BIOL 240 *GENERAL MICROBIOLOGY* (Part IV) – Detailed Terms & Concepts 11/19/2006

12. VIRUSES: DNA or RNA, double or single-stranded; protein coat, some enveloped, specific host range receptors (spikes). Helical, polyhedral; Obligate intracellular parasites – must be grown in host cells → **Plaques**. Identify – cytopathic effects, serology, PCR. Bacteriophage Lytic cycle: Attachment, penetration – inject DNA, biosynthesis, Maturation/ assembly, Release – lysis of host…. Lysogenic cycle: ***prophage*** genome integrated into host chromosome. Animal Viruses: attachment, penetration by endocytosis or fusion, uncoating, biosynthesis of viral DNA and proteins, Maturation/assembly, release – budding or rupture. **Retrovirus *reverse transcriptase***, **Provirus**; **Budding of enveloped viruses**. dsDNA viruses = papilloma/warts, pox, herpes, Hepa*dna*virus (hepatitis B), polio, cold; ssRNA+: polio, cold, Hepatitis A, rubella, West Nile, Hepatitis C, SARS; ssRNA-: rabies, ebola, mumps, Flu, Hantavirus; Retrovirus: tumors (HTLV), HIV; dsRNA: reovirus, rotavirus (resp., digest. illness) PRIONS --- spongiform encephalopathies, resistant proteins that convert normal cellular proteins to parasitic. VIROIDS – small, stable infectious RNAs in plants.

15. PATHOGEN MECHANISMS: pathogenicity, virulence. Entry- Mucous membranes, skin, parenteral. ID50, LD50. Adherence – ***adhesins*** (glycocalyx/capsule, fimbriae, M-protein); **Virulence Factors** (coagulase, kinases, hyaluronidase, collagenase, IgA proteases, Siderophores, Antigenic variation); **Exotoxins** – **A-B toxins** (protein), **Superantigens** (***TSST***), **Membrane-disrupting toxins** (hemolysins, leukocidins), ***Lysogenic conversion***. **Endotoxin** (LPS lipid A) – systemic inflammation & shock; Viral Lysis and Inclusions, Fungi – waste products, allergy, toxins, proteases, capsules; Protozoa – waste, avoid defenses --grow in phagocytes, antigenic variation. Helminths – feed on host tissues, block organ functions, wastes harmful; Algae – neurotoxins in dinoflagellates & diatoms.

16. NONSPECIFIC HOST DEFENSES: Mechanical factors: **Skin** (epidermis, keratin), **Mucous membranes**, ***Ciliary escalator***, lacrimal apparatus, saliva, urine, vaginal secretins. Chemical Factors: **Sebum**, low pH, **Lysozyme** (sweat, tears, saliva, mucous), Gastric juice, Transferrins, reactive oxygen (NO, etc.)k Normal microbiota. Leukocytes: **Neutrophils**/PMNs (phagocytic), [**Lymphocytes** – B, T], **Monocytes** (immature macrophages; phagocytic), **Eosinophils** (parasite toxins, phago.), **Basophils** (histamine, inflamm.). Phagocytosis – evasion (M-protein, capsules inhibit adherence; Leukocidins, MAC complement complex, escape phagosome, prevent phago-lysosome fusion, survive in phagolysosome). INFLAMMATION – redness, pain, heat, swelling/edema, **acute-phase proteins** (complement, cytokines), vasodilation (histamine, prostaglandins), Margination and ***Diapedesis*** (emigration) of WBCs, tissue repair. Damaged cells→ **histamine & kinins** (vasodilation, vessel permeability), **prostaglandins** (intensify hist./kinin effect), **Leukotrienes** increase permeability & attach phagocytes. Fever: hypothalamus reset higher in response to endotoxin→IL1→ prostaglandins; shivering & fever; remove IL1 – sweat to normal Temp. ("crisis"). COMPLEMENT System: **Opsonization**, ***MAC*** = C6-C9 **Cytolysis**, **chemoattraction** of phagocytes (inflammation). Classical Pathway (IgG + C1, C2, C4 →C3, C5); Alternative pathway (B, D, P serum proteins directly bind bacterial cell wall → C3/C5→ MAC cytolysis & opsonization). INTERFERONS: **alpha & beta** → stimulate anti-viral defense in cells neighboring infected cell (nucleases degrade viral RNA; inhibit protein synth.); **Gamma Interferon** → phagocytosis of bacteria.

