2024
SUMMARY

MICROBIOLOGY 1

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ARKAN
ACADEMY

Classification of microorganism		
Prokaryotes		
Eukaryotes		
Acellular	Viruses	➢ Smallest infectious agent ➢ Obligate Intracellular
	Viroid's	➢ ssRNA Without protein coat ➢ Smaller than virus ➢ Infect Plants
	Prion	➢ Misfolded protein without N.A ➢ Causing diseases like: ✓ Creutzfeldt-Jakob disease (CJD) in humans ✓ BSE or mad cow disease in cattle

	Nuclear membrane	Size	Membrane organelles	#Chromosome	Ribosome	Cell wall	Cell membrane	Division	Include
Eukaryotic	Yes (Nucleus)	10-100µm	Present	Multiple (linear)	80S (40S -60S)	No	Has sterol	Mitosis	Fungi Parasites Algae
Prokaryotic	No (Nucleoid)	0.05-10µm	Absent	One (circular)	70S (30S-50S)	Yes	No sterols	Binary fission	Bacteria

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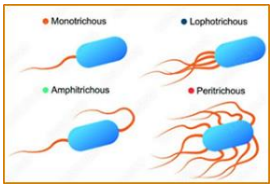
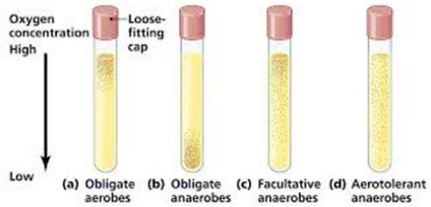
Bacterial structure		
Essential components		
	Cell wall	• Function: ➢ Bacterial rigidity and shape ➢ Protection against osmotic changes ➢ Porous to allow nutrients passage. ➢ Structure differs in gram positive & negative bacteria which appear in staining: ✓ Gram positive cell wall: violet/blue ✓ Gram negative cell wall: pink • **Gram stain** ➢ Crystal violet: primary stain ➢ Iodine: fixation ➢ Acetone: decolonization ➢ Safranin: counter stain
	Plasma membrane (cytoplasmic membrane)	• Function: ➢ Synthesis of precursors of cell wall polymers and membrane lipids. ➢ Selective permeability and active transport of molecules into cells. ➢ Energy generation by oxidative phosphorylation. ➢ Excretion of enzymes and toxins.
	Ribosome	• 70S • Function: Sites of protein synthesis
	Nucleoid	• Area on cytoplasm where bacterial DNA (Double stranded, Circular) located without nuclear membrane • Function: carry genetic information for growth and survival
	Inclusion bodies	• Function: Food and energy storage granules

Accessory components		
	Capsule	• Function: ➢ Protect Cell wall: Bacteriophage, Complement, lysozyme ➢ Prevent phagocytosis (Virulence) ➢ Adherence (initial step of infection) ➢ Development of vaccine (Antigenic)
	Pilus or fimbria	• Function: adhesion and conjugation
	Flagella	• Function: motility 
	Spores	• Function: to survive bacteria in unsuitable condition
	Plasmid	• EXTRA chromosomal dsDNA. • Function: contain genes that confer some properties such as: Antibiotic resistance, Virulence factors (exotoxin), Genes for pili.
	Transposons	• Jumping genes

Bacterial growth	
	• Increase in the size of organisms and an increase in their number.
Bacterial growth stages	• Lag phase: **little** or no change in # cells • Log or exponential phase: the **increase** in bacterial growth • Stationary phase: **equilibrium** between cell division and death • Death (decline) phase: **increase** the number of deaths
Bacterial division	• Binary fission
Bacteria naming	• Phototrophs: use **light** as their energy • Chemotrophs: use **chemical** compounds • organotrophs : use **organic** compounds • lithotroph: use **inorganic** sources • Autotrophs : carbon from **carbon dioxide** • Heterotrophs: carbon from **organic** compounds • Mixotrophic : carbon from **both** • Acidophilus : live in **acidic** condition • Alkalophilus: live in **alkaline** condition • Psychrophiles: live in **20** • Mesophiles : live in **35-42** • Thermophiles: live in **65-80** 

