

# NEET PG Microbiology Sample Paper-7

Duration: 15 Minutes

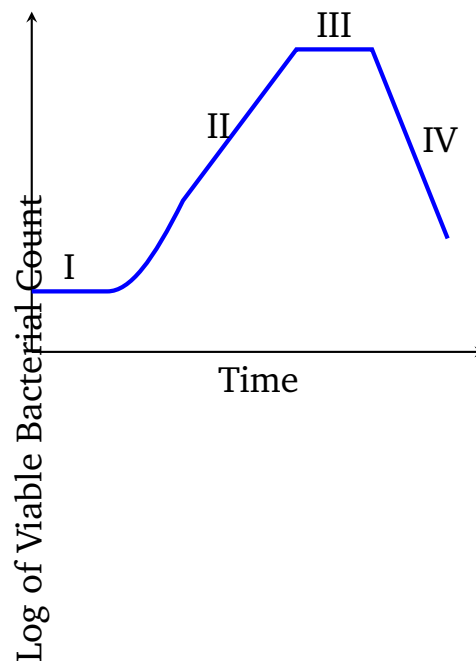
Maximum Marks: 80

## 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 49-year-old male presents with a painless, indurated ulcer (chancre) on his genitalia. Dark-field microscopy of the exudate reveals motile, corkscrew-shaped spirochetes. Which of the following is the primary mechanism of motility for this organism?
- (A) Peritrichous flagella extending outward into the medium  
(B) Endoflagella (axial filaments) located within the periplasmic space  
(C) Gliding motility mediated by slime secretion  
(D) Pili-mediated twitching motility across mucosal surfaces
- Q2.** A laboratory technician plots the growth of an enteric pathogen cultured in a closed batch system over time, resulting in the schematic curve shown below:





During which phase (labeled I to IV) are beta-lactam antibiotics like penicillin most lethal to the bacterial population?

- (A) Phase I
- (B) Phase II
- (C) Phase III
- (D) Phase IV

**Q3.** A 45-year-old chronic alcoholic presents with severe lobar pneumonia. His sputum is thick, bloody, and resembles "red currant jelly." Culture yields Gram-negative, heavily encapsulated bacilli that form large, mucoid colonies. Which virulence factor primarily prevents phagocytosis in this organism?

- (A) Lipopolysaccharide O-antigen
- (B) Capsular polysaccharide containing glucuronate
- (C) Outer membrane porin proteins
- (D) Heat-labile enterotoxin production

**Q4.** A patient undergoing chemotherapy develops a nosocomial bloodstream infection. Blood cultures grow oxidase-positive, non-fermenting Gram-negative



bacilli that produce a distinct sweet, grape-like odor and a blue-green pigment on nutrient agar. Which of the following pigments is responsible for the blue-green coloration?

- (A) Pyoverdine
- (B) Pyocyanin
- (C) Pyorubrin
- (D) Pyomelanin

**Q5.** A 10-year-old boy presents with a severe sore throat, fever, and a thick, greyish-white pseudomembrane tightly adhering to his tonsils and pharynx. The causative organism produces a potent exotoxin. What is the precise molecular mechanism of action of this toxin?

- (A) ADP-riboxylation of Elongation Factor-2 (EF-2), halting protein synthesis
- (B) Cleavage of synaptobrevin, blocking neurotransmitter release
- (C) Inactivation of the 60S ribosomal subunit by removing a specific adenine base
- (D) Constitutive activation of adenylate cyclase via G-protein ADP-riboxylation

**Q6.** An emergency room physician sustains a needlestick injury from a patient known to have chronic Hepatitis B infection. The physician's serum profile shows an absence of anti-HBs antibodies. Which type of sterilization or high-level disinfection is most reliable to render medical instruments contaminated with this virus completely safe?

- (A) Pasteurization at 63°C for 30 minutes
- (B) Glutaraldehyde 2% aqueous solution exposure for 20 minutes
- (C) Steam autoclaving at 121°C at 15 psi for 20 minutes
- (D) Low-frequency ultraviolet radiation for 10 minutes

**Q7.** A 62-year-old male post-laparotomy develops a deep surgical site abscess. Anaerobic culture isolates a Gram-negative, pleomorphic bacillus that is resistant to kanamycin, neomycin, and penicillin, but grows abundantly on



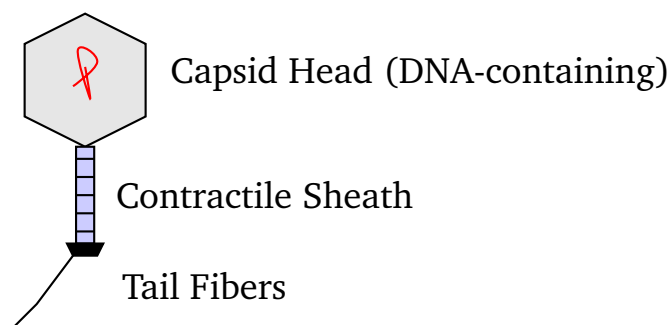
Bile Esculin Agar forming black colonies. Which organism is the most likely pathogen?

- (A) Bacteroides fragilis
- (B) Clostridium perfringens
- (C) Fusobacterium nucleatum
- (D) Peptostreptococcus anaerobius

**Q8.** A 28-year-old pregnant female at 12 weeks of gestation presents with a low-grade fever, maculopapular rash starting on the face and spreading downward, and prominent post-auricular lymphadenopathy. Which of the following viral families does the causative agent of this condition belong to?