17. SPECIFIC HOST DEFENSES: Innate defenses; Immunity; Antigen, Antibody. Acquired immunity; Humoral Immunity, Cell-Mediated Immunity. Humoral: **B-Lymphocytes** (Bone Marrow), extracellular Ag's: **Antigen-Antibody interactions** → (agglutination, ***opsonization***, complement activation, inflammation, neutralization, Ab-dependent cell-mediated cytotoxicity), **Epitopes**.. C & V regions of antibody **(immunoglobulin**, **Ig**). **IgG**, **IgM**, **IgA**, IgD, IgE. **Clonal Selection**, **Effector cells** (plasma B, or Tc), **Memory cells**. Clonal Deletion. Cytokines – interleukins, γ-interferon, chemokines. Cell-Mediated: **T cells** (Thymus) respond to intracellular Ag's. G.I. tract entry – **M-Cells** in **Pyers patches** with **Dendritic Cells** (**APC**'s) & T cells. ***Th (CD4) cells*** – interleukins stimulate B cells & more T cells, activate NK; ***Tc (CD8) cells*** – ***perforin*** destruction of infected/cancerous cells. **[[APC** (macrophage, dendritic, any host cell) presents foreign antigen with **MHC** complex at cell surface & makes **IL1** → activates **Th cell (IL2)** → activates specific Tc cells and B cells**.]] Cell-mediated cytotoxicity by Tc with APC.** Nonspecific: activated macrophages, ***NK cells***. HIV & AIDS: (immunodeficiency). Infects and destroys CD4 cells (T helper, macrophages, dendritic cells). **CD4** & **CXCR4** recepors bound by ***gp120 protein***, endocytosis, envelope fusion, uncoating, release of 2 RNA genome strands, **Reverse transcriptase**, and **HIV protease**. (**Provirus *latent infection***, HIV particles in vacuoles, and fast mutation all avoid host defenses.) Detect by serum antibodies, antigens, and PCR of viral load (most sensitive method). Chemotherapy- **Nucleoside RTase inhibitors**, **non-nucleoside RTase inhibitors**, **Protease inhibitors** (inhibit protein assembly**), Virus decoys** (CD4 analogs, etc.).

21. SKIN DISEASES: (salty, low pH, fatty acid sebum, lysozyme). Mucous membranes: line body cavities, secrete mucous, some with **cilia**. Normal microbiota: gram pos. salt-tolerant (*staph., micrococcus, diptheroids*). ***Staph aureus*** – coagulase, leukocidin, exfoliative toxin (impetigo, toxemia, scalded skin, **TSS** (toxic shock)); ***Strep pyogenes*** – Group A β-hemolytic; **M-proteins** (adhesive, antiphagocytic), **streptokinases**, **hyaluronidase**, **Exotoxin A** (superantigen – TSS). ***Pseudomonas aeruginosa*** (gram -) – dermatitis, otitis, post-burn. **Poxviruses**: Smallpox (Variola), **Herpesviruses** – HHV1 & HHV2 (cold sores, genital) – latent in trigeminal or sacral nerve ganglia.

22. NERVOUS SYSTEM DISEASES: by trauma or systemic infection; **Meningitis** in cerebrospinal fluid – all meningitic bacteria (and fungi) have thick polysaccharide capsules. Also, encephalitis of brain. ***Haemophilus influenzae (gram-)***, Hib vaccine, capsule B (gram -, normal throat microbiota). ***Strep. pneumoniae*** (eg: Griffiths' transformation) Encapsulated, normal nasopharyngeal microbiota; High mortality in elderly & children. Listeria monocytogenes: gram+, grow in fridge, foodborne, cross placenta, reproduce in phagocytes, actin tails/rockets for cell-cell spread. **Tetanus** = toxin-induced disease (no colonization of host) – gram +/spores/anaerobe (***Clostridium tetani***); ***Tetanospasmin*** (Ttx) → blocks release of GABA → spastic paralysis. DTP vaccine; antitoxin. **Botulism**: ***(C. botulinum)*** (~C.t.) ingest ***Botox*** → blocks release of Acetylcholine → flaccid paralysis. (canning, honey).

