NEET PG Microbiology Sample Paper-10

Duration: 15 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **20** Multiple Choice Questions.
- Each correct answer carries **+4** mark. Incorrect answer: **−1** marks. Only **one** correct option.
- Unattempted questions carry **0** marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. A 57-year-old male presents with a painless indurated ulcer on his penis. Dark-ground microscopy of the scraping reveals motile, corkscrew-shaped spirochetes. Which of the following components of the cell wall structure is responsible for the characteristic motility of this organism?

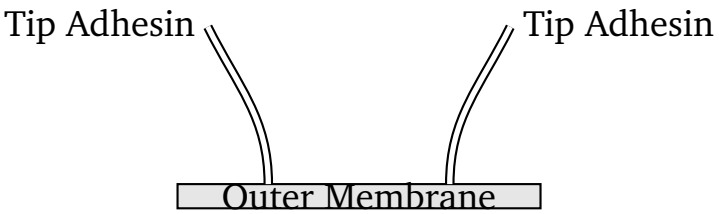
(A) Alternating units of N-acetylglucosamine and N-acetylmuramic acid

(B) Endoflagella located in the periplasmic space between the outer membrane and peptidoglycan

(C) Lipopolysaccharide layer with a highly variable O-antigen chain

(D) Lipoteichoic acid anchors extending deep into the cytoplasmic membrane

Q2. A 28-year-old female presents with acute dysuria, urgency, and increased urinary frequency. A urine culture grows Gram-negative bacilli that produce pink colonies on MacConkey agar and are indole-positive. What is the mechanism of action of the structural component shown below that allows this organism to ascend the urinary tract?



(A) Binding of mannose-resistant fimbriae (P pili) to digalactoside receptors on uroepithelial cells

(B) Injection of effector proteins via a Type III secretion system to induce membrane ruffling

(C) Degradation of secretory IgA at the mucosal surface by a specific zinc metalloprotease

(D) Hydrolysis of urea to elevate local pH and form struvite micro-calculi

Q3. An infant born at 36 weeks of gestation develops a high-grade fever, irritability, and neck stiffness within 48 hours of birth. A lumbar puncture shows purulent cerebrospinal fluid with Gram-positive coccobacilli. The causative pathogen exhibits tumbling motility at 25°C but is non-motile at 37°C. Which of the following virulence factors is crucial for this organism to escape the phagosome after entering host cells?

(A) Poly-D-glutamic acid capsule that inhibits opsonization

(B) Phospholipase C and a cholesterol-dependent pore-forming hemolysin

(C) IgA1 protease that cleaves mucosal antibodies

(D) Filamentous hemagglutinin that binds to integrins on ciliated epithelium

Q4. A 35-year-old intravenous drug user is admitted with a high-grade fever and a new systolic murmur. Echocardiography reveals large, friable vegetations on the tricuspid valve. Blood cultures turn positive within 14 hours. The isolated organism is a Gram-positive coccus that is catalase-positive and coagulase-positive. Which component of this organism's cell wall specifically binds to the Fc portion of IgG, preventing opsonophagocytosis?

(A) Clumping factor A

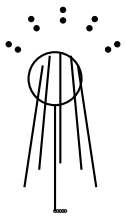
(B) Protein A

(C) Fibronectin-binding protein

(D) Teichoic acid

Q5. A 50-year-old patient undergoing intensive chemotherapy for acute myeloid leukemia develops fever and a cough productive of sputum mixed with

blood. A chest CT scan reveals a nodule with a surrounding halo of ground-glass opacification (halo sign). Tissue biopsy demonstrates dichotomously branching, septate hyphae at an angle of approximately 45°. Which structural configuration matches the reproductive conidiophore of the causative organism?



(A) A flask-shaped vesicle with phialides covering the upper two-thirds, producing chains of globose conidia

(B) A branching tree-like structure forming clusters of blastoconidia from fragile pseudohyphae

(C) A spherical sporangium filled with endospores anchored by root-like rhizoids

(D) A multi-septate, spindle-shaped macroconidium with thick, echinulate cell walls

Q6. A 60-year-old male with a history of poorly controlled type 2 diabetes mellitus is brought to the emergency department with an acute, painful black necrotic eschar on his nasal bridge and palate. Histopathological evaluation of the scraped tissue reveals broad, ribbon-like, aseptate hyphae branching at right angles (90°). What is the primary therapeutic mechanism required to manage this infection?

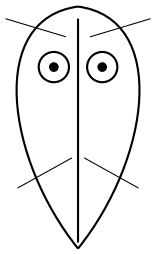
(A) Inhibition of 1,3-β-D-glucan synthase in the cell wall

(B) Binding to ergosterol in the fungal cell membrane, creating transmembrane pores

(C) Inhibition of squalene epoxidase to disrupt lanosterol synthesis

(D) Competitive inhibition of thymidylate synthase to block nucleic acid synthesis

Q7. A 29-year-old male returns from a 2-month trekking trip in a rural tropical region. He complains of a 3-week history of abdominal bloating, foul-smelling, greasy diarrhea, and significant flatulence. Microscopic examination of a stool sample reveals a characteristic structure with two nuclei, four pairs of flagella, and a large ventral sucking disk. Which of the following represents the correct morphologic description of this stage of the parasite?



