Vibrio, Aeromonas & Plesiomonas

Assistant prof. Buroooj M.R. Al-aajem

Department of Microbiology

College of Medicine

General Characteristics of Vibrio, Aeromonas and Plesiomonas

- Similarities to Enterobacteriaceae
  - Gram-negative
  - Facultative anaerobes
  - Fermentative bacilli
- Differences from Enterobacteriaceae
  - **Polar flagella**
  - **Oxidase positive**
- **Formerly classified together as Vibrionaceae**
  - **Primarily found in water sources**
  - **Cause gastrointestinal disease**
  - Shown **not closely related** by molecular methods

Morphology & Physiology of Vibrio

- **Comma-shaped (vibrioid) bacilli**
- ***V. cholerae*, *V. parahaemolyticus*, *V. vulnificus*** are most significant human pathogens
- Broad temperature & pH range for growth on media
  - 18-37°C
  - pH 7.0 - 9.0 (useful for enrichment)
- Grow on variety of simple media including:
  - MacConkey's agar
  - TCBS (**T**hiosulfate **C**itrate **B**ile salts **S**ucrose) agar
- ***V. cholerae* grow without salt**
  - Most **other vibrios are halophilic**

Epidemiology of Vibrio spp.

- *Vibrio* spp. (including *V. cholerae*) grow in **estuarine and marine environments** worldwide
- All *Vibrio* spp. can **survive and replicate in contaminated waters** with **increased salinity** and at **temperatures of 10-30^{o}C**
- Pathogenic *Vibrio* spp. appear to form symbiotic (?) **associations with chitinous shellfish** which serve as an important and only recently recognized **reservoir**
- **Asymptomatically infected humans** also serve as an important **reservoir** in regions where cholera is endemic

Taxonomy of Vibrio cholerae

- >200 serogroups based on somatic O-antigen
- **O1** and **O139 serogroups** are responsible for **classic epidemic cholera**
- **O1 serogroup subdivided** into
  - **Two biotypes: El Tor** and **classical** (or **cholerae**)
  - **Three serotypes: ogawa, inaba, hikojima**
- Some O1 strains do not produce cholera enterotoxin (atypical or nontoxigenic O1 *V. cholerae*)
- Other strains are identical to O1 strains but do not agglutinate in O1 antiserum (non-cholera (NCV) or non-agglutinating(NAG) vibrios) (non-O1 *V.cholerae*)
- Several phage types

Epidemiology of Vibrio cholerae

- Cholera recognized for more than two millennia with sporadic disease and epidemics
- **Endemic** in regions of Southern and Southeastern Asia; origin of pandemic cholera outbreaks
- Generally in communities with **poor sanitation**
- **Seven pandemics (possible beginning of 8th)** since 1817 attributable to increased world travel
- Cholera spread by **contaminated water and food**
- **Human carriers and environmental reservoirs**

Pathogenesis of V.cholerae

- **Incubation period:** 2-3 days
- **High infectious dose:** >10^8 CFU
  - 10^3 -10^5 CFU with **achlorhydria** or **hypochlorhydria** (lack of or reduced stomach acid)
- Abrupt onset of vomiting and **life-threatening watery diarrhea** (**15-20 liters/day**)
- As more fluid is lost, feces-streaked stool changes to **rice-water stools:**
  - Colorless
  - Odorless
  - No protein
  - Speckled with mucus

Pathogenesis of V.cholerae (cont.)

- Cholera toxin leads to profuse loss of **fluids and electrolytes** (sodium, potassium, bicarbonate)
  - **Hypokalemia** (low levels of K in blood)
  - Cardiac **arrhythmia** and **renal failure**
- Cholera toxin **blocks uptake of sodium & chloride** from lumen of small intestine

- **Death attributable to:**
  - **Hypovolemic shock** (due to abnormally low volume of circulating fluid (plasma) in the body)
  - **Metabolic acidosis** (pH shifts toward acid side due to loss of bicarbonate buffering capacity)

Laboratory Identification of Vibrios

- Transport medium - Cary-Blair semi-solid agar
- Enrichment medium - **alkaline peptone broth**
  - Vibrios **survive and replicate at high pH**
  - Other organisms are killed or do not multiply
- **Selective/differential** culture medium - **TCBS agar**
  - *V. cholerae* grow as **yellow colonies**
- Biochemical and serological tests

