Please select the best choice from the alternatives, and circle the appropriate letter beside that answer.
Read all the answers BEFORE you choose one.

1. The practical problem with using injections of IL-2 cytokine to stimulate an anti-cancer response is that
   a. it is impossible to inject IL-2 because it provokes antibody responses
   b. it is too expensive to produce enough cytokine
   c. it stimulates complement activation
   d. it can provoke a systemic cytokine storm
   e. it induces global apoptosis

2. Scientists think that the levels of MHC polymorphism are so high in most vertebrate species because
   a. recombination rates are higher in this part of the genome
   b. there are error prone recombinases that generate polymorphisms in each generation
   c. this provides population diversity that prevents all individuals from being equally susceptible to an infection
   d. there are many horizontally infectious tumors that are known to exist
   e. the diversity encourages outbreeding within the species

3. There are people who are naturally resistant to HIV infection. This is because
   a. they carry a pre-formed anti-HIV antibody from birth
   b. HIV does not grow in some people's epidermal cells
   c. there are certain individuals who lack a functional co-receptor for HIV entry into the host cells
   d. there are some people who naturally make protease inhibitors
   e. there are some people who have pre-activated macrophages due to chronic infection

4. Vaccination to prevent HIV infections is challenging because
   a. the HIV antigens are not immunogenic
   b. HIV evade a host immune response by multiple shifts in antigenic display as a consequence of an error-prone polymerase
   c. HIV genes insert in the host genome and suppress all forms of immune responsiveness
   d. HIV is an intracellular pathogen
   e. all of the above are true (a-d)

5. The primary cellular targets of the HIV-1 virus infection are the
   a. CD45 positive cells
   b. CD8 positive cells
   c. **CD4 positive cells**
   d. CD19 positive cells
   e. None of the above

6. In the primary literature paper we read describing llama antibodies, phage display libraries were used for what purpose?
   a. To identify molecular motifs that can interact with an immobilized “bait” molecule
   b. To purify enzymes that phosphorylate target molecules
c. To block the role of proteins responsible for phosphatidylserine flipping across a membrane
d. To capture all of the antigens associated with dandruff-producing disease
e. None of the above

7. Which of the following therapies would NOT be likely to enhance graft survival in graft recipients?
   a. Total lymphoid irradiation
   b. Immunosuppressive drugs
   c. Elimination of passenger leukocytes from the transplanted tissue
d. Blocking monoclonal antibodies (against IL-2R, for example)
e. **Adjuvant therapy**

8. Apoptosis ordinarily serves to prevent the development of an autoimmune response to the dying cells. This is because:
   a. The apoptosis of macrophages will limit their ability to present antigen
   b. Apoptotic cell death eliminates the inter-digital tissues in the hands of the fetus
c. **Apoptosis prevents the release of immunogenic intracellular antigens that would promote inflammation**
d. Antibodies to the Fas ligand and receptor are formed
e. Necrosis follows the apoptotic process

9. The generalized lymphoproliferative disease mutation (also known as the FasL<sup>Gld</sup> mutation) in mice results in both the inability of lymphocytes to properly undergo apoptosis and
   a. Persistent autoimmune hemolytic anemia
   b. **Cell death through necrosis, resulting in leakage of intracellular molecules and a lupus-like phenotype**
c. The onset of graft versus host disease
d. The development of antibodies against FasL
e. Both b and d

10. Autoimmune disease can be induced by
    a. Environmental antigens with structural similarity to self antigens
    b. Drugs that produce slight modification in self antigens
    c. Mutation of genes that regulate the potential for lymphocytes to undergo Fas-mediated apoptosis
d. Polyclonal activation of B cells
e. **All of the above**

11. A patient with an MHC class II deficiency (an example is the Bare Lymphocyte syndrome)
    a. will experience decreased viral susceptibility
    b. will have an excess of activated complement that binds to MHC class II<sup>+</sup> cells
c. **will experience declines in T<sub>H</sub>/APC interactions and a resulting immunodeficiency**
d. will develop an autoimmune disease called Bare Lymphocyte Adenopathy (BLA)
e. will have decreased insulin levels