23. BLOOD & LYMPH DISEASES: lymphatics, lymph nodes, *interstitial fluid*, **sepsis, septic shock**. **ANTHRAX** (***B. anthracis***)– cutaneous (cipro antibiotic), G.I., ***inhalation ~100% mortalty.*** Soil – grows and kills macrophages, release toxins, cause lesions. **PLAGUE**: ***Y. pestis***. Survives and proliferates in phagocytes. Bubonic, Septicemia, ***Pneumonic (~100% mortality)***. Reservoir = rodents, vector = rat flea.

24. RESPIRATORY DISEASES: Upper: Laryngitis, sinusitis, epiglottitis. **Diphtheria** – (gram +, *Corynebacterium diphtheriae*); **Dtx** kills host throat cells, damages heart and kidneys. Leathery membrane of fibrin, dead tissue, and bacteria in upper airway. (Vacc: DTaP, Td) Lower: ciliary escalator, (bronchitis, bronchiolitis, pneumonia). **Pertussis** (*Bordatella pertussis*, gram-) Capsule, **Ptx** kills cells systemically; **Tracheal cytotoxin** kills ciliary cells – deep, desperate coughing. (Whooping). **Tuberculosis** (gram +, acid-fast, ***Mycobacterium tuberculosis***). Human-human, ingested, survive, and multiply in alveolar macrophages – more phagocytes come en enclose infected macrophages (**Tubercule** in airway); Infected cells in caseous center may be calcified, or **liquefaction** of tubercule to destroy host cells and further infect air passages → destroy tissue, cough blood, can cause sepsis (blood and lymph). Tuberculin skin test, chest X-ray, acid-fast sputum. **Influenza**: (**8 ssRNA, enveloped virus**) – fever, headache, muscle ache only! H-spikes = attachment (**hemagglutanin**); **Neuramidase** (N) Spikes used to break down host cells for release. Avoid immunity by antigenic shift and antigenic drift.

25. GASTROINTESTINAL DISEASES: **Fecal-Oral cycle**; Normal microbiota – many in mouth and large intestine (*E. coli, Bacteroides, Enterobacter, Klebsiella, Lactobacillus, Proteus*). Lower GI symptoms: diarrhea, gastroenteritis, dysentery**. Infectious growth = 12hr-2wk incubation; Intoxication = symptoms 1-48hr. Staph. Food poisoning** – ***Enterotoxin superantigen*** preformed in food; heat-stable, after bact. Killed! **Shigellosis**: ***Shigatoxin***: invades epithelial cells and spreads cell-cell with lysis of intestinal epithelium and actin-tail; survive and grow in macrophages; bloody diarrhea (Like ***E. coli* O157:H7** = enterohemorragic *E. coli*, w/ shigatoxin!). ***Salmonella enterica* Typhimurium** – **Salmonellosis**: replicates in epithelium, invades bloodstream and lymph → liver & kidneys, fever, perforation of intestine, sepsis/shock***; Salmonella typhi*** (**Typhoid Fever**) – systemic thru phagocytes; severe sepsis, fever, shock. Viral gastroenteritis (common!) = Rotovirus, Norovirus ("stomach flus"??).

27. ENVIRONMENTAL MICROBIOLOGY: Biogeochemical cycles: Carbon cycle (producers, consumers, decomposers, atmosphere, oceans), Nitrogen cycle (**decomposition, ammonification, nitrification, denitrification, nitrogen fixation**). **Legume-Rhizobium Symbiosis**: root nodule formation, infection threads, colonization, fixation. Decomposition & **Bioremediation**; ***Biofilms***, Bioluminescence (Luciferase).