- (A) Parparamyxoviridae
- (B) Togaviridae
- (C) Picornaviridae
- (D) Flaviviridae

**Q9.** Consider the structural schematic of a complex viral agent shown below:



Which viral entity matches this structure, and what is its primary mechanism for delivering its genetic material into a host bacterial cell?

- (A) T-even Bacteriophage; direct injection via tail sheath contraction through the cell wall
- (B) Influenza virus; receptor-mediated endocytosis followed by membrane fusion



- (C) Adenovirus; penton-mediated membrane disruption after receptor attachment
- (D) Human Immunodeficiency Virus; gp120-CD4 binding followed by direct fusion

**Q10.** A 6-month-old infant is admitted with severe respiratory distress, wheezing, and a harsh cough. Nasopharyngeal aspirate is positive for a virus that causes syncytia formation in tissue culture. Which viral surface protein is directly responsible for mediating the formation of these multinucleated giant cells?

- (A) Hemagglutinin (H) protein
- (B) Neuraminidase (N) protein
- (C) Fusion (F) protein
- (D) Matrix (M) protein

**Q11.** A 42-year-old HIV-positive patient with a CD4+ T-lymphocyte count of 80 cells/ $\mu$ L presents with progressive vision loss. Funduscopic examination reveals extensive retinal hemorrhages and pale exudates ("pizza-pie retinopathy"). Which of the following acts as the first-line antiviral drug for this condition by inhibiting viral DNA polymerase?

- (A) Acyclovir
- (B) Ganciclovir
- (C) Foscarnet
- (D) Cidofovir

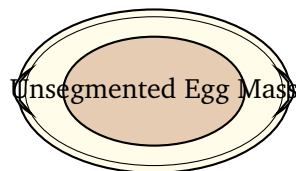
**Q12.** A diabetic patient presenting with ketoacidosis develops acute, aggressive rhinocerebral symptoms, including black necrotic eschars in the nasal cavity and proptosis. Biopsy of the tissue shows broad, ribbon-like, aseptate hyphae branching at right angles ( $90^\circ$ ). Which fungal order is responsible for this condition?

- (A) Mucorales
- (B) Moniliales



- (C) Aspergillaceae
- (D) Cryptococcaceae

**Q13.** Stool examination of a 7-year-old child presenting with abdominal pain and rectal prolapse reveals characteristic parasitic eggs under light microscopy, represented schematically below:



Which nematode produces these distinctive barrel-shaped eggs with prominent bipolar mucous plugs?

- (A) *Ascaris lumbricoides*
  - (B) *Trichuris Pools* (*Trichuris trichiura*)
  - (C) *Ancylostoma duodenale*
  - (D) *Enterobius vermicularis*
- Q14.** A 35-year-old traveler returning from East Africa presents with high cyclic fevers, chills, and severe headache. A thin blood smear reveals infected erythrocytes that are enlarged, contain fine pink granules (Schuffner's dots), and show amoeboid trophozoites. Which plasmodium species is implicated?
- (A) *Plasmodium falciparum*
  - (B) *Plasmodium vivax*
  - (C) *Plasmodium malariae*
  - (D) *Plasmodium ovale*
- Q15.** A 29-year-old HIV patient presents with a dry cough, exertional dyspnea, and low-grade fever. Silver staining of a bronchoalveolar lavage specimen reveals crushed ping-pong ball-shaped cysts. Which of the following statements regarding this organism is correct?
- (A) It is a protozoan parasite that responds well to amphotericin B

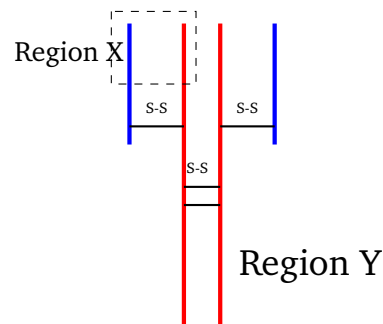


- (B) Its cell membrane contains ergosterol as its dominant sterol
- (C) It is a fungus whose cell wall lacks ergosterol, making it intrinsically resistant to azoles
- (D) It can be easily grown on Sabouraud Dextrose Agar within 48 hours

**Q16.** A newborn presents with recurrent bacterial infections, delayed separation of the umbilical cord, and marked neutrophilia in peripheral blood. A defect in leukocyte adhesion molecules (LAD-1) is suspected. Which of the following molecular structures is defective or absent in this patient?

- (A) Sialyl-Lewis X modified glycoprotein
- (B)  $\alpha_2$  – integrins (CD11/CD18 cluster)
- (B) L-selectin on neutrophil surfaces
- (C) ICAM-1 on endothelial cells

**Q17.** The structural archetype of a basic monomeric serum immunoglobulin is illustrated in the diagram below:



Which segment of this molecule determines the idiotype specificity of the antibody, and which region determines its biological effector isotype class?

- (A) Region X determines the idiotype; Region Y determines the isotype
- (B) Region Y determines the idiotype; Region X determines the isotype
- (C) Region X determines both idiotype and isotype classes
- (D) Region Y determines both idiotype and isotype classes

**Q18.** A 24-year-old male with a history of severe asthma experiences acute systemic hypotension, bronchospasm, and urticaria within minutes of receiving



an intravenous dose of penicillin. Which cell surface event initiates the degranulation process in this immediate hypersensitivity reaction?