(A) A motile, pear-shaped trophozoite showing a bilateral symmetry resembling an old man with glasses

(B) A non-motile, oval cyst containing four nuclei and retracted flagella fibers

(C) An elongated, crescent-shaped tachyzoite with a prominent central nucleus and a conoid tip

(D) A flagellated promastigote with a single kinetoplast situated anterior to the nucleus

Q8. A tissue biopsy obtained from a chronic subcutaneous lesion on the foot of a 40-year-old farmer shows brown-pigmented, thick-walled, round fungal cells clustered together. These cells divide by internal septation (medlar bodies or copper pennies) rather than budding. This finding is highly pathognomonic for which of the following clinical entities?

(A) Mycetoma

(B) Chromoblastomycosis

(C) Sporotrichosis

(D) Rhinosporidiosis

Q9. A 30-year-old man presents with a localized skin rash on his chest. On physical examination, there are well-demarcated hypopigmented macules

with fine scaling. A scraping of the lesion is treated with 10% KOH and shows a classic "spaghetti and meatballs" appearance under the microscope. Which of the following statements accurately characterizes the causative pathogen?

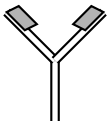
(A) It is a dimorphic fungus that requires a temperature shift to 37°C to convert to a yeast form

(B) It forms a distinct capsule composed of glucuronoxylomannan that excludes India ink

(C) It induces a granulomatous delayed-type hypersensitivity reaction involving CD4+ T cells

(D) It is a lipophilic yeast that requires the addition of olive oil or medium-chain fatty acids for growth in culture

Q10. During a routine prenatal screening, a 24-year-old pregnant woman is evaluated for a panel of viral infections. The laboratory reports the presence of high-affinity antibodies that can cross the placenta to provide passive immunity to the fetus. Which structural configuration represents the antibody class responsible for this specific transfer?



(A) A dimeric structure held together by a joining (J) chain and a secretory component

(A) A basic monomeric structure containing two heavy γ chains and two light chains

(A) A pentameric macro-globulin framework featuring ten antigen-binding sites

(A) A monomeric structural layout with extra constant domains (C_H4) that binds tightly to mast cell surfaces

Q11. A 4-year-old child presents with recurrent, severe pyogenic bacterial infections caused by Streptococcus pneumoniae and Staphylococcus aureus.

Laboratory investigations reveal normal counts of B cells and T cells, but serum levels of IgG, IgA, and IgE are profoundly low, while IgM levels are markedly elevated. A defect in which of the following molecular interactions is responsible for this phenotype?

(A) Binding of CD40 ligand (CD154) on activated T cells to CD40 on B cells

(B) Signaling through the Bruton tyrosine kinase (BTK) downstream of the pre-B cell receptor

(C) Cleavage of the leader sequence during VDJ recombination by RAG-1/RAG-2 endonucleases

(D) Interaction between CD28 on T cells and B7-1/B7-2 (CD80/CD86) on antigen-presenting cells

Q12. An experimental animal model is developed to evaluate the kinetics of the primary immune response. Following a single exposure to a novel protein antigen, there is a distinct lag phase before antibodies are detected in the serum. Which of the following cellular events occurs first during this lag phase?

(A) Somatic hypermutation within the germinal centers of secondary lymphoid organs

(B) Processing and presentation of antigen fragments via MHC Class II molecules by dendritic cells

(C) Isotype switching from IgM production to high-affinity IgG production

(D) Differentiation of memory B cells into long-lived bone marrow plasma cells

Q13. A 34-year-old male undergoes a tuberculin skin test (Mantoux test) as part of a pre-employment hospital screening. After 48 hours, a firm, indurated area measuring 18 mm in diameter is noted at the injection site. Which pair of cytokines and cell types coordinates the primary mechanism driving this cutaneous presentation?

(A) IL-4 and IL-5, mediated primarily by eosinophils and Th2 cells

(B) IL-17 and IL-22, mediated primarily by neutrophils and Th17 cells

(C) IL-10 and TGF-β, mediated primarily by regulatory T cells (Tregs)

(D) IFN-γ and TNF-α, mediated primarily by macrophages and Th1 cells

Q14. A patient presents with recurrent episodes of angioedema triggered by minor trauma or emotional stress. Laboratory testing indicates exceptionally low functional levels of the C1 esterase inhibitor (C1-INH). Unchecked activation of which complement component or pathway sequence directly leads to the excessive generation of vasoactive mediators in this disease?

(A) Continuous cleavage of C3 by the alternative pathway C3 convertase ($C3bBb$)

(B) Unregulated activation of C1, leading to the consumption of C4 and C2

(C) Accelerated formation of the membrane attack complex ($C5b-9$) on host cell membranes

(D) Overproduction of properdin, which stabilizes the fluid-phase C5 convertase

Q15. A 6-month-old male infant presents to the pediatric clinic with a 3-day history of low-grade fever, wheezing, tachypnea, and a persistent, harsh cough. Physical examination reveals intercostal retractions and diffuse bilateral expiratory wheezes. A rapid antigen test confirmed Respiratory Syncytial Virus (RSV) infection. What is the fundamental genomic and structural architecture of this virus?

