds to an enhancer and promotes transcription. For 10 points, name this transcription factor associated with cyclic AMP.
ANSWER: CREB-TF [or cyclic AMP response element-binding protein]

2. Francks et al determined that a gene named after this structural motif was associated with being left-handed. Listeria invades cells by binding to c-Met and cadherins using a group of proteins containing this motif called internalins. Basically all (-) R-gene proteins contain a nucleotide binding protein domain and one of these motifs. Adaptive immunity in jawless fish is controlled by a group of receptors characterized by this motif called (+) variable lymphocyte receptors. While it doesn't involve biotin, which isn't even a protein, the non-enzyme protein that forms the strongest known protein-protein interaction possesses many copies of this motif. TLR ectodomains contain about 20 copies of this structural motif. The canonical example of a protein which contains this motif is (*) ribonuclease inhibitor. The alpha/beta horseshoe fold is formed by this structural motif. For 10 points, identify this motif characterized by high amounts of an amino acid which also forms namesake "zippers."
ANSWER: leucine-rich repeats [or LRRs]

3. In 2009, Wu et al found that a subclass of these cells, unlike all other cells in a superclass of these cells, are able to perform phagocytosis. Spencer et al found that an elevation of these cells occurs in both celiac disease and cow-milk-sensitive enteropathy/post-enteritis syndrome. A Thy-1 positive subclass of these cells present during fetal development are called dendritic epidermal cells. (-) Non-peptidic antigens are antigens which bind to a protein on a subclass of these cells. The mevalonate pathway intermediate HMBPP is a far stronger activator of a subclass of these cells than any other molecule. Heilig and Tonegawa, as well as Garman, Doherty and Raulet created systems of nomenclature for these cells in mice. These cells exist at approximately three times their normal proportion in the epithelial layer of mammalian (+) mucosal lining. Unlike their counterpart, antigen processing and subsequent presentation with MHC does not need to occur for the activation of these cells. Approximately 5% of all (*) T cells are--for 10 points--what type of T cell with an unusual T cell receptor?
ANSWER: gamma/delta T cells [accept specifically V γ 9/V δ 2 T cells; prompt on T cells]

4. Wogulis et al determined the crystal structure of an enzyme which acts on these non-peptide molecules by complexing it with OTFP. Many experiments with these molecules knock out the apterous gene, which partially controls production of these molecules. A receptor for these molecules is the only known basic helix loop helix/PAS domain containing protein that acts as a (-) ligand-dependent transcription factor. These molecules are inactivated by an enzyme which possess an identical catalytic triad as microsomal epoxide dihydroxylase. (+) Methoprene is a synthetic analogue of these molecules. CYP15A1 catalyzes the epoxidation of methyl farnesoate to produce the 3 form of these sesquiterpenoid molecules. While not PTTH, these molecules are secreted by the (*) corpus allatum and are inhibited by allatostatins. Lepidoptera mostly produce the 1 and 2 isohormones of these hormones, while every basically other order of insects produce the 3 isohormone. For 10 points, name these hormones which prevent metamorphosis in insects.
ANSWER: juvenile hormones [or neotenin; accept JH; accept specific juvenile hormones like JH I or juvenile hormone II]

5. Isobe Toshihiro headed a team which discovered the ability of these proteins to inhibit protein kinase C. The phosphorylation of Chibby causes it to form a heterotrimer with beta-catenin and one of these proteins in Chibby's role in antagonizing the canonical Wnt pathway. Phosphorylation of (-) BAD by protein kinase B causes it to form a heterodimer with one of these proteins. Inactive Raf is found in the serum bound to hsp50, hsp90, and one of these proteins. Strafinin is one of these proteins found in stratified epithelial cells. The eta form of these proteins in synovial fluid is a novel biomarker for (+) rheumatoid arthritis. Along with WW domain and forkhead-associated domains, these proteins bind to phosphoserine. Elevated levels of epsilon and gamma members this family of proteins in the CSF is a common diagnostic marker for (*) Creutzfeldt-Jakob disease. For 10 points, identify this family of proteins named after three numbers, two of which are the same.