- (A) Complement activation yielding anaphylatoxins C3a and C5a binding to neutrophils
- (B) Cross-linking of membrane-bound IgE molecules by the multivalent allergen on mast cells
- (C) Binding of antigen-antibody complexes to the FcRIII receptor on NK cells
- (D) Direct activation of T-cell receptors by a chemical superantigen hapten

**Q19.** A patient presents with recurrent neisserial infections (meningitis and disseminated gonorrhoea). A detailed screening of the complement cascade is ordered. Which specific complement deficiency profile is most consistently correlated with this unique vulnerability?

- (A) Deficiency of C1q, C1r, or C1s
- (B) Deficiency of C2 or C4
- (C) Deficiency of C3 or C3b-inactivator
- (D) Deficiency of C5, C6, C7, C8, or C9 (Membrane Attack Complex)

**Q20.** During a mixed lymphocyte reaction, antigen-presenting cells display processed exogenous viral peptides to helper T-lymphocytes. Which specific human leukocyte antigen (HLA) class class molecule presents this peptide, and which T-cell coreceptor stabilizes the interaction?

- (A) HLA Class I molecule interacting with the CD8 coreceptor
- (B) HLA Class II molecule interacting with the CD4 coreceptor
- (C) HLA Class II molecule interacting with the CD8 coreceptor
- (D) HLA Class I molecule interacting with the CD4 coreceptor



## Detailed Solutions

Q1.

## Solution

**Concept:** The question evaluates knowledge of bacterial morphology and specialized motility apparatuses. Spirochetes are a distinct group of mobile, spiral-shaped bacteria, including pathogenic species like *Treponema pallidum* (the causative agent of syphilis). Unlike common flagellated bacteria that possess external flagella projecting directly into the surrounding aqueous medium, spirochetes exhibit a unique structural modification that allows them to move efficiently through highly viscous environments like connective tissue and mucous membranes.

**Solution:**

- (a) *Treponema pallidum* is the causative organism behind the painless, indurated primary genital ulcer known as a chancre. It is a thin, tightly coiled spirochete that cannot be easily visualized by standard light microscopy or Gram staining due to its minimal width, necessitating dark-field microscopy.
- (b) The motility of spirochetes is driven by specialized internal structures termed endoflagella, which are also frequently referred to as axial filaments or periplasmic flagella.
- (c) These endoflagella are anchored at both poles of the cellular cylinder and reside completely within the periplasmic space, bounded securely between the rigid peptidoglycan cell wall and the flexible outer lipid membrane.
- (d) When these internal filaments rotate, they exert torque against the rigid cell cylinder, causing the entire bacterial body to move in a distinctive corkscrew-like, twisting, or undulating motion.
- (e) This mechanical arrangement is highly adaptive, enabling the organism to burrow efficiently through dense cellular matrices and mucosal barriers, facilitating widespread systemic dissemination.
- (f) Options describing external peritrichous flagella, slime-mediated gliding, or pili-driven twitching represent mechanisms utilized by other distinct bacterial classes, not spirochetes.

**Final Answer:** Endoflagella (axial filaments) located within the periplasmic space

Answer: (B)

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Q2.

**Solution**

**Concept:** This question focuses on the correlation between the dynamic phases of the bacterial growth curve in a closed system and the pharmacodynamics of cell-wall synthesis inhibitors. Bacterial growth typically follows four sequential phases: the lag phase, the exponential (log) phase, the stationary phase, and the decline (death) phase. Understanding when specific classes of antimicrobial agents exert their maximum therapeutic efficacy is vital for clinical management and pharmacological application.

**Solution:**

- (a) The provided growth curve illustrates the four classic stages of bacterial culture: Phase I is the lag phase (adaptation, no division); Phase II is the log or exponential phase (rapid cell division); Phase III is the stationary phase (equilibrium due to nutrient depletion); and Phase IV is the death phase.
- (b) Beta-lactam antibiotics, including penicillins and cephalosporins, function by specifically binding to penicillin-binding proteins (PBPs) inside the bacterial cell envelope.
- (c) This binding directly inhibits the transpeptidation enzyme step, preventing the cross-linking of adjacent peptidoglycan strands, which compromises the structural integrity of the bacterial cell wall.
- (d) For these agents to cause structural failure and subsequent osmotic lysis, the targeted bacterial population must be actively synthesizing new peptidoglycan layers to support binary fission.
- (e) This structural synthesis occurs almost exclusively during Phase II, where the metabolic rate and replication velocities reach their absolute peak within the closed environment.
- (f) Consequently, non-dividing cells in the lag or stationary phases exhibit high phenotypic tolerance to penicillins, making Phase II the exact period where these bactericidal agents display maximum lethality.

**Final Answer:** Phase II**Answer: (B)**[Go Back to Question 2](#)

Q3.

**Solution**

**Concept:** This case vignettes a classic presentation of severe lobar pneumonia caused by *Klebsiella pneumoniae*, an opportunistic pathogen frequently found in individuals with chronic alcohol use disorder or diabetes. The question probes the primary structural virulence factor that allows this encapsulated Gram-negative bacillus to survive within host respiratory tissues by evading the cellular arms of the innate immune system.

**Solution:**

- (a) The clinical description of lobar pneumonia presenting with a thick, bloody sputum resembling "red currant jelly" in an alcoholic patient points directly to an infection caused by *Klebsiella pneumoniae*.
- (b) When cultured, this organism displays large, noticeably mucoid colonies due to the production of an extensive, thick, and highly organized extracellular polysaccharide capsule.
- (c) The primary capsule of pathogenic *Klebsiella* strains is rich in specific acidic polysaccharides, notably containing glucuronate and galactose subunits, which give the layer a strong negative surface charge.
- (d) This prominent capsule physically masks underlying surface structures and uses its negative charge to electrostatically repel the negatively charged membranes of professional phagocytic cells like neutrophils and macrophages.
- (e) Furthermore, this capsule inhibits the deposition and activation of the complement component C3b on the bacterial surface, preventing effective opsonization and subsequent recognition.
- (f) Because phagocytes cannot easily bind, engulf, or destroy the opsonin-deficient encapsulated bacilli, the bacteria proliferate freely within the alveolar spaces, causing extensive tissue necrosis and alveolar hemorrhage.