(A) Enveloped, linear, single-stranded, negative-sense, non-segmented RNA virus

(B) Non-enveloped, segmented, double-stranded RNA virus with a double-layered capsid

(C) Enveloped, single-stranded, positive-sense, diploid RNA virus with reverse transcriptase

(D) Non-enveloped, linear, single-stranded, positive-sense RNA virus

Q16. A 40-year-old male presents with chronic fatigue, anorexia, and mild right upper quadrant abdominal discomfort. Serological markers show positive HBsAg, positive anti-HBc IgG, and negative anti-HBs. His serum HBV DNA level is 5×10^6 copies/mL. Which of the following replication steps unique to the Hepadnaviridae family occurs inside the capsid during the assembly of new viral particles?

(A) Direct translation of genomic positive-sense RNA into a giant polyprotein precursor

(B) Reverse transcription of a greater-than-genome-length pregenomic RNA template into negative-strand DNA

(C) Splicing of viral mRNAs by host cell nuclear spliceosomes to generate distinct structural transcripts

(D) Excision of viral DNA from the host chromosome mediated by a viral integrase enzyme

Q17. A 10-year-old boy is brought to the emergency department because of difficulty swallowing, painful muscle spasms in his neck, and profound hydrophobia. His parents mention that he was scratched by a stray dog while playing in the woods 6 weeks ago. If a brain biopsy were performed postmortem, which of the following cytopathic structural configurations would be observed within the cytoplasm of the Purkinje cells of the cerebellum?

(A) Large, round-to-oval, eosinophilic cytoplasmic inclusion bodies (Negri bodies)

(B) Cowdry A eosinophilic nuclear inclusions with a surrounding clear halo

(C) Basophilic intranuclear inclusions resembling an "owl's eye" appearance

(D) Multinucleated giant cells containing syncytia with both nuclear and cytoplasmic inclusions

Q18. A 23-year-old medical student develops a sudden onset of high fever, severe retro-orbital pain, generalized myalgia ("breakbone fever"), and a maculopapular rash 5 days after returning from a tropical research assignment.

Laboratory testing confirms infection with Dengue virus. Which of the following cellular receptors is primarily used by this virus to gain entry into host monocytes and macrophages, especially during a secondary infection with a heterologous serotype?

(A) CD4 receptor interacting with viral envelope glycoproteins

(B) Fc receptors binding to non-neutralizing IgG-virus complexes

(C) Sialic acid residues on host cell surface glycoproteins

(D) Integrin $\alpha_v\beta_3$ receptors interacting with capsid proteins

Q19. A 72-year-old nursing home resident presents with a sudden onset of high fever, severe chills, non-productive cough, and profound generalized myalgia. A rapid molecular test is positive for Influenza A virus. The patient is prescribed oseltamivir. Which specific viral process is targeted and inhibited by this therapeutic agent?

(A) Uncoating of the viral genome within the endosome by blocking the M2 proton channel

(B) Binding of hemagglutinin to host cell sialic acid receptors to block viral attachment

(C) Cleavage of sialic acid residues by neuraminidase to prevent the release of progeny virions from the host cell

(D) Initiation of viral transcription by inhibiting the cap-snatching endonuclease activity of the polymerase complex

Q20. A 24-year-old female presents with acute dysuria and painful, clustered vesicular lesions on an erythematous base on her bilateral labia majora. Tzanck smear of the vesicle fluid shows multinucleated giant cells with acantholysis. Which of the following patterns correctly describes the mechanism of latency used by this causative pathogen?

(A) Integration of viral double-stranded DNA directly into the host chromosome of CD4+ T helper cells

(B) Maintenance of the viral genome as a circular episome within the nuclei of sensory nerve ganglia

(C) Persistent, low-level replication and budding within vascular endothelial cells without causing cytolysis

(D) Sequestration of viral negative-sense RNA complexes inside memory B lymphocytes

Detailed Solutions

Q1.

Solution

Concept: Spirochetes possess a unique structural layout for locomotion that distinguishes them from classic flagellated bacteria. Understanding the location and composition of this flagellar apparatus is a high-yield microbiological concept for identifying Treponema pallidum infections under dark-ground illumination.

Solution:

(a) Treponema pallidum is the causative spirochete of syphilis, which clinically manifests as a painless, indurated genital ulcer known as a hard chancre.

(b) Unlike conventional Gram-negative bacilli that possess external flagella projecting into the surrounding medium, spirochetes contain axial filaments known as endoflagella.

(c) These endoflagella are structurally anchored to the cell poles and reside entirely within the periplasmic space, which is situated between the rigid peptidoglycan layer and the outer membrane.

(d) The rotation of these periplasmic flagella forces the entire flexible cell body to twist, creating a distinct corkscrew-like, twisting, or undulating motility pattern.

(e) This internal motor configuration allows the fragile spirochete to drill through viscous extracellular matrices, mucosal surfaces, and intercellular junctions, enabling rapid systemic dissemination.

(f) Alternative components like standard lipopolysaccharides or teichoic acids contribute to outer membrane structure or cellular adherence but do not provide active mechanical locomotion.