12. Antibody-drug conjugates are valuable therapeutics for the treatment of cancer because
    a. They kill antibody producing cells
b. They can specifically target tumor antigen-expressing cells, reducing the necessary concentration of toxin to be used
c. They are less expensive than conventional antibodies
d. They do not bind neoplastic cells.
e. All of the above

13. Xenogeneic grafts
   a. can survive in most individuals
   b. are readily rejected by immunocompetent individuals
   c. are grafts between individuals of the same species
   d. are skin graft exchanges to the same site on donor and recipient
   e. all of the above

14. Hyperacute graft rejection is caused by
   a. the presence of cytokines that initiate a cytokine storm
   b. pre-existing antibodies that can immediately activate complement and damage the transplanted tissues and their blood vessels
   c. proto-oncogene conversion to oncogenes
   d. failure to revascularize the grafted tissue due to genetic defects in angiogenesis
   e. activation of CD4 cells

15. Graft versus host disease (GVHD) relies on what cells to develop?
   a. Passenger leukocytes brought along with the transplanted tissues
   b. Virally infected cells.
   c. Engrafted cells that synthesize complement.
   d. Activated neuronal cells.
   e. Immunosuppressed cells.

16. Tasmanian devils can horizontally transmit an oral tumor from one devil to another through bites. The cellular exchange from the donor devil successfully grows in the recipient devil due to:
   a. The composition of Tasmanian devil DNA, which allows for tumor DNA to easily be transmitted into the recipient devil.
   b. The bites on the face of the devils increases the likelihood of infection, and often the uptake of the virus that transmits the cancer
   c. The genetic predisposition of Tasmanian devils to cancer
   d. The limited MHC polymorphism in Tasmanian devils
   e. Both b and c

17. RNA dependent DNA Polymerase is used to
   a. Excise viral DNA from host DNA
   b. Transcribe cDNA from mRNA
   c. Translate cDNA to protein
   d. Transcribe mRNA from cDNA
   e. None of the above
18. The Ames Assay can be used to detect mutations caused by chemicals that
   a. cause genome-wide deletions
   b. cause changes similar to those found in teratocarcinomas
   c. induce mutations in Salmonella typhimurium that result in histidine operon reversions
   d. are known to be carcinogenic
   e. none of the above

19. Toll-like receptors (TLRs) are
   a. molecules that regulate the passage of cells from the vasculature into the tissues by
      assessing a molecular “toll” on their movement
   b. receptors that are responsible for the detection of olfactory chemosignals
   c. pattern recognition receptors that identify classes of signals often associated with infection
   d. the evolutionary predecessors of the cytokine molecules
   e. all of the above

20. At the conclusion of the expansion phase of an immune response, there is a shrinkage in both T and
    B cell numbers. The shrinkage in an antigen-specific pool of B cells is thought to depend upon
    mechanisms described as the
    a. Complement Cascade
    b. Ames Protocol
    c. anti-idiotypic responses described by the Jerne Network hypothesis
    d. Kohler and Milstein phenomenon
    e. Janeway effect

21. In the graph shown below, cells were analyzed by flow cytometry. What is true about the graphed data?

   a. The cells all express similar levels of CD8α and CD11b
   b. There are two major populations that each express one of the two antigens
   c. There are two major populations that each express equal amounts of CD8α
   d. The analyzed cells express 4 different fluorescent colors
   e. the size and granularity of the analyzed cells is not uniform

22. Polyclonal activation of lymphocytes can be accomplished by culturing these cells with the
    appropriate lectin or with LPS. This activation is used as a surrogate for what kind of natural
    response?
   a. This response is thought to mimic the individual proliferative responses of single
      antigen-specific clones of lymphocytes
   b. This response is thought to mimic the phagocytic activities of dendritic cells
   c. Polyclonal activation simulates the formation of immune complexes in plasma or serum
   d. Polyclonal activation is a substitute for the activation that would occur after complement
      dependent, antibody mediated cytotoxicity
   e. All of the above (a through d) are correct
23. What effect might the injection of soluble CD4 molecule have on the immune system of an AIDS patient?
   a. It might serve to prevent the attachment of mature HIV-1 viral particles to the helper T cell membrane.
   b. It might bind to CXCR4 chemokine receptors and initiate chemotaxis.
   c. It might bind to CD3 molecules and activate T cell function.
   d. All of the above.
   e. None of the above.