ANSWER: 14-3-3 proteins [accept specific 14-3-3 proteins like 14-3-3 eta]

6. The presence of a GC-rich discriminator in the fis sequence allows this molecule, which is far smaller than a protein, to bind to it. In addition to binding to a certain holoenzyme, the noncoding 6S RNA controls the transcription of several enzymes which regulate levels of this molecule. (-) DksA and Rsd are proteins which enhance the effect of this molecule. The binding of acyl carrier protein to the TGS domain controls the activity of several enzymes which control levels of this molecule. (+) RelA and SpoA are responsible for the synthesis and degradation of this molecule, respectively. This molecule promotes synthesis of the stationary-phase sigma factor, sigma factor s. Formyl-methionine phenylalanine dipeptide formation is inhibited by the binding of this molecule to initiation factor 2. The (*) stringent response is regulated by--for 10 points--what bacterial alarmone produced in response to amino acid starvation and cellular stress?

ANSWER: ppGpp [or guanosine tetraphosphate; or pppGpp; or guanosine pentaphosphate; do NOT accept or prompt on GTP or guanosine triphosphate; do NOT accept or prompt on answers which refer to guanine instead of guanosine]

7. ALF186 is the canonical example of an enzyme triggered molecule that releases this molecule in vivo. The binding activity of Holo-NPAS2, a transcription factor involved in circadian rhythms, is regulated by this molecule. A team lead by Brouard et al determined that this molecule suppresses (-) apoptosis in endothelial cells. This molecule can be delivered in vivo using a complex in which ruthenium is attached to a chlorine, a glycine and three of this molecule. The body metabolizes dichloromethane into this molecule. While it doesn't contain nitrogen, Augustine (+) Choi headed a team which discovered the p38 MAPK pathway could be activated by this gas. Along with biliverdin and ferrous iron, this molecule is produced by the 32 kilodalton heat shock protein (*) heme oxygenase. For 10 points, name this anti-inflammatory gaseous signalling molecule.

ANSWER: carbon monoxide [or CO]

8. A group led by Eckard Picht created an ImageJ tool used to analyze the interaction between these two proteins. Fluo-3 and its acetoxymethyl ester derivative are typically used to visualize the interaction between these two proteins. The hypotheses of (-) pernicious attrition, stochastic attrition and the sticky cluster model describe the interaction between these two proteins. The interaction between these two proteins is defective in dyspedic mice. An altered coupling between these two proteins is the most common cause of (+) malignant hyperthermia. One of these proteins is found on the surface sarcolemma or on T-tubules, while the other is found on the (*) sarcoplasmic reticulum. An action potential causes the first of these proteins to open, causing calcium to bind to the cytosolic end of the second, triggering more calcium to enter the cytosol through the second. The calcium spark is triggered by--for 10 points--what two calcium channels, one partially named after a toxin produced by Ryania, the other after a somewhat unsaturated nitrogen containing heterocycle?

ANSWER: in either order:

dihydropyridine receptors [or DHPR; or dihydropyridine channels; or DHP receptors; or DHP channels; or L-type calcium channels; or Cav1.1; or Cav1.2; or Cav1.3; or Cav1.4; prompt on calcium channels] AND

ryanodine receptors [or Ryr; or specific forms like Ryr1; prompt on calcium channels]

9. In 2003, a team headed by Sergey Deyev and Andreas Pluckthun developed an antibody multimerization system reliant on the interaction between some proteins produced by a bacteria in this genus. A bacteria in this genus produces a thiazole/oxazole-modified microcin ribosomal natural product called (-) plantazolicin. Several bacteria in this genus produce the Rhizoctonia solani suppressing lipopeptides fengycin and iturin A. Alan Fersht developed the method of (+) phi value analysis with his experiments with a protein produced by a bacteria of this genus. A bacterium in this genus produces a ribonuclease that is deadly to itself unless in the presence of a 89-amino acid inhibitor peptide that forms a notably tight complex. One bacteria of this genus produces a protein consisting of a single 110 amino acid peptide with no cis-prolines, no disulfide bonds and a reversible (*) folding transition, making it of interest in protein folding experiments. For 10 points, the amyloliquefaciens species of what genus produces barnase and the restriction enzyme BamHI?
ANSWER: Bacillus [accept Bacillus amyloliquefaciens]