Final Answer: Endoflagella located in the periplasmic space between the outer membrane and peptidoglycan

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept: Uropathogenic Escherichia coli (UPEC) utilizes specialized surface structures to colonize host tissues and resist physical clearance mechanisms. Differentiating the function of specific virulence factors like fimbriae is essential for understanding the pathogenesis of ascending urinary tract infections.

Solution:

(a) The clinical picture describes an acute lower urinary tract infection (cystitis) caused by Escherichia coli, confirmed by its pink (lactose-fermenting) colonies on MacConkey agar and positive indole test.

(b) The schematic diagram highlights filamentous surface appendages projecting from the outer membrane with specific tip adhesins, which are morphologically characteristic of fimbriae (pili).

(c) UPEC strains produce specialized mannose-resistant fimbriae, known as P pili (pyelonephritis-associated pili), which carry the PapG adhesin tip.

(d) These tip adhesins bind with high affinity to specific α-D-galactopyranosyl-(1$\rightarrow$4)-β-D-galactopyranoside (digalactoside) receptors expressed abundantly on human uroepithelial and kidney cells.

(e) This firm attachment prevents the mechanical washing away of bacilli during micturition, allowing the bacteria to successfully ascend from the bladder up into the ureters and renal pelvis.

(f) Other mechanisms, such as Type III secretion systems or urease production, belong to different pathogens like Salmonella or Proteus mirabilis, rather than typical uropathogenic E. coli.

Final Answer: Binding of mannose-resistant fimbriae (P pili) to digalactoside receptors on uroepithelial cells

Answer: (A)

Go Back to Question 2

Q3.

Solution

Concept: Intracellular pathogens require specialized molecular tools to cross host membranes after internal engulfment. Recognizing the virulence cascades of neonatal pathogens helps clarify how they breach protective cellular barriers to cause systemic disease.

Solution:

(a) The presence of Gram-positive coccobacilli causing neonatal meningitis with characteristic temperature-dependent tumbling motility (motile at 25°C but non-motile at 37°C) explicitly identifies the pathogen as Listeria monocytogenes.

(b) Listeria is a facultative intracellular bacterium that enters host macrophages and non-professional phagocytes through internalin-mediated receptor interaction.

(c) Once inside the host cell, the pathogen is initially confined within a specialized phagosomal vacuole designed to destroy foreign invaders.

(d) To survive and multiply, Listeria secretes listeriolysin O (LLO), a cholesterol-dependent pore-forming hemolysin, alongside two distinct forms of phospholipase C enzymes.

(e) These specific toxins synergistically disrupt and lyse the lipid bilayer membrane of the phagosome, allowing the bacilli to escape freely into the host cell cytoplasm.

(f) Once inside the cytoplasm, the bacteria utilize ActA proteins to polymerize host actin, forming tails that propel them directly into neighboring cells without entering the extracellular space.

Final Answer: Phospholipase C and a cholesterol-dependent pore-forming hemolysin

Answer: (B)

Go Back to Question 3

Q4.

Solution

Concept: Bacterial cell wall proteins often mimic host components or bind host molecules in reverse orientations to subvert the immune system. Identifying these surface proteins explains how aggressive pathogens evade humoral immunity during endovascular infections.

Solution:

(a) A intravenous drug user presenting with tricuspid valve endocarditis and cultures growing catalase-positive, coagulase-positive Gram-positive cocci points directly to a severe infection caused by Staphylococcus aureus.

(b) S. aureus possesses an array of surface-anchored virulence factors; a major component among these is a 42 kDa surface protein known as Protein A.

(c) Protein A is covalently bound to the peptidoglycan backbone of the cell wall and functions as an effective immunological shield.

(d) It specifically binds to the Fc (crystallizable fragment) portion of immunoglobulin G (IgG) molecules, rather than the standard antigen-binding Fab fragments.

(e) By binding the Fc region, Protein A forces the antibody into an abnormal, inverted orientation where the Fab arms point outward away from the bacterial body.

(f) Because the Fc region is hidden and unavailable to interact with host phagocytic receptors, classical complement activation is blocked, and opsonophagocytosis is completely inhibited.

Final Answer: Protein A

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: The structural arrangement of fungal conidiophores provides critical morphology for definitive laboratory identification. Recognizing these microscopic features allows physicians to differentiate opportunistic molds under direct examination.

Solution:

(a) The clinical picture of a neutropenic leukemia patient presenting with hemoptysis, a classic CT halo sign, and 45° acute-angle branching septate hyphae confirms invasive pulmonary aspergillosis.

(b) Aspergillus species are identified in the laboratory by studying their unique asexual reproductive structures, known as conidiophores, which match the provided TiKz diagram.

(c) The anatomy consists of an upright conidiophore stem that expands at its apex into a swollen, flask-shaped central vesicle.

(d) From this vesicle surface, specialized secretory cells called phialides (or sterigmata) arise, which can be uniseriate or biseriate depending on the species.

(e) These phialides produce long, basipetal chains of pigmented, globose conidia (spores) that extend outward into the environment.

