MEDICAL EDUCATION RESOURCE

ENTERIC GRAM-NEGATIVE RODS (ENTEROBACTERIACEAE)

? ENTERIC GRAM-NEGATIVE RODS (ENTEROBACTERIACEAE)

? CLASSIFICATION & GENERAL CHARACTERISTICS

? Definition & Overview

- Family of **Gram-negative, non-spore forming bacilli**
- Primarily **intestinal commensals**, but many are **important pathogens**
- Facultative anaerobes
- Major cause of:
    - **Gastrointestinal infections**
    - **Urinary tract infections**
    - **Septicemia**

? Habitat

- **Normal intestinal flora**
  - E. coli (dominant)
  - Enterobacter, Klebsiella (less common)
- **Environmental presence**
  - Soil
  - Water
  - Food

? Morphology

- Gram-negative rods
- Non-spore forming
- Motility:
  - **Motile** ? peritrichous flagella (E. coli, Salmonella, Proteus)
  - **Non-motile** ? Klebsiella, Shigella

? Cultural Characteristics

- Grow on **ordinary media**

- **MacConkey agar**:
    - **Lactose fermenters (LF)** ? pink colonies
    - **Non-lactose fermenters (NLF)** ? pale colonies

? Cell Wall Structure (VERY HIGH-YIELD)

- Outer membrane contains **LPS (Endotoxin)**

Components:

- **Lipid A**
    - Toxic component ? fever, shock
- **Core polysaccharide**
- **O antigen**
    - Serotyping basis

? Biochemical Properties

- Oxidase negative
- Catalase positive
- Ferment glucose
- Reduce nitrates to nitrites

? Antigenic Structure

ANTIGEN	LOCATION	FUNCTION	EXAMPLE
O antigen	Cell wall	Serotyping	Salmonella
H antigen	Flagella	Motility	Salmonella
K antigen	Capsule	Virulence	Klebsiella
Vi antigen	Capsule	Anti-phagocytic	S. typhi

? Mechanism of Endotoxin (VERY IMPORTANT)

- LPS (Lipid A) released
  ? Macrophage activation
  ? Cytokines (TNF, IL-1)
  ? Complement activation
  ? Coagulation cascade
  ? **DIC + septic shock**

? Virulence Factors

FACTOR	FUNCTION	EXAMPLE
Capsule	Anti-phagocytic	Klebsiella
Fimbriae	Adhesion	E. coli (UTI)
Toxins	Tissue damage	ETEC toxins

FACTOR	FUNCTION	EXAMPLE
Invasion factors	Cell entry	Shigella

? Plasmids & Resistance

- **R plasmids** ? antibiotic resistance
- **ESBL (Extended spectrum ?-lactamase)**
- **Carbapenemases (NDM, KPC)** ? highly resistant strains

? Classification

Based on Lactose Fermentation

LACTOSE FERMENTERS	NON-LACTOSE FERMENTERS
E. coli	Salmonella
Klebsiella	Shigella
Enterobacter	Proteus
Serratia (late LF)	

Based on Motility

MOTILE	NON-MOTILE
E. coli	Klebsiella

MOTILE	NON-MOTILE
Salmonella	Shigella
Proteus	

Based on IMViC Reactions

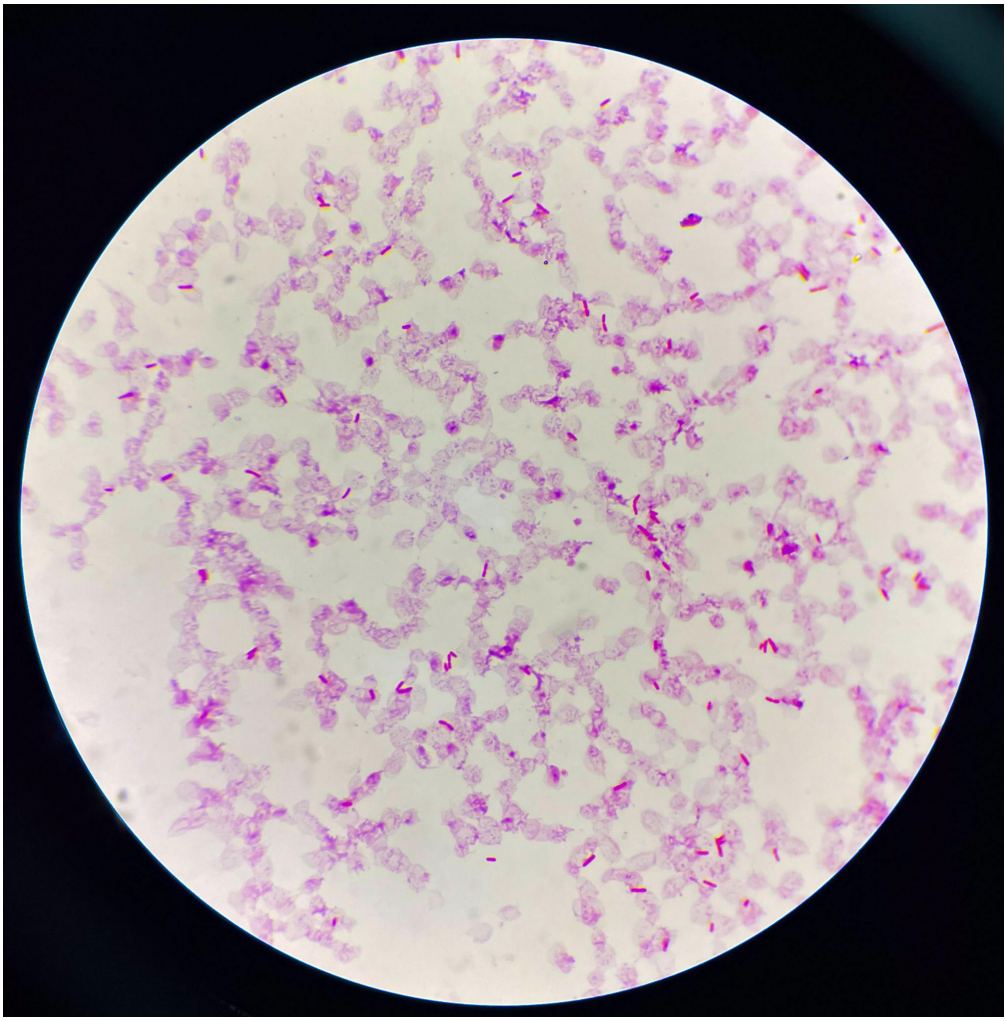
ORGANISM	INDOLE	MR	VP	CITRATE
E. coli	+	+	–	–
Klebsiella	–	–	+	+
Enterobacter	–	–	+	+