24. The BcR found on B cells and the TcR found on T cells share common molecular motifs beyond the shared ability to interact with antigen. One of these shared characteristics is:
   a. they can both activate complement
   b. they can both provoke phagocytosis
   c. they can both block NK cell activation
   d. they both have hydrophobic transmembrane domains
   e. none of the above (a-d) is true

25. In the graph shown below, lymphocytes from Tasmanian Devils were mixed with lymphocytes of other Tasmanian Devils (noted as the MLR-Devils columns), or were cultured with ConA (noted as the ConA-Devils columns) in an MLR assay. Which of the following is true about the data shown?
   a. The assay shows that there is no significant stimulation of Devil lymphocytes co-cultured with lymphocytes from other Devils when cultured in an MLR
   b. The data shows that Devil lymphocytes cannot respond to Concanavalin A.
   c. The data shows that the immune response to tumors is primarily T cell based
   d. The data shows that Devils are highly polymorphic for CD8 antigens
   e. The data shows that Devils have a robust antibody synthesis capacity.

26. There are naturally occurring camel and llama antibodies that are
   a. covalently bound to Ricin A and B chains
   b. heptameric antibodies
   c. able to differentiate structures at a sub-atomic level
   d. able to withstand elevated temperatures and other denaturing conditions
   e. found in commercially produced shampoos
27. Autoimmune disease has been treated experimentally by giving a lethal dose of irradiation, followed by injection of bone marrow from a healthy donor. How would you monitor the success of the transplanted material in the regeneration of the immune response in the irradiated host?
   a. Measure the ability of cells from the peripheral blood of the patient to proliferate in response to stimulation with lectin.
   b. Measure the levels of circulating antibody.
   c. Count the number of circulating lymphocytes in the peripheral blood.
   d. All of the above (a-c).
   e. none of the above (a-c).

28. Neoplasia requires that cells develop the capacity to exceed the Hayflick limit. One way to do this is by increasing the level of an enzyme that maintains chromosome stability. This enzyme is
   a. caspase
   b. aspartame
   c. telomerase
   d. invertase
   e. DNAse

29. Proto-oncogenes are
   a. genes that have mutated to elicit a cancerous phenotype in a cell
   b. the normal forms of genes that can mutate in ways that elicit cancer formation
   c. the prototypes of CD45 molecules
   d. the genes found in early evolution that produce the complement-like proteins
   e. all of the above

30. Ricin is a product of the castor bean plant that can kill cells
   a. by the effect of Ricin B subunit to activate the membrane attack complex of the complement cascade
   b. by the effect of the lethal factor encoded by a plasmid
   c. by the activation of CTL specific for the Ricin B bound to the plasma membrane
   d. by the change in osmotic pressure when the cells are put in saline solution
   e. by the cleavage of ribosomal RNA in the 60s subunit

31. In the collagen-induced arthritis (CIA) mouse model of the human disease rheumatoid arthritis, injection of the stress response protein metallothionein had which of the following effects?
   a. Up-regulation of TNF-alpha and increased incidence of arthritis
   b. Down regulation of the cox-2 gene and decreased incidence of arthritis
   c. No effect on arthritis alone, but acted synergistically with cox-1/cox-2 inhibitors to decrease arthritis
   d. Chronic stimulation of CD4+ T cells and a chronic progression of the disease process
   e. Up-regulation of antigen presentation and a faster disease onset