**Final Answer:** Capsular polysaccharide containing glucuronate

**Answer: (B)**

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Q4.

**Solution**

**Concept:** The question focuses on identifying the characteristic biochemical and physiological properties of *Pseudomonas aeruginosa*, a major cause of opportunistic nosocomial bloodstream infections in immunocompromised or neutropenic chemotherapy patients. This organism produces several unique secondary metabolic pigments that aid in diagnostic identification and contribute to its virulence profile within infected host ecosystems.

**Solution:**

- (a) A nosocomial infection yielding oxidase-positive, non-fermenting, Gram-negative rods that produce a sweet, grape-like or tortilla-like odor is classic for *Pseudomonas aeruginosa*.
- (b) This pathogen is renowned for generating an array of water-soluble pigments that diffuse directly into standard laboratory agar media, producing highly distinctive color changes.
- (c) The classic blue-green coloration observed on nutrient or clear agar formulations is primarily due to the production of pyocyanin, a blue-green phenazine pigment.
- (d) Pyocyanin functions as a notable virulence factor by generating reactive oxygen species (ROS) that induce oxidative stress, damaging host epithelial tissue and disrupting ciliary clearance mechanisms.
- (e) It is frequently co-produced with pyoverdine, a yellow-green fluorescent pigment that serves as a high-affinity siderophore to scavenge essential iron ions from the host environment.
- (f) Other pigments, such as pyorubrin (dark red-brown) and pyomelanin (black), can be produced by specific strains but are not responsible for the characteristic blue-green hue described in standard clinical cultures.

**Final Answer:** Pyocyanin

**Answer: (B)**

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Q5.

**Solution**

**Concept:** The scenario details a textbook presentation of respiratory diphtheria, caused by the lysogenized strains of *Corynebacterium diphtheriae*. The question tests precise comprehension of the molecular pathogenesis and biochemical mechanism of action exerted by diphtheria toxin, a classic prototype of bacterial AB exotoxins.

**Solution:**

- (a) The presentation of an unimmunized or under-immunized child with pharyngitis, fever, and a dense, adherent, greyish pseudomembrane that bleeds upon attempts to dislodge it establishes a diagnosis of diphtheria.
- (b) The clinical manifestations are mediated by diphtheria toxin, a potent polypeptide exotoxin encoded by a *tox* gene introduced into the bacterium via a lysogenic corynebacteriophage.
- (c) Diphtheria toxin is organized as an A-B structural toxin: the B (binding) subunit attaches to the heparin-binding epidermal growth factor receptor on susceptible host cell surfaces, inducing receptor-mediated endocytosis.
- (d) Following endosomal acidification, the active A (catalytic) subunit translocates directly across the vacuolar membrane into the host cell cytoplasm.
- (e) Once inside the cytosol, the A subunit functions as an enzyme that catalyzes the transfer of an ADP-ribose moiety from intracellular NAD<sup>+</sup> to a modified histidine residue (diphthamide) on Elongation Factor-2 (EF-2).
- (f) This covalent ADP-riboxylation completely inactivates EF-2, permanently arresting polypeptide chain elongation during ribosomal protein synthesis, which leads directly to cellular necrosis and systemic organ damage.

**Final Answer:** ADP-riboxylation of Elongation Factor-2 (EF-2), halting protein synthesis

**Answer: (A)**

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Q6.

**Solution**

**Concept:** This question focuses on the principles of sterilization and high-level disinfection within clinical environments, specifically addressing the elimination of bloodborne viral pathogens like the Hepatitis B Virus (HBV). Medical devices are classified based on infection risk, requiring rigorous physical or chemical processing to eliminate highly resilient viral and bacterial contaminants completely.

**Solution:**

- (a) Medical instruments that enter sterile tissues or the vascular system are classified as critical items and must undergo complete sterilization before reuse to eliminate all microbial life, including spores and viruses.
- (b) The Hepatitis B virus is highly resilient compared to other enveloped viruses, possessing high thermal stability and resistance to various ambient environmental conditions.
- (c) Low-level methods like pasteurization or ultraviolet exposure are insufficient for instruments because they lack deep penetration and fail to achieve true sterilization parameters.
- (d) While chemical disinfectants like 2% glutaraldehyde can achieve high-level disinfection or sterilization with prolonged contact times, liquid submersions carry risks of user error, dilution, and inadequate rinsing.
- (e) Steam autoclaving utilizes saturated steam under pressure to deliver high thermal energy rapidly, ensuring the complete denaturing of all structural proteins and viral nucleic acids.
- (f) Operating at 121°C at 15 pounds per square inch (psi) of pressure for a minimum duration of 20 minutes represents the gold standard for reliably sterilizing critical medical equipment.

**Final Answer:** Steam autoclaving at 121°C at 15 psi for 20 minutes

**Answer: (C)**

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Q7.

**Solution**

**Concept:** This clinical case describes a deep-seated anaerobic intra-abdominal abscess developing after abdominal surgery. The question focuses on identifying the specific biochemical profiles and selective culture requirements of the dominant non-spore-forming anaerobic Gram-negative rods that populate the human gastrointestinal tract.