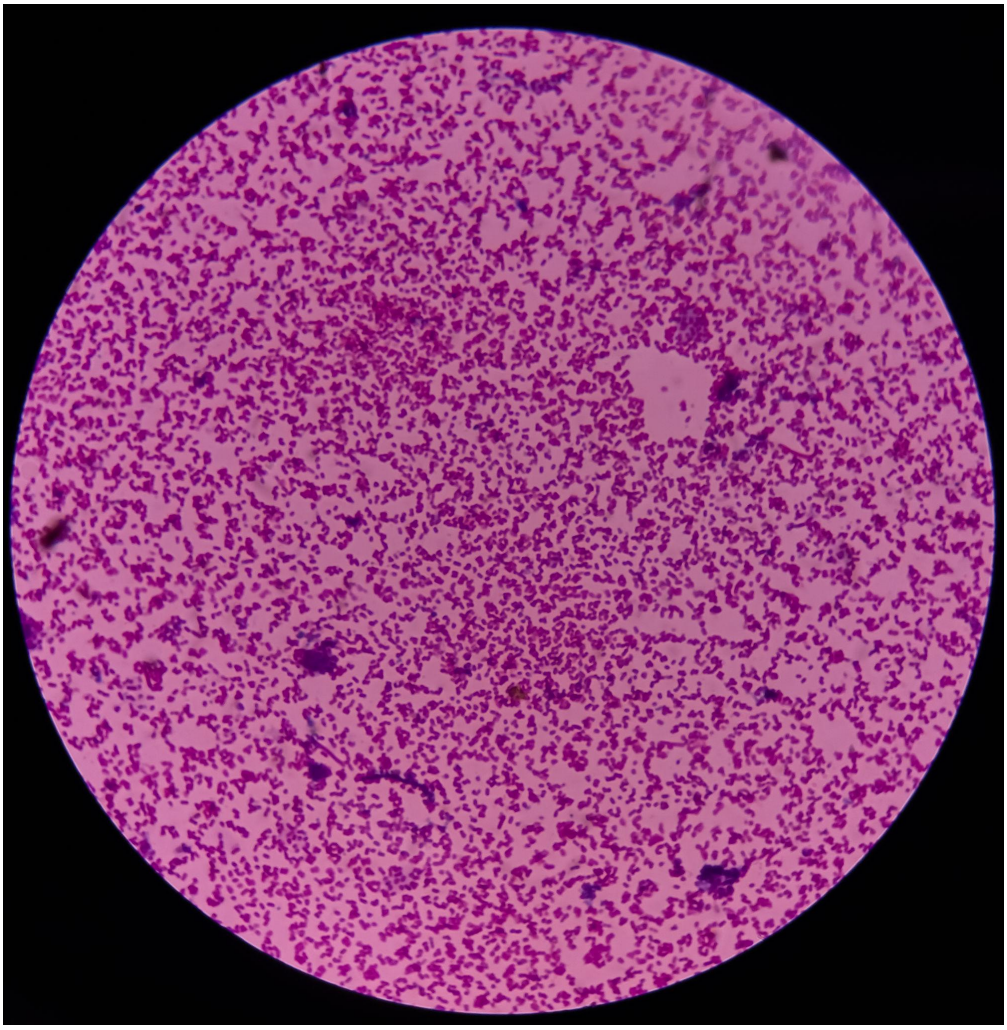
? Important Genera

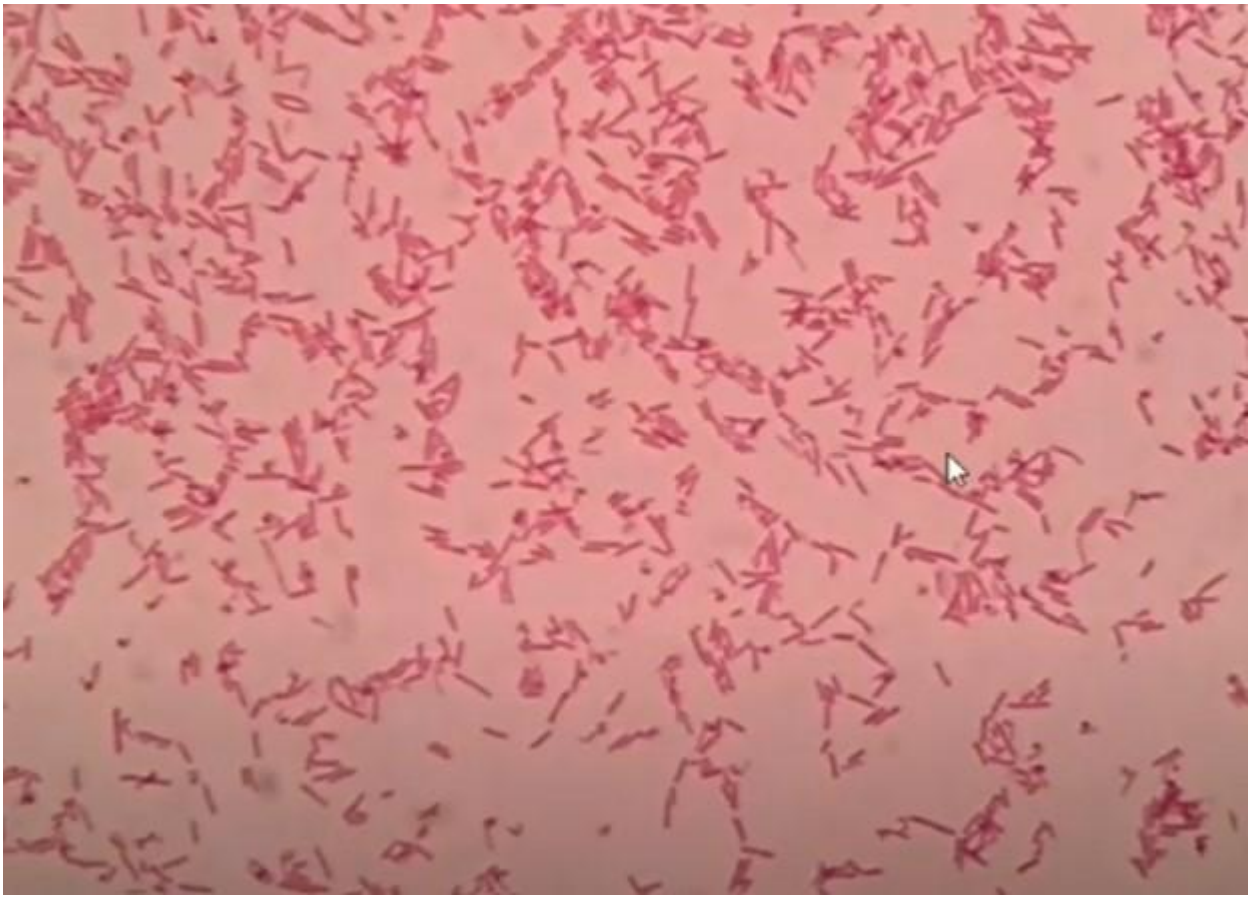
- Escherichia
- Klebsiella
- Proteus
- Enterobacter
- Citrobacter
- Serratia
- Shigella