Sterilization and disinfection	
Sterilization	• Killing **all** microbes and spores (100% killing) • Methods of Sterilization: • Heat • Dry: Red heat , Flaming, incineration, hot air oven • Moist Types: ➢ Moist heat at temperature below 100C: ✓ Pasteurization ✓ Inspissation

	➢ Moist heat at temperature at 100 C: ✓ Boiling ✓ Tyndallisation ➢ Moist heat at temperature above 100 C: ✓ Autoclaving • Radiation: U.V. rays, Ionizing radiation, I.R.(Infra-red) rays • Filtration : Positive Pressure Environment [room pressure higher than outside] • Chemical agents: Ethylene oxide/ Aldehydes/ Halogens/ Oxidizing agents [peroxides and ozen] / Alcohol [ethanol and Isopropanol]
Disinfection	• The **reduction** of pathogenic organisms
Antisepsis	• disinfection applied to **living** tissue

Identification of bacteria by lab test	
1. Phenotypic	• Microscopy (staining): Gram stain / Ziehl-Neelsen stain • **Media**: ➢ Basal media: Nutrient broth, nutrient agar and peptone water. ➢ Enriched media: blood agar, Chocolate agar, Lowenstein-Jensen media. ➢ Selective media: SSA, Mannitol Salt Agar. ➢ Differential media: Blood agar and MacConkey agar • **Biochemical test** (rapid test methods): ➢ Indole test (+ve red or pink layer) ➢ Methyl Red / Vogues-Proskauer : (+ve red media) ➢ Citrate utilization: green to blue ➢ Coagulase test: Clot formation ➢ H2S production (TSA): black precipitate ➢ Urease test: pink ➢ Phenylalanine deaminase test: green color
2. serological tests	• Agglutination tests • ELISAs • IFAs
3.Genotypic techniques	• PCR (polymerase chain reaction) • Nucleic acid sequence analysis • RNA analysis • RFLP (restriction fragment length polymorphism) • Plasmid fingerprinting.
Another test	• Vitek • MALDI - TOF • Mass spectrometric method • Rapid identification • Growing database.

Taxonomy	Is the science of classification of organisms
Methods of typing	• Phage typing • Bactericin typing • Resistotyping • Biotyping • Serotyping • Plasmid typing
Naming microorganisms	*Staphylococcus aureus (S. aureus)*

Bacterial chromosome	
Bacterial DNA	• Bacterial chromosome: is circular double helix supercoiled • Extra genetic material (plasmids) Types: ➢ Fertility (F) Plasmids: conjugation ➢ Resistance (R) Plasmids: resistance ➢ Col Plasmids: bacteriocins. ➢ Virulence Plasmids: Transform
Transcription &Translation	• Transcription ➢ RNA polymerase: RNA polymerase(activators and repressory) ➢ Elongation: RNA polymerase ➢ Termination: Rho-Independent, Rho-dependent Termination • Translation ➢ Initiation: tRNA, start codon ➢ Elongation: Peptidyltransferase ➢ Termination: stop codon (UAA, UAG, UGA).
DNA replication	• DnaA: Initiator protein that binds to the origin of replication. • (Helicase): Unwinds the DNA double helix. • SSBs (Single-Stranded Binding Proteins): Stabilize unwound DNA strands. • (Primase): Synthesizes RNA primers. • DNA Polymerase III: Main enzyme for DNA synthesis. • DNA Polymerase I: Replaces RNA primers with DNA. • DNA Ligase: Joins Okazaki fragments.
DNA mutations **(Exogenous Triggers)**	• Substitution Mutations: Silent Mutation/ Missense Mutation/ Nonsense Mutation/ Null Mutations • Frameshift Mutation: insertion or deletion
Horizontal Gene transfer	• Conjugation (pili) • Transformation (uptake) • Transduction (bacteriophages)