**Solution:**

- (a) Deep abscesses occurring after colorectal surgery or laparotomy are frequently polymicrobial infections dominated by obligate anaerobes originating from the endogenous intestinal flora.
- (b) *Bacteroides fragilis* is the most isolated anaerobic pathogen from these intra-abdominal infections, noted for its high resistance to multiple antimicrobial agents.
- (c) Structurally, it is a Gram-negative, highly pleomorphic, encapsulated bacillus that exhibits resistance to aminoglycosides (such as kanamycin and neomycin) and beta-lactams due to penicillinase production.
- (d) For selective isolation, laboratories utilize Bacteroides Bile Esculin (BBE) agar, which contains 20% bile salts to inhibit most other anaerobic and facultative organisms.
- (e) *Bacteroides fragilis* is distinctively bile-tolerant and actively hydrolyzes the carbohydrate esculin present in the media, which reacts with iron salts to produce a dark iron complex.
- (f) This metabolic reaction results in the rapid development of characteristic charcoal-black colonies surrounded by black zones, confirming its identity over other anaerobes like *Fusobacterium* or *Clostridium* species.

**Final Answer:** Bacteroides fragilis

Answer: (A)

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Q8.

**Solution**

**Concept:** The question tests taxonomic and clinical knowledge regarding viral exanthems occurring during pregnancy. Rubella (German measles) presents as a mild disease in adults but poses severe teratogenic risks to the developing fetus, causing Congenital Rubella Syndrome (CRS) if contracted during the first trimester.

**Solution:**

- (a) The combination of a low-grade fever, a maculopapular rash that originates on the face and spreads cephalocaudally, and prominent, tender post-auricular or suboccipital lymphadenopathy is classic for Rubella.
- (b) This clinical presentation can resemble regular measles (Rubeola), but the prominent lymphadenopathy and shorter duration of the rash are distinctive features of Rubella.
- (c) The Rubella virus is an enveloped, positive-sense, single-stranded RNA virus belonging to the *Togaviridae* family, classified under the genus *Rubivirus*.
- (d) Identifying this viral family is clinically vital because maternal infection during the first 12 weeks of gestation carries an extremely high risk of transplacental transmission.
- (e) Transplacental infection disrupts fetal organogenesis, leading to classic congenital defects including sensorineural deafness, cataracts, microcephaly, and congenital heart defects like patent ductus arteriosus.
- (f) Other listed families are incorrect: *Paramyxoviridae* includes measles and mumps; *Picornaviridae* includes enteroviruses; and *Flaviviridae* includes viruses like Dengue, Zika, and Hepatitis C.

**Final Answer:** Togaviridae

**Answer: (B)**

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Q9.

**Solution**

**Concept:** The question evaluates the structural morphology and specific host-delivery mechanisms of bacteriophages. These specialized viruses infect bacterial hosts using intricate mechanical structures designed to penetrate rigid outer cell walls and deliver genomic material directly into the host cytoplasm.

**Solution:**

- (a) The schematic illustrates a classic tailed bacteriophage, such as a T-even coliphage, characterized by an icosahedral head, a central contractile sheath, and specialized baseplate tail fibers.
- (b) The icosahedral head capsomer structure functions solely to enclose and protect the tightly packed double-stranded viral DNA genome from environmental degradation.
- (c) The long tail assembly is a highly specialized mechanical apparatus evolved to overcome the structural barrier presented by the outer peptidoglycan cell wall of bacteria.
- (d) Infection initiates when the distal tail fibers bind specifically to lipopolysaccharide or protein receptors on the host bacterial outer membrane surface.
- (e) Following attachment, conformational changes cause the rigid outer tail sheath to contract forcefully, driving an inner core tube through the bacterial cell envelope like a hypodermic needle.
- (f) This mechanical penetration allows the viral DNA within the head to pass down the central tube and inject directly into the host cytosol, leaving the empty protein capsid shell outside.

**Final Answer:** T-even Bacteriophage; direct injection via tail sheath contraction through the cell wall

**Answer: (A)**

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Q10.

**Solution**

**Concept:** The question explores the clinical features and structural molecular biology of Respiratory Syncytial Virus (RSV), a leading cause of severe lower respiratory tract disease, bronchiolitis, and pneumonia in infants and young children worldwide. The pathogenesis depends heavily on specific surface viral glycoproteins that alter host cell membrane dynamics.

**Solution:**

- (a) An infant presenting with acute respiratory distress, wheezing, tachypnea, and hyperinflation on a chest radiograph during winter months strongly indicates bronchiolitis induced by Respiratory Syncytial Virus.
- (b) RSV is an enveloped, negative-sense, single-stranded RNA virus classified within the *Pneumoviridae* family, lacking the hemagglutinin and neuraminidase proteins seen in influenza or other paramyxoviruses.
- (c) The envelope of RSV contains two major functional surface transmembrane glycoproteins: the attachment glycoprotein (G protein) and the fusion glycoprotein (F protein).
- (d) The G protein mediates the initial anchoring of the virion to the surface receptors of host respiratory tract epithelial cells.
- (e) The Fusion (F) protein then drives the fusion of the viral envelope with the host cell plasma membrane, allowing the viral nucleocapsid to gain entry into the host cytoplasm.
- (f) Crucially, the F protein remains active on the surface of infected cells, promoting direct plasma membrane fusion between adjacent host epithelial cells, creating multinucleated syncytia that clog small airways.