(f) In Aspergillus fumigatus, the phialides typically cover only the upper two-thirds of the vesicle, giving it a characteristic fan-like appearance, which directly corresponds to option A.

Final Answer: A flask-shaped vesicle with phialides covering the upper two-thirds, producing chains of globose conidia

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept: The cell membranes of fungi contain unique sterols that serve as primary targets for systemic antifungal agents. Understanding the specific targets of polyenes versus azoles or echinocandins is essential for managing aggressive angioinvasive zygomycotic infections.

Solution:

(a) The presentation of an uncontrolled diabetic patient with a palatal or nasal black necrotic eschar and broad, aseptate, ribbon-like hyphae branching at 90° is diagnostic of rhino-orbital-cerebral mucormycosis.

(b) Mucormycosis is an aggressive, life-threatening angioinvasive infection caused by molds belonging to the order Mucorales, such as Rhizopus, Mucor, or Lichtheimia.

(c) These organisms are inherently resistant to many standard antifungal drugs, making the immediate administration of high-dose Amphotericin B the mainstay of medical management.

(d) Amphotericin B is a polyene macrolide that exerts its therapeutic effect by binding directly to ergosterol, the principal sterol component found in fungal cell membranes.

(e) This binding causes drug molecules to aggregate, forming large, hydrophobic transmembrane pores that disrupt membrane integrity, leading to the leakage of intracellular ions and rapid cell death.

(f) Other mechanisms, like inhibiting glucan synthesis or squalene epoxidase, are ineffective against Mucorales because their cell wall and metabolic pathways differ from regular yeasts.

Final Answer: Binding to ergosterol in the fungal cell membrane, creating transmembrane pores

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept: Protozoan flagellates exhibit distinct morphological phases that correspond to their diagnostic and infective states. Recognizing these microscopic features is critical for identifying protozoan causes of malabsorption from stool samples.

Solution:

(a) A traveler returning with bloating, flatulence, and persistent, foul-smelling, greasy diarrhea (steatorrhea) suggests a malabsorptive diarrheal illness caused by Giardia lamblia.

(b) Giardia colonizes and multiplies in the human duodenum and upper jejunum, where it adheres firmly to the mucosal brush border using a specialized structure.

(c) The active, motile stage found in diarrheic stools is the trophozoite, which is accurately represented by the provided bilaterally symmetrical TiKz schematic.

(d) Morphologically, the trophozoite is pear-shaped (pyriform) with a broad, rounded anterior end and a tapered posterior end.

(e) It contains two distinct nuclei positioned symmetrically on either side of the midline axostyles, giving it a characteristic "old man with glasses" appearance.

(f) It also features four pairs of flagella that provide a falling-leaf motility pattern and a large ventral sucking disk used to securely anchor itself to the intestinal epithelium.

Final Answer: A motile, pear-shaped trophozoite showing a bilateral symmetry resembling an old man with glasses

Answer: (A)

Go Back to Question 7

Q8.

Solution

Concept: Subcutaneous mycoses often present with unique tissue-level structures that serve as primary diagnostic clues. Differentiating between these chronic fungal manifestations prevents misdiagnosis and guides correct long-term therapy.

Solution:

(a) The case describes a chronic subcutaneous infection on the foot of an agricultural worker displaying round, thick-walled, dark brown fungal elements that divide by internal septation.

(b) These characteristic structures are known as sclerotic bodies, Medlar bodies, or "copper pennies" due to their chestnut-brown coloration and distinct internal cross-walls.

(c) Sclerotic bodies represent a specialized tissue form of dematiaceous (pigmented) molds and are highly pathognomonic for chromoblastomycosis.

(d) Chromoblastomycosis is typically caused by the traumatic inoculation of environmental molds like Fonsecaea pedrosoi or Cladophialophora carrionii into the skin.

(e) Over months to years, the infection progresses to form hyperkeratotic, verrucous, cauliflower-like lesions that must be differentiated from mycetomas or sporotrichosis.

(f) While mycetomas present with discharging sinuses containing macroscopic fungal grains, chromoblastomycosis lacks granules and instead shows these diagnostic internal-septating cells on histopathology.

Final Answer: Chromoblastomycosis

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept: Superficial mycoses are caused by specialized yeasts that adapt to the lipid-rich microenvironments of human skin. Understanding their metabolic requirements explains their behavior in vivo and their culture characteristics in vitro.

Solution:

(a) Hypopigmented or hyperpigmented scaling macules on the trunk that demonstrate a classic "spaghetti and meatballs" appearance under KOH examination confirm a diagnosis of Pityriasis (Tinea) versicolor.

(b) This superficial infection is caused by Malassezia furfur, a dimorphic, opportunistic yeast that exists as part of the normal cutaneous flora.

(c) Malassezia species are lipid-dependent (lipophilic) organisms because they lack the fatty acid synthase genes required to synthesize long-chain fatty acids independently.

(d) To support their growth in a laboratory setting, standard mycological media like Sabouraud Dextrose Agar must be overlaid with olive oil or medium-chain triglycerides.

(e) The "spaghetti and meatballs" microscopic appearance represents a mixture of short, angular, unbranched hyphae alongside spherical, budding yeast cells.