- Salmonella

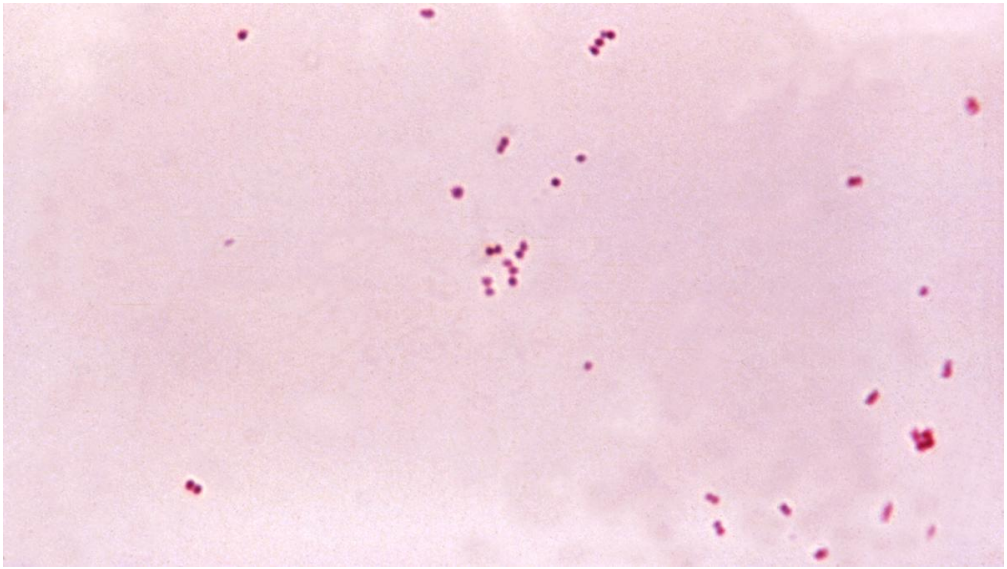
? SLIDES (EXAM FAVORITE)

Gram-negative bacilli





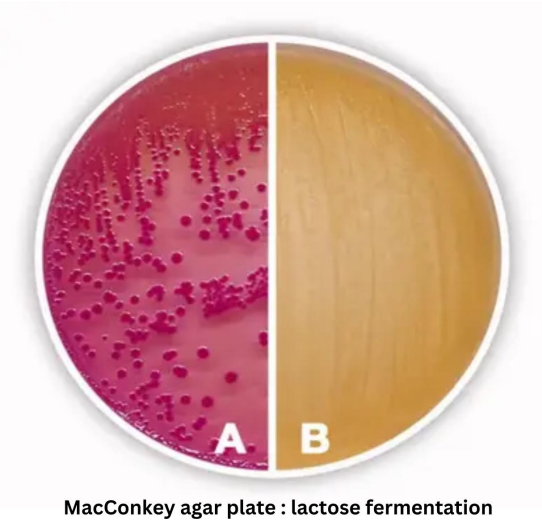




MacConkey agar (LF vs NLF)