**Final Answer:** Fusion (F) protein

**Answer: (C)**

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Q11.

**Solution**

**Concept:** Cytomegalovirus (CMV) retinitis is a serious opportunistic infection occurring in advanced HIV-positive patients, particularly when CD4 counts fall below 50 to 100 cells per microliter. Identifying the pathognomonic fundoscopic features and knowing the definitive first-line therapeutic agent that targets viral replication machinery is essential for saving the patient's vision.

**Solution:**

- (a) The classic fundoscopic presentation displaying extensive retinal hemorrhages interspersed with fluffy, pale white retinal exudates is colloquially described as a pizza-pie retinopathy or cheese and ketchup appearance, signaling severe necrotizing retinitis.
- (b) The causative pathogen is human herpesvirus five, commonly known as Cytomegalovirus, which reactivates under conditions of profound cell-mediated immunodeficiency.
- (c) CMV causes lytic destruction of retinal architecture, which leads to permanent visual field defects or complete blindness if left untreated.
- (d) Ganciclovir serves as the preferred first-line antiviral agent for this condition due to its superior efficacy profile.
- (e) Mechanistically, ganciclovir is a nucleoside analogue of deoxyguanosine that undergoes initial monophosphorylation by a viral-encoded protein kinase, UL97, inside infected cells.
- (f) Host cellular kinases subsequently convert it into ganciclovir triphosphate, which competitively inhibits viral DNA polymerase and terminates viral DNA elongation.
- (g) While foscarnet and cidofovir also inhibit viral DNA polymerase, they are generally reserved as second-line or alternative options due to their significant nephrotoxicity profiles.

**Final Answer:** Ganciclovir

**Answer: (B)**

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Q12.

**Solution**

**Concept:** Rhinocerebral mucormycosis is a rapidly progressive and life-threatening opportunistic fungal infection that primarily strikes individuals with uncontrolled diabetes mellitus who are suffering from diabetic ketoacidosis or those under profound medical immunosuppression. This question evaluates the recognition of the diagnostic histopathological appearance of the invading organism and its subsequent taxonomic grouping.

**Solution:**

- (a) In patients experiencing diabetic ketoacidosis, elevated ambient blood glucose combined with a low physiological pH and a high concentration of free serum iron creates an optimal environment for the rapid proliferation of specific angioinvasive environmental molds.
- (b) These fungal elements physically invade the local vascular endothelium, resulting in extensive intravascular thrombosis, localized tissue infarction, and the development of black necrotic eschars inside the nasal passages, paranasal sinuses, or hard palate.
- (c) Direct microscopic inspection of tissue biopsy sections or surgical debridement specimens remains the most definitive diagnostic approach to confirm this clinical suspicion.
- (d) The histopathological features show broad, ribbon-like hyphae that are predominantly aseptate or exhibit sparse, rare septations.
- (e) These wide filaments characteristically demonstrate non-dichotomous, irregular branching that occurs at wide angles approaching ninety degrees, also described as right-angle branching.
- (f) Taxonomic classification categorizes the primary pathogens responsible for this clinical condition, such as the prominent genera *Rhizopus* and *Mucor*, under the specific fungal order Mucorales.
- (g) Orders like Aspergillaceae display narrow, septate hyphae branching at acute forty-five-degree angles.

**Final Answer:** Mucorales

**Answer: (A)**

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Q13.

**Solution**

**Concept:** The question focuses on the morphological identification of helminthic ova via stool microscopy. Intestinal parasitic infections often present with distinct gastrointestinal manifestations, and identifying the unique structural characteristics of their shed eggs under light microscopy remains the gold standard for diagnostic confirmation.

**Solution:**

- (a) The schematic diagram and the clinical presentation of abdominal discomfort alongside rectal prolapse in a young child are highly diagnostic of an intensive infection caused by the nematode *Trichuris trichiura*, commonly known as the human whipworm.
- (b) Adult whipworms embed their thin anterior segments into the mucosal lining of the cecum and proximal large intestine. Severe burdens weaken the local structural support of the rectal mucosa, directly leading to rectal prolapse during defecation.
- (c) Under microscopic examination of a standard stool sample, *Trichuris trichiura* sheds highly characteristic ova that cannot be easily confused with other human intestinal parasites.
- (d) These eggs are precisely described as barrel-shaped, elongated, or symmetric ovals measuring approximately fifty micrometers in length with a thick, smooth, translucent amber-colored shell wall.
- (e) The defining diagnostic feature of these eggs is the presence of prominent, clear, dome-shaped bipolar mucous plugs located symmetrically at both ends of the longitudinal axis.
- (f) The internal structure contains a distinctive unsegmented ovum mass. In contrast, *Ascaris* ova are roughly spherical with rough mammillated coats, *Ancylostoma* ova display thin clear shells with internal segmentation cleavage, and *Enterobius* ova are asymmetric flattened ovals.

**Final Answer:** Trichuris Pools (*Trichuris trichiura*)

**Answer: (B)**

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Q14.

**Solution**

**Concept:** This question requires identifying the specific species of the genus *Plasmodium* responsible for malaria based on clinical history and morphology within a peripheral blood smear. Distinguishing between malaria species is essential for understanding the clinical course, predicting specific patterns of cyclic paroxysms, and choosing an appropriate therapeutic regimen to eliminate both blood and tissue stages.