Biorisk Management	Reduce potential exposure lab hazared
Biosafety	Prevent the unintentional exposure to the biological agents
Biosecurity	Prevent the loss of hazared
International standards	From organizations like OSHA, NIH, ISO, OIE, FAO, and WHO

Pathogenesis of bacterial infection	
Transmission of Bacteria:	• Contact, airborne, droplet, vector and vehicular
Adhesion	• Pili and fimbriae
Motility	• Flagella
Invasion	• Tight junctions of epithelial surfaces or internalization into epithelial cells.
Toxins/Exotoxins	• Secreted toxin ex: enterotoxins
Toxins/Endotoxins	• Gram negative : LPS (toxic shock)
Secretion Systems	• Types of Secretion Systems: ➢ Type III Secretion Pathway: injecting toxin proteins directly into host cells. ➢ Type I and IV Secretion Systems: Found in both G+ &G- ➢ Type II, III, V, and VI Secretion Systems: Specific G-
Iron Uptake Mechanisms:	• Siderophores
Evasion of Immune System	• Capsule, enzymes, different protein prevent phagocytosis and Opsonization.
Enzyme production	• Hyaluronidase , collagenase and cytolysins
Pathogenicity Islands	• Genetic units aiding bacterial virulence.
Biofilm	• A community of bacteria that are attached to a surface encased in (EPS).

Streptococci	
Classification method	• Lancefield groupings (A to W) • Hemolytic Patterns [β (complete hemolysis)/ α (partial hemolysis)/ γ (no change) • Biochemical Properties: Based on physiological traits
Key Pathogenic Species	• *Streptococcus pyogenes* (Group A Streptococcus/GAS) ➢ **Immune Evasion Mechanisms:** ✓ Hyaluronic acid capsule: inhibits phagocytosis. ✓ M Protein: Blocks complement and aid to adherence ✓ C5a Peptidase: Deactivates C5a ➢ **Toxins and Enzymes**: ✓ Streptococcal Pyrogenic Exotoxins ✓ Streptolysin S&O ✓ Streptokinase/ DNases (A-D) ➢ **Clinical Manifestations:** ✓ Suppurative (Pus-forming) Infections: Pharyngitis/ Scarlet Fever/Pyoderma/ Erysipelas/ Cellulitis/Necrotizing Fasciitis/Streptococcal Toxic Shock Syndrome ✓ Non-suppurative (Post-infectious) Infections: Rheumatic Fever/Acute Glomerulonephritis • *Streptococcus agalactiae* (Group B Streptococcus/GBS) • *Group D Streptococcus* (Enterococci) • **Virulence:** ➢ Ability to adhere to tissues and form biofilms ➢ Antibiotic Resistance ➢ Nosocomial Infections • *Streptococcus pneumonia* • **Immune Evasion Mechanisms:** ➢ Polysaccharide Capsule/ Pneumolysin/ Phosphorylcholine/ IgA Protease/ Amidase • *Streptococcus viridans* within this group have *S.mutans* : dental plaque

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Staphylococci	
	Gram-positive, non-motile, spherical cells, catalase-positive
Species	• *Staphylococcus aureus* • *Staphylococcus epidermidis* • *Staphylococcus lugdunensis* • *Staphylococcus saprophyticus*
Cell Wall Components	• Peptidoglycan • MSCRAMMs, • Teichoic Acids
Clinical Manifestations	• Localized Infections: ➢ Impetigo/ Folliculitis/ Furuncles (Boils)/Carbuncles • Toxin-Mediated Diseases: ➢ Food Poisoning/Scalded Skin Syndrome/ Toxic Shock Syndrome. • Coagulase-Negative Staphylococcus (CoNS) Infections: ➢ Device-Related Infections/Endocarditis/ Urinary Tract Infections

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