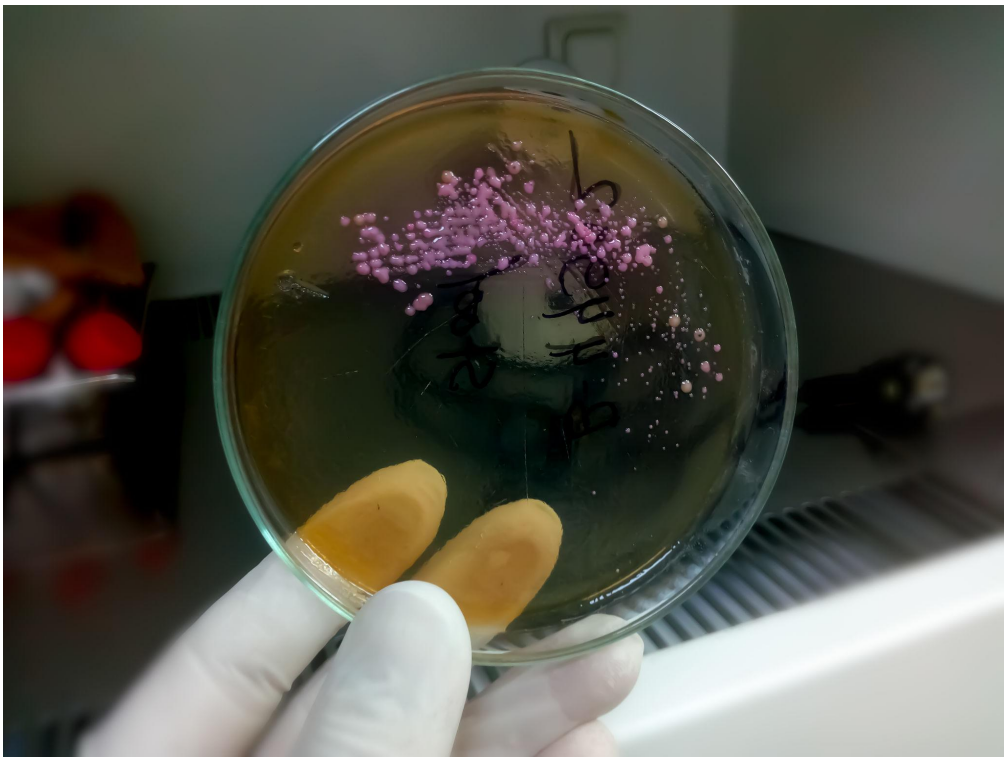
Lactose non fermentor Lactose Fermetor

Macconkey Agar



MacConkey agar plate : lactose fermentation (A) vs non-fermentation of lactose (B)

MacConkey agar plate : Klebsiella colonies are often mucoid, large (4-6 mm) and dark to pale pink (@lab.elm)



Capsule demonstration (Klebsiella)

? DIAGRAMS / FLOWCHARTS

? Classification of Enterobacteriaceae

Gram-negative bacilli
?
Enterobacteriaceae
?
Lactose fermenters ? E. coli, Klebsiella
Non-lactose fermenters ? Salmonella, Shigella

? LPS Endotoxin Mechanism

LPS (Lipid A)
?
Macrophage activation
?
Cytokines (TNF, IL-1)
?
Complement activation
?
Coagulation cascade
?
DIC ? Shock

? Lactose Fermentation Differentiation

MacConkey agar
?
Pink colonies ? Lactose fermenter
?
E. coli / Klebsiella

Colorless colonies ? Non-lactose fermenter
?
Salmonella / Shigella

? LABORATORY DIAGNOSIS (VERY HIGH-YIELD CORE)

? Specimen Collection

- **Stool**
  - Acute diarrhea, dysentery
  - Fresh sample preferred
- **Blood**
  - Enteric fever (1st week best)
- **Urine**
  - UTI (E. coli, Klebsiella, Proteus)
- **Pus / body fluids**
  - Abscess, wound infection, septicemia

? Transport Media

- **Cary-Blair medium**
  - Preserves enteric pathogens
  - Prevents overgrowth of commensals

? Culture Media

- **MacConkey agar**
  - LF ? Pink colonies
  - NLF ? Pale colonies
- **XLD agar (Xylose Lysine Deoxycholate)**
  - Salmonella ? Red colonies with black center (H?S)
  - Shigella ? Red colonies
- **SS agar (Salmonella-Shigella agar)**
  - Salmonella ? Colorless with black center
  - Shigella ? Colorless
- **DCA agar (Deoxycholate citrate agar)**
  - Selective for enteric pathogens

? Enrichment Media

- **Selenite F broth**
  - Enhances Salmonella growth
- **Tetrathionate broth**
  - Selective enrichment for Salmonella

? Colony Characteristics

- Size, shape, margin, elevation
- Pigmentation
- Hemolysis (if any)
- Swarming ? Proteus

? Biochemical Identification

IMViC Tests

- Indole
- Methyl red
- Voges–Proskauer
- Citrate

TSI (Triple Sugar Iron) Test

- Glucose, lactose, sucrose fermentation
- Gas production
- H?S production

Other Tests

- **Urease test**
  - Positive ? Proteus, Klebsiella
- **Citrate test**
  - Positive ? Klebsiella, Enterobacter
- **Motility test**
  - Motile ? Salmonella, E. coli
  - Non-motile ? Shigella, Klebsiella

? Automated Systems (Brief)

- **VITEK**
  - Rapid identification + antibiotic sensitivity
- **MALDI-TOF**
  - Protein-based rapid organism identification

? TABLES (VERY HIGH-YIELD)

? Selective & Differential Media

MEDIUM	FUNCTION	ORGANISM IDENTIFIED

MacConkey	LF vs NLF	E. coli, Salmonella
XLD	Enteric pathogens	Salmonella, Shigella
SS agar	Selective for pathogens	Salmonella, Shigella
DCA	Enteric pathogens	Salmonella

? IMViC Reactions (Detailed)

ORGANISM	INDOLE	MR	VP	CITRATE
E. coli	+	+	–	–
Klebsiella	–	–	+	+
Enterobacter	–	–	+	+

? TSI Reaction Patterns

ORGANISM	SLANT	BUTT	GAS	H?S
E. coli	A	A	+	–
Salmonella	K	A	±	+
Shigella	K	A	–	–
Proteus	K	A	+	+