**Solution:**

- (a) The clinical description outlines a classic presentation of malaria acquired in an endemic region of East Africa, characterized by paroxysms of high fevers, chills, and rigors corresponding to synchronous erythrocyte rupture.
- (b) Analysis of thin blood films allows for precise species identification by examining infected red blood cell size, internal cellular modifications, and the specific architecture of the intraerythrocytic parasites.
- (c) The presence of enlarged, mature red blood cells containing active amoeboid trophozoites with irregular cytoplasm immediately eliminates *Plasmodium falciparum* (which infects all sizes and shows normal-sized cells with delicate ring forms) and *Plasmodium malariae* (which prefers older, smaller cells).
- (d) The detection of fine, evenly distributed eosinophilic or pink-purple granules within the host erythrocyte cytoplasm represents Schüffner's dots, a phenomenon restricted to infections by *Plasmodium vivax* and *Plasmodium ovale*.
- (e) To differentiate these two, *Plasmodium vivax* characteristically presents with markedly enlarged, pale, distorted erythrocytes containing highly active, pleomorphic, and spread-out amoeboid trophozoites.
- (f) While *Plasmodium ovale* also induces Schüffner's dots, it is distinguished by producing noticeably oval-shaped host erythrocytes with fimbriated or ragged margins and more compact, non-amoeboid internal parasitic forms.

**Final Answer:** Plasmodium vivax

**Answer: (B)**

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Q15.

**Solution**

**Concept:** This question tests understanding of the unusual biological characteristics, taxonomic classification, and therapeutic profiles of *Pneumocystis jirovecii*. This opportunistic pathogen is a major cause of severe interstitial pneumonia in individuals with advanced human immunodeficiency virus (HIV) infection presenting with low CD4+ T-cell counts.

**Solution:**

- (a) The presentation of a dry cough, gradual dyspnea, and low-grade fever in an immunocompromised patient combined with bronchoalveolar lavage fluid demonstrating crushed ping-pong ball-shaped cysts on methenamine silver stain confirms *Pneumocystis jirovecii* pneumonia.
- (b) Historically misclassified as a protozoan parasite due to its unique trophic and cystic life cycles, modern nucleic acid sequencing and biochemical analysis have definitively established that *Pneumocystis jirovecii* belongs to the kingdom Fungi.
- (c) Despite its fungal classification, it possesses distinct biochemical structural deviations that differentiate it from classic medical molds and yeasts, drastically altering its susceptibility to standard antifungal protocols.
- (d) The cell membrane of typical fungi uses ergosterol as its predominant structural sterol, which serves as the direct target for polyenes like amphotericin B and inhibitors like azoles.
- (e) In contrast, the cell membrane of *Pneumocystis jirovecii* lacks ergosterol completely, incorporating cholesterol and other unique sterols instead, making it intrinsically resistant to traditional azoles and polyenes.
- (f) Additionally, it is an obligate extracellular parasite that cannot be cultivated on standard laboratory media such as Sabouraud Dextrose Agar, relying instead on trimethoprim-sulfamethoxazole rather than classic antifungal agents for clinical management.

**Final Answer:** It is a fungus whose cell wall lacks ergosterol, making it intrinsically resistant to azoles

**Answer: (C)**

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Q16.

**Solution**

**Concept:** This question explores the molecular pathophysiology underlying primary immunodeficiency disorders, specifically Leukocyte Adhesion Deficiency Type 1 (LAD-1). Effective innate immune defense requires circulating neutrophils to leave the bloodstream and migrate into infected tissues through a tightly coordinated, multi-step cascade of cellular adhesion events.

**Solution:**

- (a) The classic triad of recurrent bacterial infections lacking pus formation, delayed separation of the umbilical cord past the normal two-week postpartum window, and persistent, marked neutrophilia points directly to LAD-1.
- (b) Neutrophilia occurs because leukocytes are synthesized normally by the bone marrow and remain viable within the intravascular compartment but cannot cross the vascular endothelium into peripheral tissues.
- (c) The multi-step adhesion cascade involves initial selectin-mediated rolling, followed by firm integrin-mediated adhesion and crawling, culminating in transmigration through the endothelial junction.
- (d) Leukocyte Adhesion Deficiency Type 1 is caused by heterogeneous mutations in the ITGB2 gene, which encodes the common beta-two subunit (CD18) of the leukocyte integrin heterodimers.
- (e) This genetic defect leads to a complete absence or severe reduction of functional beta-two integrins—including LFA-1 (CD11a/CD18), Mac-1 (CD11b/CD18), and p150,95 (CD11c/CD18)—on the surface of phagocytes.
- (f) Without functional CD11/CD18 integrin clusters, neutrophils roll normally via selectins but cannot bind firmly to endothelial ICAM-1 molecules, preventing extravasation and leaving tissue spaces vulnerable to infection.

**Final Answer:** 2 – integrins (CD11/CD18 cluster)

**Answer: (B)**

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Q17.

**Solution**

**Concept:** The question examines the structural anatomy of an immunoglobulin monomer and evaluates how specific regions correlate with immunological diversity and functional classification. Immunoglobulins are composed of pairs of heavy and light polypeptide chains organized into highly specialized functional domains.

