

Virology and Immunology Packet

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1. In a highly unusual form of this process, the proteins UL31 and UL34 assemble into a complex that forms a hexameric lattice. PPXY, PTAP, and other L domain motifs recruit ESCRT ["ESCORT"] proteins to the site of this process, where some of them form filamentous spirals. Coronaviruses unusually perform this process in the cis (+) Golgi network, and herpesviruses undergo two rounds of it, once in the nucleus. The restriction factor tetherin, which interferes with this process, is antagonized by the HIV protein Vpu. This process is classified into four types denoted by Roman numerals, depending on whether it is driven by matrix proteins, the (*) Gag polyprotein, capsid proteins, or envelope proteins. This process is typically followed by scission at the neck and the membrane "pinching" off. For 10 points, name this process by which a newly-formed virus uses a host-derived membrane to form its own envelope, typically just as it's leaving the cell.

ANSWER: viral **budding** [or vesicular **budding**; prompt on vesicle formation or similar answers; be generous and prompt on answers like exit or egress before "Golgi" is read]

2. Combinatorial chemist Mario Geysen pioneered the idea of generating overlapping linear molecules to "map" these entities, a technique called Pepscan. The efficacy of the DTaP vaccine is limited by a phenomenon known as linked-[this word] suppression. These things can undergo (+) "spreading" in diseases like pemphigus vulgaris, by which previously hidden "cryptic" examples of them can be uncovered. Mutations in immunodominant examples of these sites is a major mechanism of immune evasion. These things are said to be conformational or discontinuous when they consist of far apart portions of the (*) amino acid sequence that are brought together by protein folding. Complementary determining regions in the variable domain bind to these specific sites. For 10 points, name this part of an antigen that is recognized by the immune system.

ANSWER: **epitopes** [or **antigenic determinants**; prompt on antigen until read]

3. Like a closely related, physically larger species, these organisms contain estradiol-dependent natural killer-like cells known as Kurloff cells. The complement protein C3 was first isolated from the heat-inactivated serum of this animal. This animal model most accurately mirrors (+) genital HSV-2 infection in humans. Though they show no overt symptoms of severe illness, these animals are naturally susceptible to influenza virus and are often used to characterize transmissibility of newly emerged strains. Like bats, these common laboratory animals have lost the ability to synthesize vitamin C. Microbiology research often uses the outbred (*) Hartley strain of this animal. Robert Koch tested his four postulates on these members of the genus *Cavia*. For 10 points, name these rodents whose name is synonymous with being a test subject.

ANSWER: domestic **guinea pigs** [accept *Cavia porcellus* before “Cavia” is read; accept domestic **cavy** before “Cavia” is read]

4. This is the type of cell most commonly analyzed by a technique that uses *E. coli* to biotinylate genetically-engineered protein monomers, then adds streptavidin to assemble them into tetramers. The active repression of the transcription factor ThPOK is required for “double (+) positive” cells to develop into these cells. A surface protein expressed primarily by these cells is a disulfide-linked heterodimer of α and β domains, each consisting of an extracellular immunoglobulin-variable-like domain anchored to the membrane by an extended polypeptide chain. Mucosal linings contain a cell population very similar to this one, known as intraepithelial lymphocytes, that unusually do not require (*) priming. These cells can be activated by either cross-presentation or by display of intracellular proteins by MHC Class I molecules. Like NK cells, these cells release granzysin, granzymes, and perforin. For 10 points, name these CD8-expressing T cells that destroy damaged cells.

ANSWER: **cytotoxic T** cells [or **killer T** cells; or **CD8 T** cells before “CD8”; accept “lymphocytes” in place of “cells”; prompt on **T** cells; prompt on **lymphocytes**, though that’s really pushing it]

5. One of this virus’s proteins undergoes a conformational change to its mature form by binding to insulin-degrading enzyme. In immunocompromised individuals, this virus causes progressive outer retinal necrosis, or PORN. Particles of this virus remain attached to plasma membranes in long rows called “viral highways” in cell culture, where this virus induces extensive (+) syncytia formation. In 2017, a recombinant vaccine containing this virus’s gE protein was approved in the U.S. for adults aged 50 and over, whereas its Oka/Merck strain is the basis for a vaccine given as a shot for kids between 12-15 months old followed by a (*) booster when they’re 4-6. The unusually poetic phrase “dewdrop on a rose petal” is often used to describe the rash caused by this virus. Following primary infection, this virus remains dormant in trigeminal or dorsal root ganglia and reactivates to cause shingles. For 10 points, name this member of the herpesvirus family that causes chickenpox.