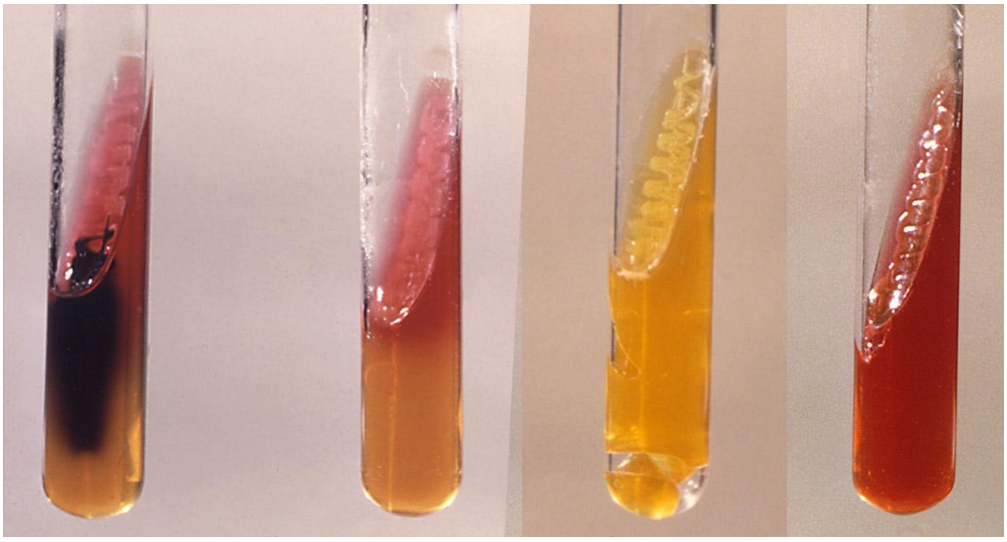
(A = Acid, K = Alkaline)

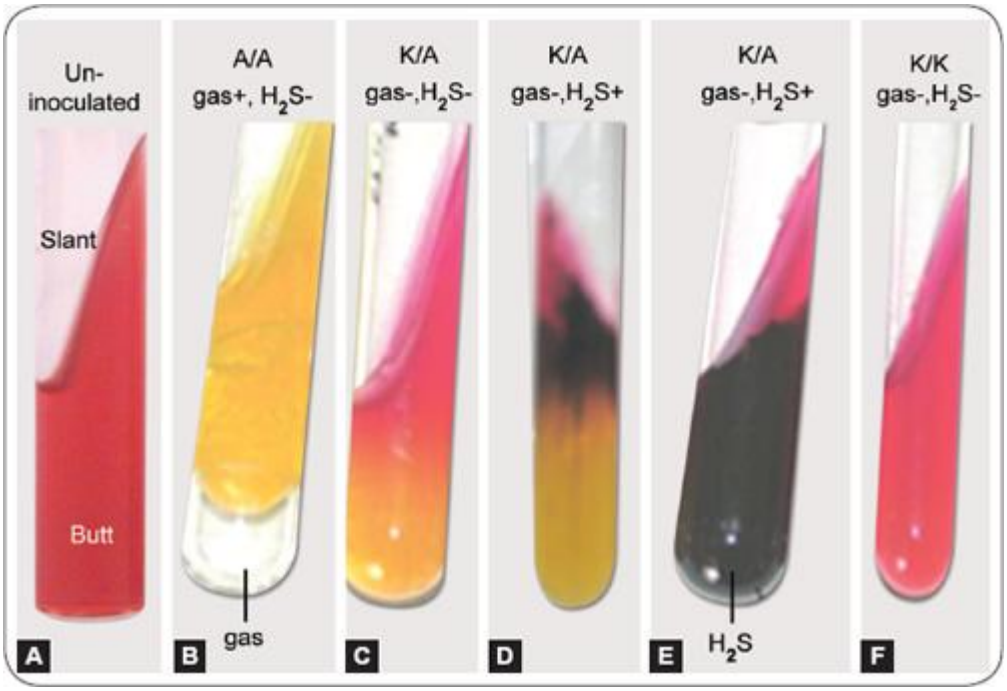
? Biochemical Test Interpretation

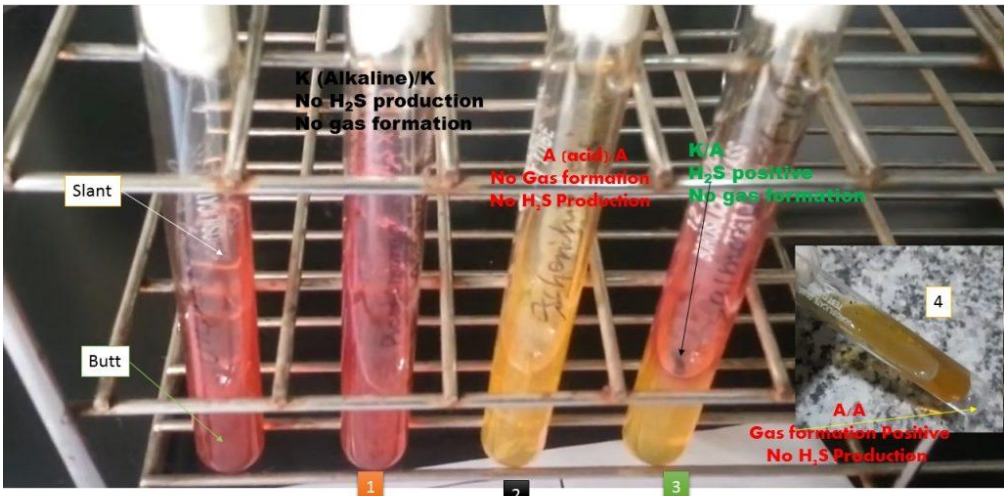
TEST	POSITIVE ORGANISM
Urease	Proteus, Klebsiella
Citrate	Klebsiella, Enterobacter
Motility	Salmonella, E. coli

? SLIDES (EXAM FAVORITE)