(f) The hypopigmentation observed in patients is driven by the production of azelaic acid, a metabolic byproduct that competitively inhibits tyrosinase, disrupting host melanin synthesis.

Final Answer: It is a lipophilic yeast that requires the addition of olive oil or medium-chain fatty acids for growth in culture

Answer: (D)

Go Back to Question 9

Q10.

Solution

Concept: The structural anatomy of immunoglobulins determines their functional capabilities and tissue distribution. Identifying the specific structural features of the antibody monomer explains how maternal immunity is selectively transferred across the placenta.

Solution:

(a) The question asks for the structural configuration of the specific antibody class capable of crossing the human placenta to provide passive immunity to a developing fetus.

(b) Immunoglobulin G (IgG) is the only antibody class capable of crossing the placental barrier, a process mediated by its binding to neonatal Fc receptors (FcRn) on trophoblast cells.

(c) The structural layout of IgG is a basic, monomeric Y-shaped unit with a molecular weight of approximately 150 kDa, as depicted in the provided TiKz diagram.

(d) This monomeric framework consists of two identical heavy chains (γ chains) and two identical light chains (κ or λ), linked together by disulfide bonds.

(e) Pentameric structures held together by a J chain describe Immunoglobulin M (IgM), which cannot cross the placenta due to its large size and lack of specific receptor transport.

(f) Similarly, dimeric secretory IgA is designed for mucosal secretion rather than systemic transplacental transfer, making the basic monomeric layout of IgG the correct option.

Final Answer: A basic monomeric structure containing two heavy γ chains and two light chains

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept: The primary immune deficiency diseases often manifest due to flawed molecular communication checkpoints between adaptive immune cells. Disruption of key ligand-receptor interactions prevents normal class-switch recombination, rendering patients susceptible to recurrent sinopulmonary and systemic pyogenic infections.

Solution:

(a) The presentation of recurrent pyogenic infections coupled with normal numbers of circulating B and T cells, but elevated IgM alongside profoundly depressed IgG, IgA, and IgE, defines Hyper-IgM Syndrome Type 1.

(b) This clinical status typically results from an X-linked recessive genetic mutation affecting the CD40 ligand (CD154) expressed on the surfaces of activated CD4+ T helper lymphocytes.

(c) Under physiological conditions, naive B lymphocytes produce IgM and IgD using baseline immunoglobulin gene configurations.

(d) To switch to other isotypes like IgG, IgA, or IgE, the B cell must receive a secondary signal through the engagement of its surface CD40 receptor by the activated T cell's CD40 ligand.

(e) This costimulatory interaction activates intracellular cascades that trigger the enzyme activation-induced cytidine deaminase (AID), which remodels heavy chain constant region loci via genomic recombination.

(f) Without this molecular interaction, B cells fail to undergo class-switch recombination, leading to an overproduction of baseline IgM and a deficiency in protective downstream antibody classes.

Final Answer: Binding of CD40 ligand (CD154) on activated T cells to CD40 on B cells

Answer: (A)

Go Back to Question 11

Q12.

Solution

Concept: The initial phases of primary adaptive immune recognition require coordinated antigen handling before antibody synthesis can begin. Identifying the chronology of this lag phase clarifies how naive immune pools transition into active effector networks.

Solution:

(a) Following primary exposure to a foreign protein antigen, a measurable kinetic delay or lag phase occurs prior to the appearance of specific antibodies in host serum.

(b) This delay reflects the time needed for rare antigen-specific lymphocyte clones to locate, identify, process, and expand in response to the immunogen.

(c) The initial event in this cascade involves peripheral professional antigen-presenting cells, such as classical dendritic cells, capturing the protein via pinocytosis or receptor-mediated endocytosis.

(d) The dendritic cell degrades the protein into immunogenic peptide fragments within endolysosomal compartments.

(e) These peptides are loaded onto Major Histocompatibility Complex (MHC) Class II molecules and transported to the cell surface.

(f) The mature dendritic cell then migrates through regional lymphatics to secondary lymphoid organs to present these complexes to naive CD4+ T helper cells.

(g) Subsequent steps, such as T cell activation, clonal expansion, B cell costimulation, somatic hypermutation, and plasma cell differentiation, follow this primary antigen-presentation event.

Final Answer: Processing and presentation of antigen fragments via MHC Class II molecules by dendritic cells

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept: Type IV hypersensitivity is a cell-mediated immunological process that does not rely on circulating humoral antibodies. Evaluating the specific cellular partners and their cytokine signals helps explain the tissue reactions seen in diagnostic skin tests.

Solution:

(a) The diagnostic presentation of a positive tuberculin skin test (Mantoux test), characterized by localized induration after 48 hours, is a classic example of Type IV (delayed-type) hypersensitivity.

(b) This localized response demonstrates that the individual possesses memory T cells from a previous exposure to Mycobacterium tuberculosis or the BCG vaccine.

(c) Upon intradermal injection of purified protein derivative (PPD), localized dendritic cells process and present the antigens to circulating memory CD4+ Th1 lymphocytes.

(d) Once activated, these specialized Th1 cells secrete high levels of interferon-gamma (IFN-γ) and tumor necrosis factor-alpha (TNF-α).