Treatment & Prevention of V. cholerae

- **Untreated: 60% fatality**
- **Treated: <1% fatality**
- **Rehydration & supportive therapy**
  - **Oral**

    Sodium chloride (3.5 g/L)
    + Potassium chloride (1.5 g/L)
    + Rice flour (30-80g/L)
    + Trisodium citrate (2.9 g/L)
  - **Intravenous** (IV)
- Doxycycline or tetracycline (Tet resistance may be developing) of secondary value
- **Water purification, sanitation & sewage treatment**
- Vaccines

Virulence Factors Associated with Vibrio cholerae O1 and O139

Virulence Factor	Biologic Effect
Cholera toxin	Hypersecretion of electrolytes and water
Coregulated pilus	Adherence to mucosal cells
Accessory colonization	Adhesin factor
Hemagglutination-protease (mucinase)	Induces intestinal inflammation and degradation of tight junctions
Siderophores	Iron sequestration
Neuraminidase	Increase toxin receptors

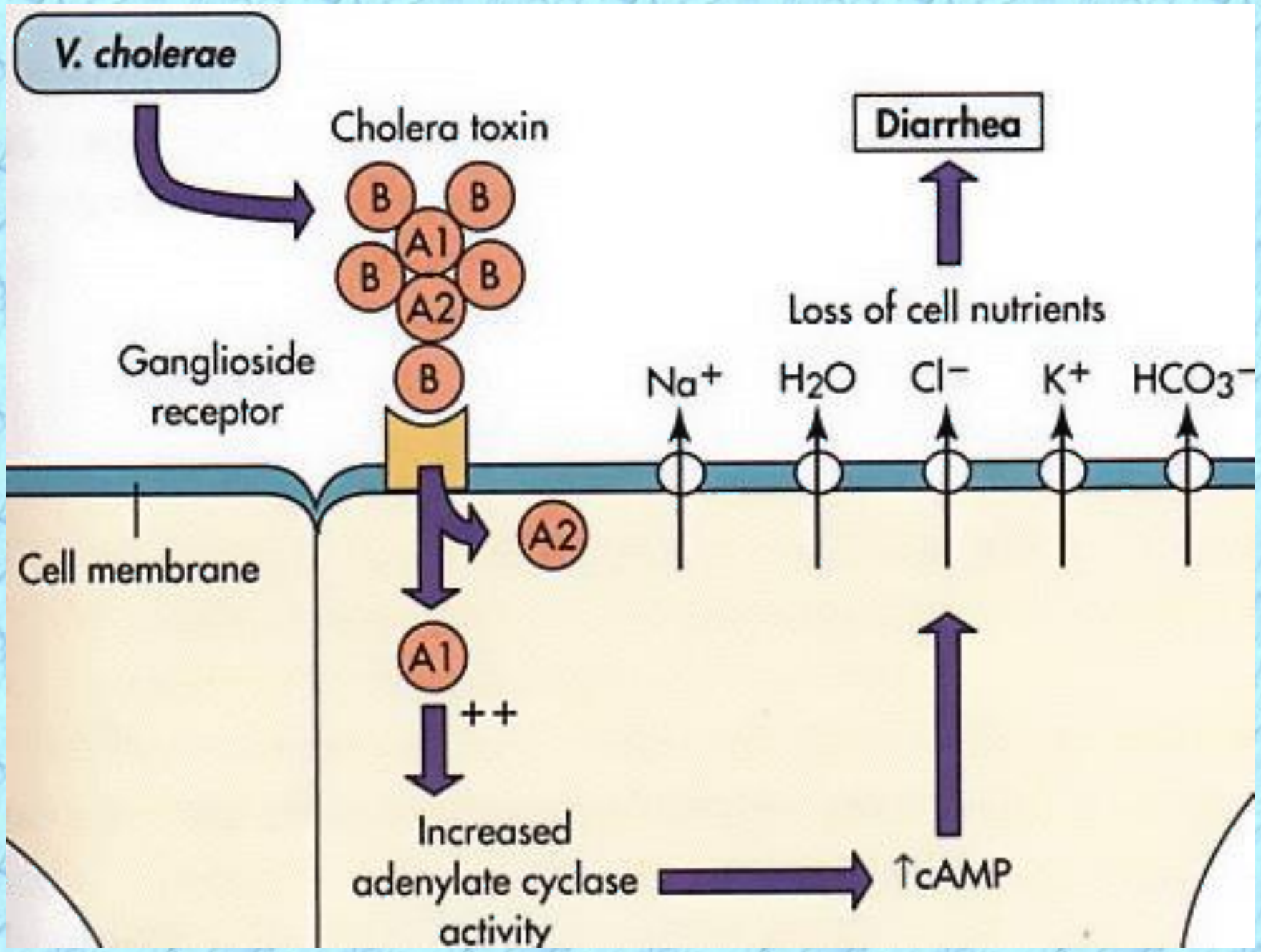
Two Broad Classes of Bacterial Exotoxins