ANSWER: **varicella zoster** virus [or human **herpesvirus 3**; or **VZV**; or **HHV-3**; I don’t think they’re ever referred to solely by these terms, but prompt on **varicella** or **zoster** alone]

6. Autoantibodies to the N-terminus of alpha-enolase are seen in most cases of a very rare condition in which this disease presents with encephalopathy. The amusingly-named EAT is a common mouse model for this disease. The transient inflammation of sphere-shaped (+) follicles caused by this disease is known by a portmanteau of this disease’s name and “toxicosis.” A key histological finding of this non-cancer disease are enlarged Hürthle cells that enclose more colloid than usual. Most people with this disease have high levels of autoantibodies to both Tg and the (*) peroxidase TPO. In countries with sufficient dietary iodine, this autoimmune disease is the most common cause of hypothyroidism. For 10 points, name this autoimmune thyroid disease first described by a namesake Japanese physician.

ANSWER: **Hashimoto’s** disease [or **Hashimoto’s** thyroiditis; or **chronic lymphocytic thyroiditis**]

7. The capsid protein of these viruses unusually cleaves itself from the structural polyprotein using its serine protease domain. This virus's TransFrame protein is produced by ribosomal frameshifting in the coding region of a gene encoding the 6K ion channel, which serves as the signal peptide for its E1 protein. It's possible to use naked RNA replicons of vectors engineered from several members of this genus, including (+) Venezuelan equine encephalitis virus, Semliki virus, and Sindbis virus. Like reoviruses, bunyaviruses, and flaviviruses, these viruses are arthropod-borne. This only genus in the family *Togaviridae* includes a virus that causes joint pain so severe that patients adopt a (*) stooped bent posture, which is why its name means "to become contorted" in the Makonde language in Tanzania. Chikungunya is caused by a member of, for 10 points, what genus of viruses known by a Greek letter?

ANSWER: **alphaviruses** [accept **Togaviridae** or **togaviruses** before mentioned; prompt on **arboviruses** before "arthropod"; prompt on positive-sense single strand **RNA viruses**; prompt on Baltimore **Class IV viruses**]

Note: I'm looking for an inherent molecular feature/property common to all the compounds described

8. Mutations at methionine 184 of a certain protein reduce susceptibility to compounds of this type, such as one that unusually contains one sulfur and one oxygen atom in a five membered ring, and is abbreviated 3TC. Two fluorine atoms are attached to the same carbon atom in a chemotherapy drug that is this kind of compound, gemcitabine. On March 23, 2020, (+) Gilead suspended access for compassionate use to a drug that is this type of compound, remdesivir. Many of these drugs are prodrugs that are activated via phosphorylation by the enzymes TK1 and TK2. The earliest treatment for (*) HIV, AZT, is a reverse transcriptase inhibitor that is this type of compound. In general, these compounds work by serving as chain terminators to stop viral DNA polymerases. For 10 points, name these antiviral compounds that mimic the monomer units of DNA.

ANSWER: **nucleoside analogs** [or **nucleotide analogs**; or things that **mimic nucleotides** or **nucleosides**; I guess prompt on **nucleosides** or **nucleotides**]

9. The laboratory of John P. Moore engineered the SOSIP.664 complex of this protein from the transmitted/founder strain BG505 to minimize the number of epitopes for non-neutralizing antibodies. The tendency of antibodies to target this protein's highly variable C3 region, bundles of six helices known as "stumps" left over from one of its domains, or other (+) immunodominant epitopes is a major challenge for vaccine design. The initial gene product of this protein is cleaved at its REKR site by the protein furin in the Golgi apparatus to produce its two major domains. The coding region for this protein's gene includes a response element for the protein Rev. The gene encoding this protein is intermediate in length between those of the two other structural proteins, (*) gag and pol. This protein is a trimer of gp41 and gp120, the latter of which simultaneously binds to either a CXCR4 or CCR5 co-

receptor as well as the CD4 receptor to trigger entry. For 10 points, name this protein on the surface of HIV, which is named for the outer phospholipid layer of many viruses.