(e) Interferon-gamma functions as a major macrophage-activating factor, drawing blood monocytes to the injection site and transforming them into active, phagocytic tissue macrophages.

(f) Tumor necrosis factor-alpha alters local vascular endothelial cells, increasing adhesion molecule expression and tissue permeability, which promotes cellular influx.

(g) The recruitment and activation of these tissue macrophages over 48 to 72 hours leads to the firm induration and inflammation measured during clinical screening.

Final Answer: IFN-γ and TNF-α, mediated primarily by macrophages and Th1 cells

Answer: (D)

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Q14.

Solution

Concept: The complement cascade is regulated by specific circulating and membrane-bound inhibitors to prevent autologous tissue injury. Understanding where these control points fail helps clarify the pathogenesis of systemic vascular diseases.

Solution:

(a) Hereditary angioedema is an autosomal dominant disorder caused by a quantitative or functional deficiency of the C1 esterase inhibitor (C1-INH).

(b) C1-INH serves as a major plasma serine protease inhibitor that regulates the initial steps of the classical complement pathway.

(c) Under physiological conditions, it binds to and inactivates the enzymatic subunits C1r and C1s, preventing spontaneous or excessive complement activation.

(d) When C1-INH function is impaired, uncontrolled activation of the C1 complex occurs, leading to the continuous cleavage of its natural substrates, C4 and C2.

(e) This unregulated consumption yields elevated levels of C2 kinin, a breakdown fragment that increases vascular permeability.

(f) Concurrently, C1-INH regulates the contact system; its absence allows plasma kallikrein to continuously cleave high-molecular-weight kininogen, generating excess bradykinin.

(g) Bradykinin acts as a potent vasodilator and fluid-regulator, driving the episodic, non-pitting subcutaneous and submucosal edema that characterizes this clinical condition.

Final Answer: Unregulated activation of C1, leading to the consumption of C4 and C2

Answer: (B)

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Q15.

Solution

Concept: Structural and genomic classification provides the foundation for identifying viral families that cause pediatric respiratory diseases. Differentiating between enveloped and non-enveloped, segmented and non-segmented architectures helps clarify viral replication and transmission patterns.

Solution:

(a) The clinical description of an infant presenting with fever, cough, tachypnea, and wheezing due to verified Respiratory Syncytial Virus (RSV) is diagnostic of acute bronchiolitis.

(b) RSV is the leading cause of lower respiratory tract disease in infants and belongs to the Orthopneumovirus genus within the Pneumoviridae family.

(c) Genomic analysis shows that RSV is an enveloped virus containing a linear, single-stranded, negative-sense, non-segmented RNA genome.

(d) The viral envelope contains key surface glycoproteins, including the attachment glycoprotein (G) and the fusion protein (F), which drive pathogenesis.

(e) The fusion protein (F) induces host cell membranes to merge with the viral lipid bilayer and triggers syncytia formation among neighboring epithelial cells.

(f) Because its genome is non-segmented, RSV does not undergo genetic reassortment (antigenic shift) like the influenza virus; its variations instead stem from progressive accumulation of point mutations.

Final Answer: Enveloped, linear, single-stranded, negative-sense, non-segmented RNA virus

Answer: (A)

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Q16.

Solution

Concept: The Hepadnaviridae family uses a distinct replication strategy that combines elements of both DNA and RNA viruses. Recognizing how genomic components are assembled inside the viral core is a high-yield concept for understanding chronic hepatitis B infections.
Solution:

(a) Hepatitis B Virus (HBV) is a prototype member of the Hepadnaviridae family, possessing a unique circular, partially double-stranded DNA (dsDNA) genome.

(b) Upon entering a host hepatocyte, the viral DNA is transported to the nucleus and repaired by host enzymes into covalently closed circular DNA (cccDNA).

(c) Host RNA polymerase II transcribes this cccDNA into viral messenger RNAs, including a greater-than-genome-length transcript known as pregenomic RNA (pgRNA).

(d) This pgRNA intermediate is exported to the cytoplasm, where it binds to the viral polymerase enzyme and is packaged into assembling core capsids.

(e) Inside the capsid, the viral polymerase functions as a reverse transcriptase, using the pgRNA as a template to synthesize the negative-strand DNA.

(f) The original pgRNA template is degraded by the ribonuclease H (RNase H) activity of the polymerase, leaving only a fragment to prime positive-strand DNA synthesis.

(g) This intra-capsid reverse transcription step is unique among DNA viruses and serves as a primary target for nucleoside/nucleotide analog therapies.

Final Answer: Reverse transcription of a greater-than-genome-length pregenomic RNA template into negative-strand DNA

Answer: (B)

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Q17.

Solution

Concept: Neurotropic viral infections often trigger distinct intracellular changes that serve as diagnostic hallmarks. Recognizing these pathognomonic inclusion bodies allows for definitive post-mortem identification of rabies encephalitis.

Solution:

(a) A patient presenting with painful neck spasms, difficulty swallowing, and hydrophobia following a dog scratch provides a classic clinical picture of rabies encephalitis.

(b) The Rabies virus is a negative-sense, single-stranded RNA virus belonging to the Lyssavirus genus of the Rhabdoviridae family, characterized by its bullet-shaped morphology.