32. Which is an example of a secondary (2⁰) immunodeficiency?
   a. HIV infection leading to reductions in CD4 numbers
   b. LYST defect in lysosomal storage granules resulting in NK cell functional defects
   c. Rag 1/Rag 2 knockouts resulting in no T or B cells
   d. FoxN1 mutation leading to an athymic mouse and no T cells
   e. MHC II defect leading to bare lymphocyte syndrome
33. Carcino-embryonic antigens are
   a. antigens found on all tumors
   b. **antigens that can be expressed on a specific normal cell population**
   c. antigens expressed in the Tasmanian Devil facial tumor
   d. antigens found on erythrocyte lineages
   e. antigens synthesized by viral genes

34. Animal models of immunodeficiency
   a. can be used to determine the effect of a single gene disruption on specific immune functions
   b. can be used to produce an animal in which cancer cells can be grown
   c. can have the same fundamental genetic defect as human forms of immunodeficiency
   d. can have increases in some forms of neoplasia
   e. **all of the above**

35. In order for a cytotoxic T lymphocyte (CTL) to kill an infected target cell, which two requirements must be met to satisfy the dual recognition phenomenon discovered by Zinkernagel and Doherty? The T cell receptor will have:
   a. Specificity for the extracellular bacterial antigen and MHC class I haplotype
   b. Specificity for the extracellular bacterial antigen and MHC class II haplotype
   c. **Specificity for the viral antigen and MHC class I haplotype**
   d. Specificity for the viral antigen and MHC class II haplotype
   e. Specificity for any foreign antigen and antibody class

36. Type IV hypersensitivity
   a. **can result in a localized inflammation when plant resins from poison ivy activate macrophages and T helper cells**
   b. results in the complement mediated lysis of cells
   c. provides a protective response against viral antigens
   d. results in hyperproliferative responses
   e. **All of the above**

37. Complement deficiency
   a. Results in a decrease in CD4+ cells
   b. Has no serious effects on immune function because other immune mechanisms can substitute for this deficiency
   c. Causes an increase in the incidence of neoplasia
   d. **Can result in increased susceptibility to bacterial infection**
   e. None of the above

38. Predict the result of treatment with a drug that blocks calcineurin dephosphorylation of NF-AT
   a. this treatment would suppress complement activation
   b. this treatment would enhance NK cell activation
   c. this treatment would increase renal damage due to immune complex accumulation
   d. **this treatment would diminish acute types of graft rejection**
   e. all of the above are true (a-d)
39. Which of the following diseases is characterized by autoimmune destruction of pancreatic islets?
   a. Systemic lupus erythematosus  
   b. Rheumatoid arthritis  
   c. **Type I diabetes**  
   d. Type II diabetes  
   e. None of the above

40. Which of the following cell types are typically the first cells to migrate to a site of tissue injury?
   a. T cells  
   b. B cells  
   c. NK cells  
   d. **Neutrophils**  
   e. Basophils

41. Which of the following diseases is characterized by formation of antibodies against DNA and chromatin?
   a. **Systemic lupus erythematosus**  
   b. Rheumatoid arthritis  
   c. Type I diabetes  
   d. Type II diabetes  
   e. All of the above

42. Which of the following describes an experimental model for Type II diabetes?
   a. **Mice fed a high-fat diet**  
   b. Mice fed a high-sugar diet  
   c. Adoptive transfer of CD45+ cells from a healthy mouse to a SCID mouse  
   d. NOD mice that spontaneously develop diabetes  
   e. Mice administered an anti-CD4 antibody

43. The Ames assay directly measures the _________ of a compound.
   a. Immunogenicity  
   b. **Mutagenicity**  
   c. Carcinogenicity  
   d. Cytotoxicity  
   e. All of the above