ANSWER: **HIV env** [or the **envelope** protein of **HIV**; accept **gp41** or **gp120** before they are read; prompt on **env** or **envelope** with “of which virus?” before “HIV” is read, but accept them afterwards]

10. The oxysterol receptor EBI2 mediates the movement of certain cells to these regions. The constitutive expression of CXCL13 drives the formation of these areas. After being excluded from these regions, transitional T1 cells die within 2-3 days. This region contains (+) dendritic cells that are unusually *not* derived from hematopoietic stem cells. The GALT includes “isolated” examples of these structures throughout the intestines, as well as more prominent ones whose “associated epithelium” is interspersed with (*) M cells. Centroblasts become centrocytes as they migrate from the dark zone to the light zone within these structures, whose periphery is known as the mantle zone. Effector T cells named for these structures help drive the formation of germinal centers within them. For 10 points, name these areas within the cortices of lymph nodes where B cells are activated.

ANSWER: B cell **follicles** [or **germinal centers** before mentioned; prompt on **lymph nodes**]

11. Like the gB protein of the not-at-all related herpes simplex virus, a protein encoded by this virus contains a central coiled-coil domain in its postfusion state as the archetypal class III fusion protein. The sand fly *Lutzomyia shannoni* transmits this virus, which in the laboratory is often recovered from plasmids by using the vaccinia virus T7 RNA polymerase system to express its N, P, and L proteins, but not its M protein. Though the (+) New Jersey strain of this virus more often causes outbreaks, the Indiana strain is better-known due to its use in the lab. The live Ebola Zaire vaccine that was approved in 2019 is a genetically engineered form of this other virus. Apart from the lyssavirus that causes rabies, this is the best known member of the family *Rhabdoviridae*. The (*) G glycoprotein of this virus, which mainly infects pigs, horses, and cattle, is commonly used to pseudotype viral vectors. For 10 points, name this popular model virus which, as its name suggests, creates cavities and ulcers in the digestive tract.

ANSWER: **vesicular stomatitis** virus [or **vesicular stomatitis Indiana** virus; or Indiana **vesiculovirus**; or **VSV**; or **VSIV**]

Note: Description acceptable

12. This process is facilitated by a drop in pH, which triggers the unfolding of a Greek key motif, in a protein known as protective antigen. Different proteins can perform this activity in proteinaceous, cylindrical, or toroidal ways. The Φ -PVL prophage in the *S. (+) aureus* bacterial chromosome encodes a protein that has this activity, named for Philip Panton and Francis Valentine. Cathelicidins, defensins, and other cationic antimicrobial peptides work by performing this action. The *S. aureus* alpha-hemolysin and the anthrax toxin are part of a family of toxins named for the fact that they perform this action. The C9 complement

protein forms a (*) ring structure that performs this action as part of the membrane attack complex. The protein perforin does this action on target cells. For 10 points, describe this way by which many cells are lysed.

ANSWER: **formation of pores** [or anything suggesting that they're **making holes** in membranes; prompt on **lysis** before "lysed" by asking "by what method"; prompt on answers suggesting **killing cells** by asking "by what method"]

13. The lab of possible fraudster Andrea Cerutti described how intestinal bacteria trigger a form of this process by secreting the cytokine APRIL. This specific process is impaired in people who suffer an X-linked syndrome characterized by mutations in the gene encoding the CD40 ligand. This process is mediated by namesake (+) G-rich stretches of repetitive DNA located between the Jh segments and the C mu gene. The phosphorylation of STAT6 triggers a specific type of this process during the immune response to an allergen. This process results from enzymes like APE1 and UNG making single-strand breaks proximal to one another on opposite strands upstream of constant-region genes such that they're converted to (*) double-strand breaks, and is mediated by the enzyme AID, just like gene conversion and somatic hypermutation. For 10 points, name this mechanism by which a B cell changes which isotype of immunoglobulin it produces.

ANSWER: immunoglobulin **class switching** [or **isotype switching**; or **class switch** recombination; or **CSR**; or **isotypic commutation**]

14. A group of F4/80+ Cd11b+ macrophages migrate away from this organ to the thymus and spleen in order to mediate a phenomenon abbreviated ACAID. An autoimmune disease that affects this organ targets proteins such as S-antigen, IRBP, and recoverin. Trauma to this organ releases sequestered antigens to surrounding tissues, activating T cells which initiate an autoimmune response, in a (+) "sympathetic" condition in which this organ is "spared." Upon injury to the epithelium of a part of this organ, released IL-1 α induces apoptosis in some specialized fibroblasts here known as keratocytes. Tissue grafts do not induce rejection when placed in the anterior chamber of this immunologically privileged organ, part of which is inflamed in (*) uveitis. A high concentration of IgA, mucins, and lysozyme is released from the lacrimal ducts near this organ. For 10 points, name this organ that is partly inflamed in conjunctivitis, making it appear pink.