(c) Following inoculation, the virus replicates locally in muscle tissue before binding to nicotinic acetylcholine receptors at the neuromuscular junction to ascend axonally to the central nervous system.

(d) Once inside the brain, the virus preferentially colonizes neurons within the hippocampus, brainstem, and the Purkinje cells of the cerebellum.

(e) Histopathological evaluation of infected brain tissue reveals Negri bodies within the cytoplasm of these large neurons.

(f) Negri bodies are round-to-oval, eosinophilic, sharply demarcated cytoplasmic inclusion bodies composed of accumulated viral nucleocapsid proteins and assembly structural complexes.

Final Answer: Large, round-to-oval, eosinophilic cytoplasmic inclusion bodies (Negri bodies)

Answer: (A)

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Q18.

Solution

Concept: Antibody-dependent enhancement (ADE) explains why secondary infections with different viral strains can cause more severe disease. Understanding how non-neutralizing antibodies interact with surface receptors clarifies the pathogenesis of severe dengue hemorrhagic fever.

Solution:

(a) The patient presents with classic features of dengue fever, an infection caused by a mosquito-borne Flavivirus with four distinct antigenic serotypes (DENV 1-4).

(b) Primary infection with one serotype induces lifelong protective immunity against that specific serotype through the production of neutralizing antibodies.

(c) However, if the individual is later infected with a heterologous serotype, pre-existing antibodies bind to the new virus but cannot fully neutralize it.

(d) These cross-reactive, non-neutralizing IgG antibodies form immune complexes with the new dengue virions, leaving their outer structural loops exposed.

(e) The Fc regions of these bound antibodies attach with high affinity to Fcγ receptors expressed on the surfaces of host monocytes, macrophages, and dendritic cells.

(f) This receptor engagement facilitates the internal uptake of the virus-antibody complex, leading to an increased viral load within these target cells.

(g) This process, known as antibody-dependent enhancement, triggers an inflammatory cascade and cytokine storm that underlies dengue hemorrhagic fever and shock syndrome.

Final Answer: Fc receptors binding to non-neutralizing IgG-virus complexes

Answer: (B)

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Q19.

Solution

Concept: Antiviral therapies are designed to disrupt specific stages of the viral life cycle, such as entry, uncoating, replication, or exit. Distinguishing between these mechanisms clarifies how neuraminidase inhibitors prevent the systemic spread of orthomyxoviruses.

Solution:

(a) The clinical scenario describes an elderly patient with confirmed Influenza A infection who is treated with the antiviral drug oseltamivir (Tamiflu).

(b) Influenza viruses are enveloped, segmented, negative-sense RNA viruses belonging to the Orthomyxoviridae family, featuring two key surface glycoproteins: hemagglutinin and neuraminidase.

(c) Hemagglutinin binds to sialic acid residues on host respiratory epithelial cells to initiate viral entry via endocytosis.

(d) Once replication is complete, progeny virions bud from the host cell membrane but remain anchored to the surface by their hemagglutinin attachments to host sialic acid.

(e) Viral neuraminidase functions as a specific sialic acid hydrolase, cleaving these terminal sugar residues to release the newly formed virions.

(f) Oseltamivir is a competitive inhibitor of this neuraminidase enzyme, locking the newly formed viral particles to the donor cell membrane.

(g) This prevents the virions from shedding into the surrounding respiratory secretions, halting the infection of neighboring epithelial cells.

Final Answer: Cleavage of sialic acid residues by neuraminidase to prevent the release of progeny virions from the host cell

Answer: (C)

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Q20.

Solution

Concept: The capacity to establish long-term latency inside distinct host cell niches is a key characteristic of the Herpesviridae family. Identifying where these viral genomes reside during inactive periods helps explain the patterns of clinical recurrence.

Solution:

(a) The presentation of clustered genital vesicles on an erythematous base, alongside a Tzanck smear showing multinucleated giant cells, is diagnostic of primary genital herpes caused by Herpes Simplex Virus Type 2 (HSV-2).

(b) HSV-2 is an enveloped, double-stranded DNA virus that replicates locally within mucosal epithelial cells, causing characteristic cytopathic damage and localized ulceration.

(c) Following primary infection, the virus enters exposed sensory nerve endings and travels retrograde via axonal transport to the sacral dorsal root ganglia (S2-S4).

(d) Within these neuronal nuclei, the virus establishes lifelong latency by entering a quiescent state where its linear DNA circularizes into an independent episome.

(e) During latency, active transcription of structural viral proteins is suppressed, and only specialized non-coding RNA transcripts, known as Latency-Associated Transcripts (LATs), are expressed.

(f) Under conditions of emotional stress, fever, or physical trauma, the virus can reactivate, traveling anterograde down the axon to cause recurrent vesicular eruptions in the same dermatomal distribution.

Final Answer: Maintenance of the viral genome as a circular episome within the nuclei of sensory nerve ganglia

Answer: (B)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	B	4	B	5	A
6	B	7	A	8	B	9	D	10	B
11	A	12	B	13	D	14	B	15	A
16	B	17	A	18	B	19	C	20	B