44. Which of the following human mutations may result in protection from HIV infection?
   a. Gp41  
   b. Gp120  
   c. CCR5  
   d. CXCR4  
   e. **C or D**
45. What is direct allorecognition of transplanted tissue?
   a. **Host recognition of a grafted tissue that involves donor antigen presenting cells**
      leaving the graft, migrating via the lymph to regional lymph nodes, and activating
      host T cells bearing the corresponding T-cell receptors
   b. Donor recognition of a grafted tissue that involves recipient antigen presenting cells leaving
      the graft, migrating via the lymph to regional lymph nodes, and activating recipient T cells
      bearing the corresponding T-cell receptors
   c. Recognition of a grafted tissue that involves the uptake of donor allogeneic proteins by the
      recipient’s antigen-presenting cells and their presentation to T cells by self MHC molecules
   d. Recognition of a grafted tissue that involves the uptake of recipient allogeneic proteins by
      the donor’s antigen-presenting cells and their presentation to T cells by self MHC molecules
   e. Graft recognition of the host antigen display

46. What is indirect allorecognition of transplanted tissue?
   a. Host recognition of a grafted tissue that involves donor antigen presenting cells leaving
      the graft, migrating via the lymph to regional lymph nodes, and activating host T cells bearing
      the corresponding T-cell receptors
   b. Donor recognition of a grafted tissue that involves recipient antigen presenting cells leaving
      the graft, migrating via the lymph to regional lymph nodes, and activating recipient T cells
      bearing the corresponding T-cell receptors
   c. **Recognition of a grafted tissue that involves the uptake of donor allogeneic proteins**
      **by the recipient’s antigen-presenting cells and their presentation to T cells by self**
      **MHC molecules**
   d. Recognition of a grafted tissue that involves the uptake of recipient allogeneic proteins by
      the donor’s antigen-presenting cells and their presentation to T cells by self MHC molecules
   e. Graft recognition of the host antigen display

47. ________ involves genetic modification of patient’s autologous T-cells to express a specific
    receptor specific for a tumor antigen, followed by *ex vivo* cell expansion and re-infusion back to the
    patient to treat cancer.
    a. Oncolytic virus therapy
    b. Patient-derived xenograft therapy
    c. CD34+ hematopoietic progenitor therapy
    d. Adoptive T cell transfer therapy
    e. **Chimeric antigen receptor T (CAR-T) cell therapy**

48. What is an epitope?
   a. An antigen that is too small to be recognized by a T or B cell receptor
   b. A large protein that allows an antigen to meet the structural requirements to elicit an
      immune response
   c. **The region of an antigen that is recognized by an antibody**
   d. A conjugate of an antigen and a carrier protein
   e. A large synthetic polymer
49. Which regions of the antibody form the antigen combining site?
   a. The constant and variable regions of the heavy chains (CH and VH)
   b. The constant and variable regions of the light chains (CL and VL)
   c. The variable regions of the heavy and light chain (VH and VL)
   d. The entire light chain (CL and VL) plus the variable region and constant region 1 of the heavy chain (CH1 and VH)
   e. All regions of the antibody are required for antigen binding

50. A congenic strain of mice carries a distinct allele at the differential locus that distinguishes this strain from the reference background strain to which it will be compared. Are there any other differences between the two strains?
   a. No, otherwise they are identical
   b. Yes, the congenic and reference strain will differ by an inserted transgene.
   c. Yes, there are loci that are not separated from the differential locus by recombination during the production of the congenic strain
   d. Yes, the mice differ from each other by a series of accumulated mutations to immunoregulatory genes across the entire genome
   e. None of the above answers describes the relationship between a congenic and its reference background strain.

EXTRA CREDIT QUESTIONS

51. Signaling through the TcR initiates a cascade that relies upon multiple enzymatic steps. Biochemical events that occur during the signal transduction cascade include:
   a. protein kinase activation
   b. protein tyrosine phosphatase activation
   c. IL-2 activation
   d. nuclear factor relocation to the nucleus
   e. all of the above (a-d) are true

52. If a patient suffering from agammaglobulinemia (the absence of secreted Ig in the serum) developed an intracellular bacterial infection, what immunological mechanism could the patient use to eliminate the infection?
   a. classical complement fixation and activation
   b. induction of CTLs
   c. production of cytokines
   d. generation of IgG to bind and opsonize the bacteria
   e. none of the above