10. A team lead by Shelley Copley discovered that when the pathway to produce this molecule is blocked, it can be synthesized anyway by coupling together three promiscuous reactions in a "serpentine pathway." Harmon (-) Dunathan proposed in reactions involving this molecule, HOMO-LUMO overlap is maximized by stereoelectronic effects that cause cleavage of a bond parallel to a pi system. Organisms which are able to biosynthesize this molecule contain either the (+) SOR1 or pdx genes, but not both, which correspond to the DXP-independent and DXP-dependent pathways of the biosynthesis of this molecule. While not TPP, this electrophilic cofactor stabilizes carbanionic intermediates. This cofactor forms an internal (*) aldimine with the epsilon-amino group of lysine, which can interact with amino acid substrates to form an external aldimine. For 10 points, many amino acid decarboxylations and all transamination reactions rely on what cofactor?
ANSWER: pyridoxal 5'-phosphate [or PLP; or P5P; prompt on vitamin B6]

11. A team headed by Jennifer Lippincott-Schwartz coined the term "RESET pathway" to describe a pathway triggered by the presence of proteins with this property. In a 2001 paper, Saborio, Permann and Soto developed a method of producing large amounts of proteins with this property, called (-) PMCA. The HIV protein Vpu induces a pathway which normally occurs in the presence of proteins with this property. Glycoproteins with this property are acted upon by (+) UGGT. In eukaryotes, proteins with this property can form bodies called JUNQ or IPOD. Within eukaryotes, EDEM removes proteins with this property from the (*) calnexin/calreticulin complex. Proteins with this property can aggregate to form an aggresome. Proteins with this property are targeted for ubiquitination in the pathway of endoplasmic-reticulum-associated protein degradation. For 10 points, the protein PrP^{Sc} is a form of PrP with what property?
ANSWER: misfolded proteins [or mutated proteins; or equivalent answers like proteins that are folded incorrectly; prompt on answers referring to prions with "prions have what property?"; do NOT accept or prompt on "unfolded" proteins or answers which otherwise refer to proteins which have not been folded]

12. In 2006, Zhou et al created a clustering and scoring strategy algorithm for identifying sites at which this molecule can form bonds. Infantile neuronal ceroid lipofuscinosis is the result in a mutation in an enzyme which acts upon this molecule. Many enzymes which catalyze the transfer of this molecule contain a (-) DHHC domain. Adding this molecule to the cysteine-3 and the cysteine-4 of GAP43 allows it to be attached to cell membranes. Synaptic formation is regulated partially by the removal and addition of this molecule to (+) PSD95. Attaching this molecule to SNAP25 allows it to be anchored to the cytosolic side of cell membranes. The post-translational attachment of this molecule to proteins is reversible, unlike the related molecules (*) farnesol, geranylgeranyl or myristic acid. The primary product of fatty acid synthesis is--for 10 points--what straight-chain unsaturated 16 carbon fatty acid?
ANSWER: palmitic acid [or palmitate; or hexadecanoic acid; or palmitoylation; or depalmitoylation; accept palmitoyl-Coenzyme A]

13. Kang et al. discovered a genetic element which they named E77 in this cell line that enhanced stable transgene expression. This cell line is resistant to poliovirus 2, Modoc virus, and buttonwillow virus. The Kyowa Hakko Kirin company knocked FUT8 out of this cell line as part of their “potelligent” platform for producing afucosylated (-) monoclonal antibodies. Peter Mazur developed his two-factor hypothesis of freezing damage from his work with this cell line. F10 and F12 are nutrient mixtures used to grow cells from this cell line. In 2011, a team lead by Bernhard Palsson and Jun Wang performed a genome sequencing of this cell line. In 1980, Urlaub and Chasin used EMS mutagenesis to produce the (+) DXB11 derivative of this cell line, which notably possess reduced dihydrofolate reductase activity. This cell line is notably proline deficient. Theodore (*) Puck created in 1957--for 10 points--what cell line, the most common to be used in the industrial production of recombinant proteins?

ANSWER: CHO-K1 [or Chinese Hamster Ovary; or other answers which contain “CHO” or “chinese hamster ovary” like CHO-DXB11]

14. A team lead by Richard Young discovered that the transcription factor Yin Yang 1 does basically the same thing this protein does. Ling et al discovered that this protein mediates an interchromosomal colocalization between Wsb1/Nf1 and a certain imprinting control region. Along with DMR1 and MAR3, the binding of this protein to the H19 imprinting control region represses expression of IGF2. This protein was first discovered by a team lead by Lobanenkov in 1990 after finding it binds to (-) CCCTC-motifs in chicken c-myc. While it is neither gypsy, nor beta-globin, this protein names a well-studied genomic (+) insulator. The homodimer of this protein can bind to DNA and induce loop formation. The complex of this protein and cohesin forms chromosomal loops called insulated neighborhoods. For 10 points, name this protein believed to demarcate the boundaries between (*) topologically-associating domains, with a four letter name.