TSI agar slants







Triple Sugar Iron(TSI) Agar

Reaction in TSI agar

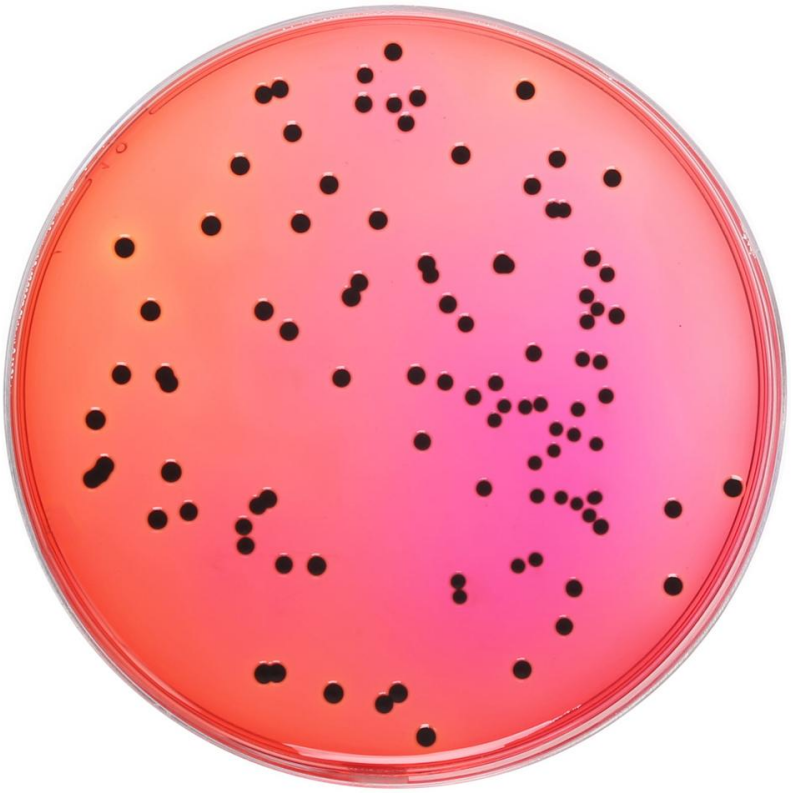
- Acid butt
- Acid slant
- Gas production
- No H_2S production

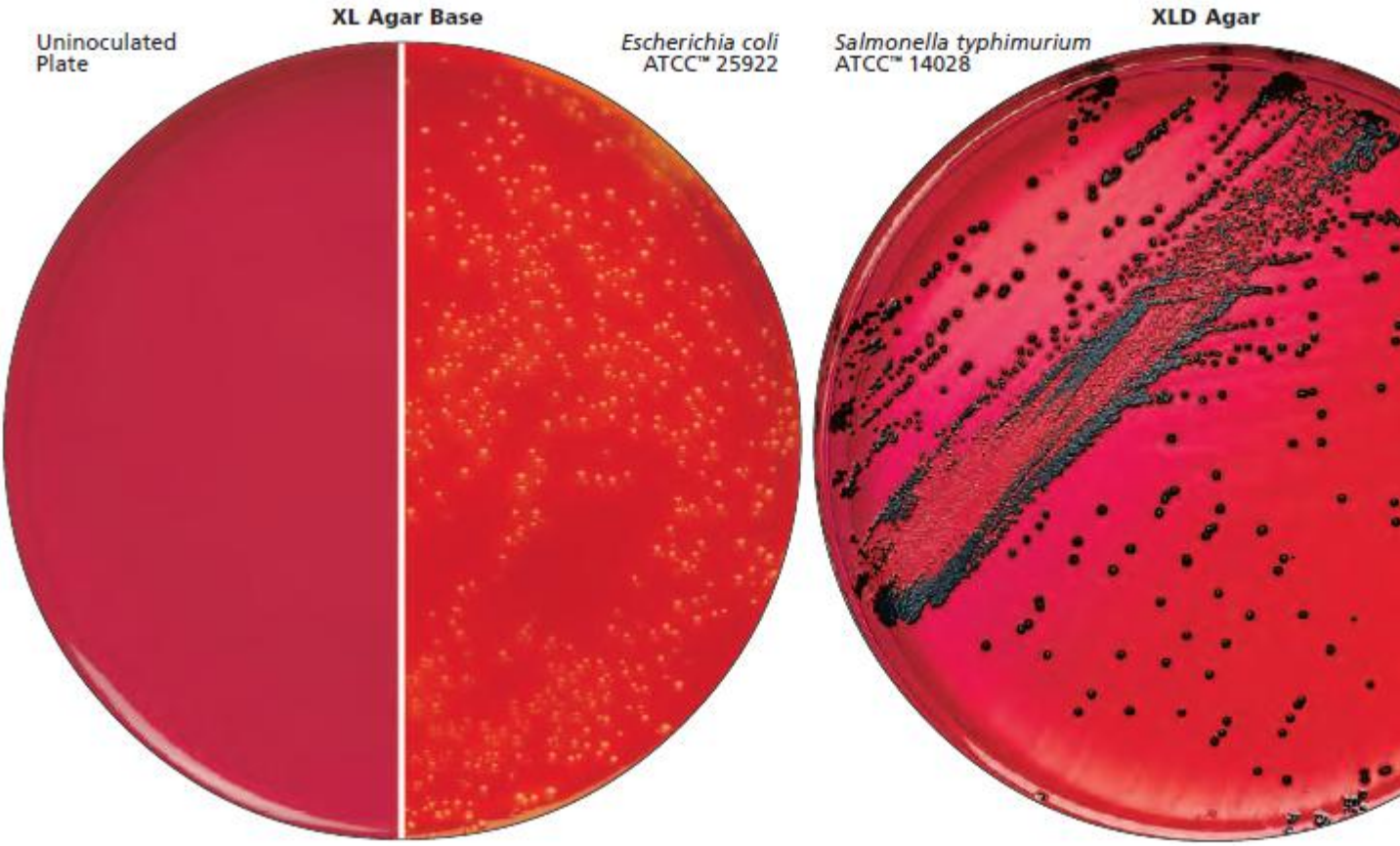
SLANT/BUTT
K/A+ GAS(H2S)