ANSWER: **eyes** [accept **cornea**; accept **retina**; accept **uvea** before "uveitis"; accept **anterior chamber** before "anterior chamber"; accept **conjunctiva** before "conjunctivitis"]

15. The antibody-drug conjugate T-DM1 delivers the drug mertasine, which inhibits microtubule formation, specifically to these structures. NY-ESO-1 is perhaps the best known protein that's expressed both in the testes and in these structures. In these structures, a significant amount of tryptophan is (+) depleted by the enzyme IDO to produce kynurenine. Cells in these structures undergo immunoediting during the "equilibrium phase," which follows the "elimination phase" and is followed by the "escape phase." Myeloid-derived

suppressor cells and (*) regulatory T cells contribute to the immunosuppressive microenvironment of these structures, which is enhanced by CTLA4, PD-1, and other targets of checkpoint inhibitors. CAR-T cells were designed to attack antigens in these structures. A “necrosis factor” is named after, for 10 points, what cancerous masses?

ANSWER: tumors [or neoplasms; or neoplasia; I guess accept cancer before “cancerous”; prompt on breast before “testes”]

16. This protein induces formation of syncytia in HEK293T cells even in the absence of proteases from the TMPRSS family. The antibody meplazumab was developed to disrupt potential interactions between this protein and CD147, or basigin. This protein contains an unexpected furin cleavage site in the boundary between its (+) S1 and S2 subunits. The laboratory of Florian Krammer at Mount Sinai designed a version of this protein containing only its receptor binding domain for use in a potential ELISA to detect seroconversion. This protein has more than ten times the affinity for angiotensin converting enzyme 2 receptor than analogous proteins from (*) related viruses. The cryo-EM structure of this protein was published on March 13, 2020, and already has 163 citations. For 10 points, name this protein that the SARS-Cov-2 virus uses to attach to cells.

ANSWER: SARS-CoV-2 spike protein [or the spike protein from Severe acute respiratory syndrome coronavirus 2; accept 2019 novel coronavirus or 2019-nCoV or “the new coronavirus” for the virus part; prompt on spike protein by asking what virus it’s from; prompt on answers that just mention “coronavirus” without specifying further; after “SARS-CoV-2” is read, just spike protein is needed; prompt on S protein until “S1” is read]

17. This virus encodes the serpin cytokine response modifier A, which inhibits production of caspase 1. Cytoplasmic inclusions caused by this virus are known as Downie bodies. In 2011, the Munich area suffered an outbreak of this virus after eight people (+) bought infected pet rats. The previous year, the CDC reported that a worker in a laboratory was infected by a sample of this virus stored in the freezer, in the first case of this viral infection in the history of the U.S. After observing an occasional activity performed by farriers, a physician took (*) samples of this virus from a pustule on the arm of Sarah Nelmes. This virus belongs to the same genus as the other famous viruses vaccinia and variola. Edward Jenner created a vaccine for smallpox using, for 10 points, what similar virus that is transferred to humans through contact with infected udders?

ANSWER: cowpox

18. The proto-oncogene SKI, short for Sloan Kettering Institute, represses transcription of genes mediated at the most upstream level by this protein. Production of this protein by epithelial cells induces some circulating T cells to express the heterodimeric integrin $\alpha E\beta 7$, converting them into tissue resident memory T cells. After this protein is synthesized, its long N terminal (+) prodomain is cleaved to form the latency associated peptide, which forms a complex with this protein and LTBP to tether it to the extracellular matrix. In the

mucosa, secretion of IL-5 and this cytokine drives class switching to IgA. It's not an interleukin, but this protein induces the differentiation of CD4+ T cells into both Th17 cells and regulatory T cells. In the canonical signaling pathway (*) named for this cytokine, it binds to its type II receptor, a constitutively active serine/threonine kinase, activating its type I receptor, which in turn phosphorylates proteins in the Smad family. Bone morphogenic protein is part of the superfamily of, for 10 points, what cytokine, named because it was found to suppress the immune response that leads to cancer growth?

ANSWER: **TGF- β** [or **transforming growth factor-beta**]