**Solution:**

- (a) The provided schematic illustrates a typical monomeric antibody structure, detailing the spatial arrangement of the heavy chains (inner structures) and light chains (outer structures) linked by covalent disulfide bonds.
- (b) Region X highlights the amino-terminal variable domains of both the heavy and light chains ( $V_H$  and  $V_L$ ). Together, these variable regions form the antigen-binding fragment (Fab) tip of the molecule.
- (c) Within Region X reside the hypervariable loops, or complementarity-determining regions (CDRs), which fit the unique molecular topography of a specific antigenic epitope.
- (d) The unique arrangement of these CDR loops forms the idiotype of the antibody, acting as a signature that defines its precise antigen-binding specificity.
- (e) Region Y encompasses the carboxy-terminal constant domains of the heavy chains ( $C_H2$  and  $C_H3$ ), which together make up the crystallizable fragment (Fc) stem of the immunoglobulin monomer.
- (f) This constant heavy region defines the biological effector isotype class (such as IgG, IgM, IgA, IgE, or IgD), which dictates whether the molecule activates the complement cascade or binds to Fc receptors on mast cells, macrophages, or natural killer cells.

**Final Answer:** Region X determines the idiotype; Region Y determines the isotype

**Answer: (A)**

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Q18.

**Solution**

**Concept:** This question addresses the cellular and molecular mechanisms driving systemic Type I (immediate) hypersensitivity reactions. These rapid, life-threatening allergic reactions occur when an individual with prior immunological sensitization is re-exposed to a specific triggering antigen or hapten.

**Solution:**

- (a) The clinical scenario describes systemic anaphylaxis developing within minutes after intravenous penicillin administration in a patient with an allergic predisposition, such as a history of asthma.
- (b) Penicillin acts as a reactive hapten, binding covalently to endogenous serum carrier proteins to form a multivalent immunogenic complex that stimulates a targeted immune response.
- (c) During the initial sensitization phase, helper T cells drive B-cell isotype switching, producing high levels of antigen-specific immunoglobulin E (IgE) antibodies.
- (d) These secreted IgE molecules bind with high affinity via their Fc regions to specific *FcεRI* receptors permanently expressed on the surface of tissue mast cells and circulating basophils.
- (e) Upon subsequent re-exposure, the multivalent penicillin-protein complexes bind simultaneously to adjacent membrane-bound IgE molecules, causing physical aggregation and cross-linking of the underlying receptors.
- (f) This cross-linking triggers an immediate intracellular signaling cascade, inducing rapid degranulation and the systemic release of preformed mediators like histamine alongside newly synthesized leukotrienes, causing widespread vasodilation, hypotension, and bronchoconstriction.

**Final Answer:** Cross-linking of membrane-bound IgE molecules by the multivalent allergen on mast cells

**Answer: (B)**

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Q19.

**Solution**

**Concept:** The question examines the clinical consequences of specific inherited deficiencies within the human complement cascade. The complement system is a highly organized biochemical network of serum proteins that enhances innate immune defenses through opsonization, leukocyte recruitment, and direct pathogen lysis.

**Solution:**

- (a) Inherited deficiencies in individual complement components reveal distinct clinical vulnerabilities, depending on where the missing protein functions within the activation pathways or structural assemblies.
- (b) Deficiencies in early classical components, such as C1q, C1r, C1s, C2, or C4, compromise the clearance of immune complexes, predisposing individuals to autoimmune conditions like systemic lupus erythematosus (SLE).
- (c) A deficiency in C3, the central convergence point for all activation pathways, impairs both opsonization and leukocyte chemotaxis, causing severe, recurrent infections with a wide range of encapsulated pyogenic bacteria.
- (d) In contrast, a selective vulnerability to recurrent, disseminated infections caused by *Neisseria* species, including *Neisseria meningitidis* and *Neisseria gonorrhoeae*, is tied to deficiencies in the late-acting terminal complement components.
- (e) These terminal components—C5, C6, C7, C8, and C9—assemble sequentially on the outer leaflet of target membranes to form the pore-like Membrane Attack Complex (MAC).
- (f) Because *Neisseria* species possess thin cell walls, they are uniquely susceptible to direct, MAC-mediated osmotic lysis; a deficiency in these terminal factors prevents MAC assembly, leaving the host dependent on less effective clearance mechanisms against these pathogens.

**Final Answer:** Deficiency of C5, C6, C7, C8, or C9 (Membrane Attack Complex)

**Answer: (D)**

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Q20.

**Solution**

**Concept:** This question focuses on the rules governing antigen presentation and the specific interactions between major histocompatibility complex (MHC/HLA) proteins and T-lymphocyte coreceptors during adaptive immune responses.

**Solution:**

- (a) The mixed lymphocyte reaction simulates antigen presentation, where specialized antigen-presenting cells (APCs) capture, process, and present exogenous proteins to helper T cells to initiate an adaptive immune response.
- (b) Exogenous antigens, such as extracellular viral particles or phagocytosed debris, are internalized by professional APCs (including dendritic cells, macrophages, and B cells) via endocytosis or phagocytosis.
- (c) These internalized proteins are degraded within acidic endolysosomal compartments into short peptide fragments, which are then loaded onto specialized human leukocyte antigen (HLA) Class II molecules.
- (d) The resulting HLA Class II-peptide complexes are transported to the plasma membrane for display to helper T-lymphocytes ( $T_H$  cells), which express antigen-specific T-cell receptors (TCRs).
- (e) This immunological synapse is stabilized by the CD4 coreceptor expressed on the helper T cell surface, which binds specifically to the invariant hydrophobic beta-two domain of the HLA Class II molecule.
- (f) This organization adheres to the "rule of eight": HLA Class II interacts with CD4 ( $2 \times 4 = 8$ ), whereas endogenous cytosolic antigens are presented on HLA Class I molecules to cytotoxic T cells expressing the CD8 coreceptor ( $1 \times 8 = 8$ ).

**Final Answer:** HLA Class II molecule interacting with the CD4 coreceptor

**Answer: (B)**

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**Answer Key**

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