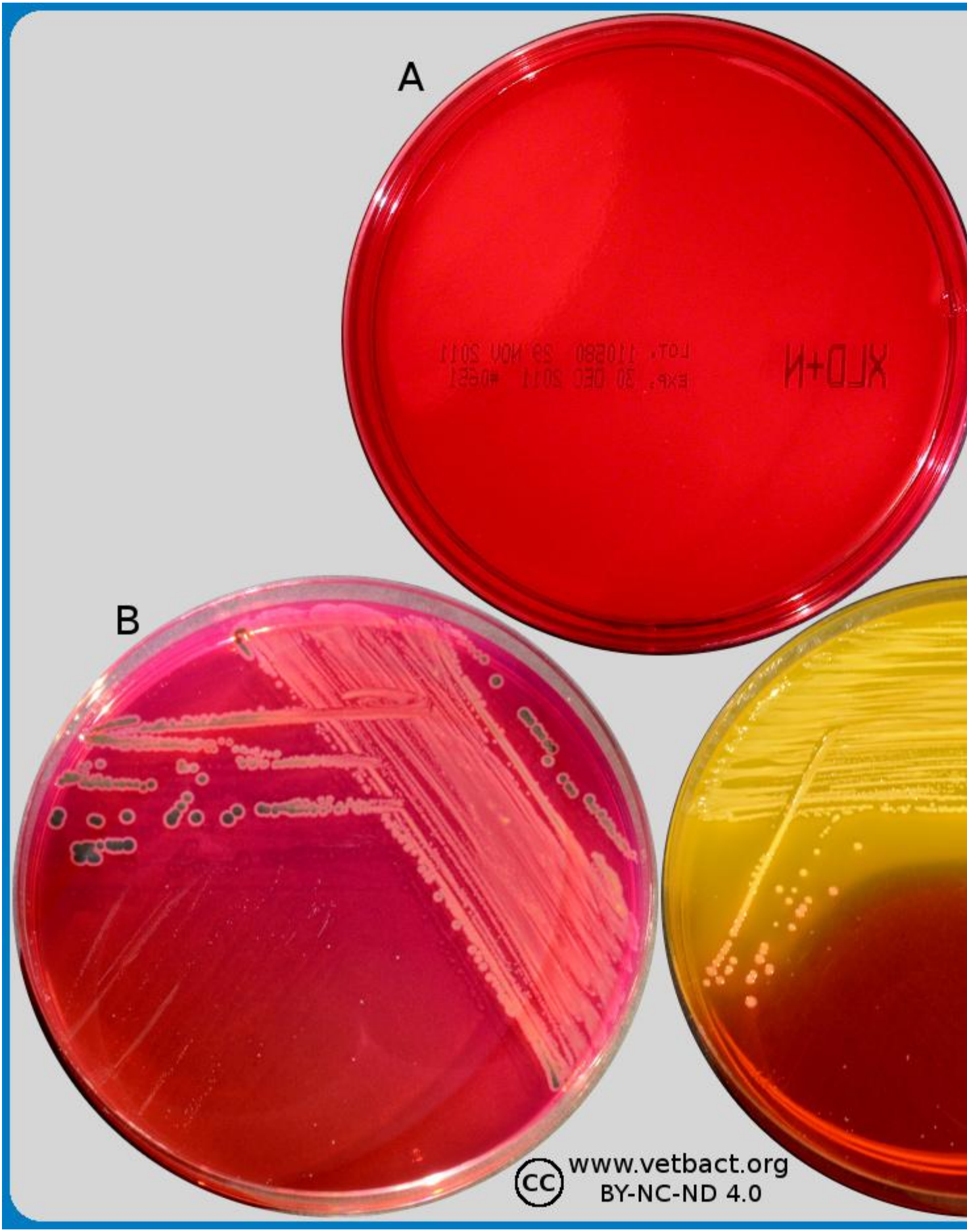
- **Only Glucose is fermented**
- **Black precipitate present - H2S gas production**

K– Alkaline
A– Acidic

XLD agar colonies




XL Agar Base
Uninoculated Plate
Escherichia coli ATCC™ 25922
XLD Agar
Salmonella typhimurium ATCC™ 14028


A
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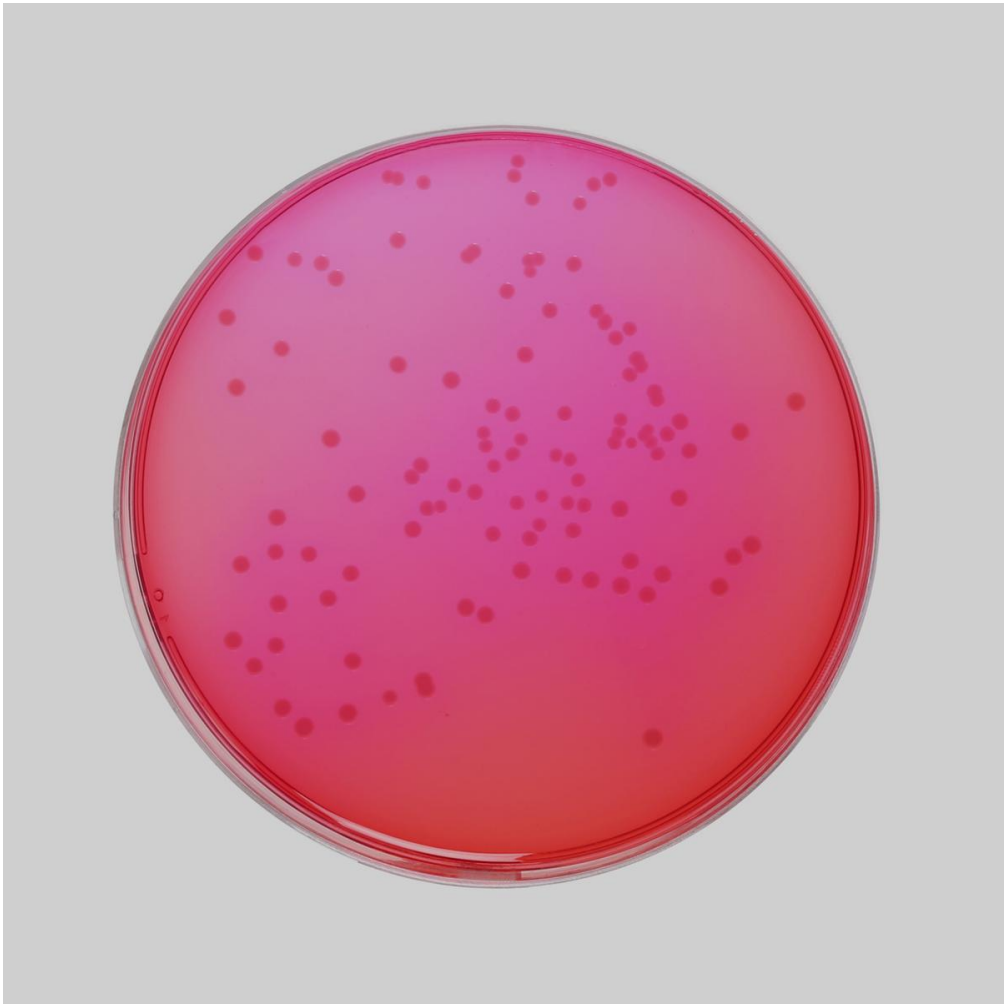