ANSWER: CTCF [or CCCTC-binding factor until “CCCTC-motifs” is read]

15. A team lead by Lucas Pelkmans discovered that the activity of the kinase DYRK3 drives the reverse of this process by phosphorylating the mTORC1 inhibitor PRAS40. Phillip A Sharp proposed a model of transcriptional control in which this process drives the function of super-enhancers. A team lead by Gary Karpen demonstrated that, in Drosophila, heterochromatin protein 1 undergoes this process in vivo, driving heterochromatin domain formation. Low complexity intrinsically (-) disordered domains in proteins like UBQLN2 and hnRNPA1 allow them to undergo this process. This process drives the formation of cytoplasmic bodies called (+) P-bodies in the cytoplasm during mRNA processing and stress granules during cellular stress, more generally, it drives the formation of membraneless organelles. For 10 points, identify this process that occurs when a supersaturated solution of components spontaneously (*) separates into a denser liquid droplet component and a dilute component that stably coexist.

ANSWER: liquid-liquid phase separation [or liquid-liquid unmixing; or demixing; prompt on spinodal decomposition or nucleation or crystallization; prompt on aggregation or compartmentalization with “what physical process drives aggregation or compartmentalization?”]

16. A team lead by Daniel Mucida identified retinoic acid as a regulator of the induction of a type of cell named after this number. A team lead by Dan Littman discovered that, in mice, the presence of segmented filamentous bacteria stimulated the production of cells named after this number. Konimaya et al determined that a type of cell named after this number was responsible for the development of (-) experimental autoimmune encephalomyelitis in mice. The (+) psoriasis treatment brodalumab binds to a receptor whose name contains this number. The differentiation of cells into a type of cell which contains this number is controlled by ROR-gamma, as well as the TGF-beta IL-6 axis. The production of IL-6 and the interleukin of this number is promoted by IL-23. Basically all the signals that promote Treg differentiation inhibit the differentiation of a type of cell named after this number, and vice versa. For 10 points, helper T-cell lineages are divided into Th1, Th2, and a (*) pro-inflammatory lineage named after what number?

ANSWER: 17 [or Th17 cells; or T helper 17 cells; or interleukin-17; or IL-17]

17. The expression of this protein triggers an increase in the secretion of the thymine catabolism product 3-aminoisobutyric acid. A team lead by David Altshuler and Leif Groop determined that genes controlled by expression of this protein were downregulated in diabetes. A team lead by Johan Auwerx determined that activation of sirtuin-1 and this protein by the supposedly anti-aging drug resveratrol protected against metabolic disease. Along with ATF6-alpha, this protein coactivates the unfolded protein response in skeletal (-) muscle. Along with HNF4, the complex of FOXO1/FKHR and this protein stimulates hepatic gluconeogenesis in an insulin-dependent manner. This cold-inducible protein, which is notably expressed during exercise, is a powerful inducer of nuclear respiratory factor 1 and 2 expression. This protein is named for coactivating a protein sometimes called the (+) glitazone receptor. For 10 points, name this master regulator of (*) mitochondrial biogenesis.

ANSWER: PGC-1 α [or HAR20; or human accelerated region 20; or peroxisome proliferator-activated receptor gamma coactivator 1-alpha]

18. A team headed by Johannes Nimpf discovered that thrombospondin-1 binds to a receptor in a signalling pathway based on this protein. One of the fastest evolving human proteins, human accelerated region 1, is produced by the same cells which produce this protein. The Albany2 and Orleans mutations result in defects in this protein, which is misspliced in (-) Shaking rat Kawasaki. The signalling pathway controlled by this protein involves the binding of it to either the apolipoprotein E2 receptor or the very low density lipoprotein receptor. Liang Wang of the Cooper laboratory created an optogenetic system involving a regulator of the signalling of this protein called (+) Dab1/disabled-1. Along with doublecortin, this extracellular matrix glycoprotein regulates human neuronal migration. Cajal-Retzius cells produce--for 10 points--what protein named after the staggered (*) gait of mice in which it is knocked out?

ANSWER: reelin