- **Intracellular Targets: A-B dimeric (two domain) exotoxins:**
  - **Receptor-mediated endocytosis** (host cell uptake and internalization of exotoxin)
  - **ADP-ribosylation** of intracellular target host molecule
- **Cellular Targets: Cytolytic exotoxins (usually degradative enzymes) or cytolysins:** hemolysis, tissue necrosis, may be lethal when administered intravenously

Cholera Toxin (A2-5B)(Vibrio cholerae)

- Chromosomally-encoded; Lysogenic phage conversion; Highly conserved genetic sequence
- Structurally & functionally similar to ETEC LT
- B-subunit binds to **GM_1 ganglioside receptors** in small intestine
- Reduction of disulfide bond in A-subunit activates A_1 fragment that **ADP-ribosylates** guanosine triphosphate (GTP)-binding protein (G_s) by transferring ADP-ribose from nicotinamide adenine dinucleotide (NAD)
- ADP-ribosylated GTP-binding protein activates adenyl cyclase leading to an **increased cyclic AMP (cAMP)** level and **hypersecretion of fluids and electrolytes**

Mechanism of Action of Cholera Toxin



Physiology and Structure

Curved gram-negative bacilli.

Facultative anaerobe.

Fermenter.

Simple nutritional requirements but requires salt for growth.

Virulence

Refer to Table 30–3 for complete listing.

Hemolysin.

Adhesin.

Epidemiology

Organism found in estuarine and marine environments worldwide.

Associated with consumption of contaminated shellfish.

Not commonly isolated in the United States but is a major pathogen in countries where raw fish is eaten.

Diseases

Diarrhea ranging from mild disease to a cholera-like illness.

Typical presentation is an explosive, watery diarrhea.

Less commonly associated with wound infections and bacteremia.

Diagnosis

Culture should be performed as with *V. cholerae*.

Treatment, Prevention, and Control

Self-limited disease, although antibiotics can shorten symptoms and fluid loss.

Disease prevented by proper cooking of shellfish.

No vaccines are available.

Characteristics and Epidemiology of Aeromonas (Family Aeromonadaceae)

- Gram-negative facultatively anaerobic bacillus resembling members of the Enterobacteriaceae
- Motile species have **single polar flagellum** (nonmotile species apparently not associated with human disease)
- 16 phenospecies: Most significant human pathogens ***A. hydrophila***
- Ubiquitous in **fresh and brackish water**
- Acquired by **ingestion of or exposure to contaminated water or food**

Clinical Syndromes of Aeromonas

- Associated with **gastrointestinal disease**
  - **Chronic diarrhea in adults**
  - Self-limited **acute, severe disease in children** resembling shigellosis with blood and leukocytes in the stool
  - 3% **carriage** rate
- **Wound infections**
- Opportunistic systemic disease in immunocompromised
- **Putative virulence factors** include: endotoxin; hemolysins; eneterotoxin; proteases; siderophores; adhesins

Characteristics of Plesiomonas

- Formerly Plesiomonadaceae
- **Closely related to *Proteus*** & now **classified as Enterobacteriaceae despite differences:**
  - Oxidase positive
  - Multiple polar flagella (**lophotrichous**)
- Single species: ***Plesiomonas shigelloides***
- Isolated from **aquatic environment** (fresh or estuarine)
- Acquired by **ingestion of or exposure to contaminated water or seafood** or by **exposure to amphibians or reptiles**
- **Self-limited gastroenteritis**: secretory, colitis or chronic forms
- Variety of uncommon **extra-intestinal infections**