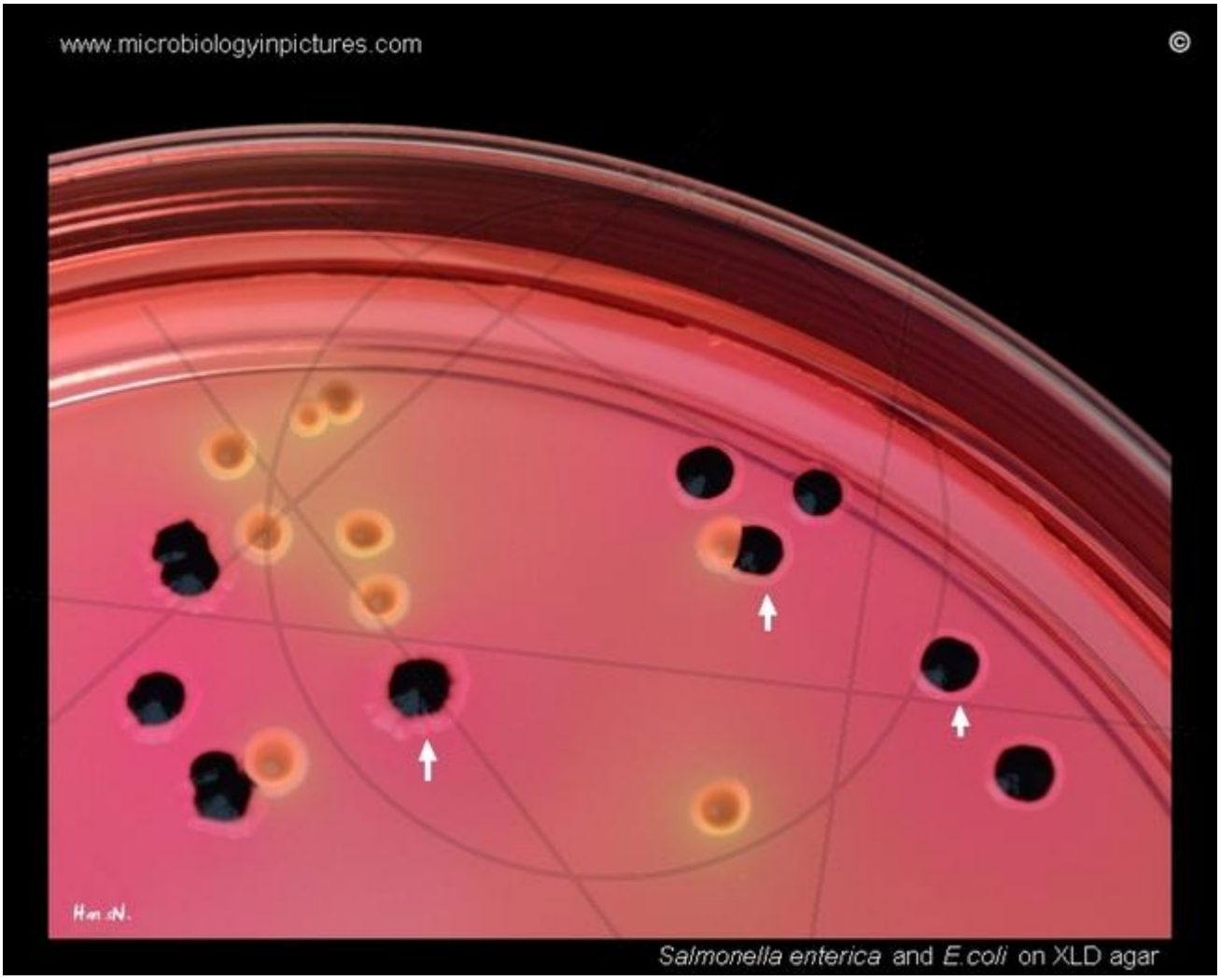
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Salmonella enterica and E.coli on XLD agar


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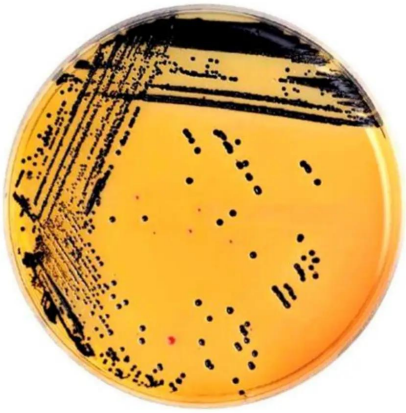
SS agar colonies

Escherichia coli

Salmonella

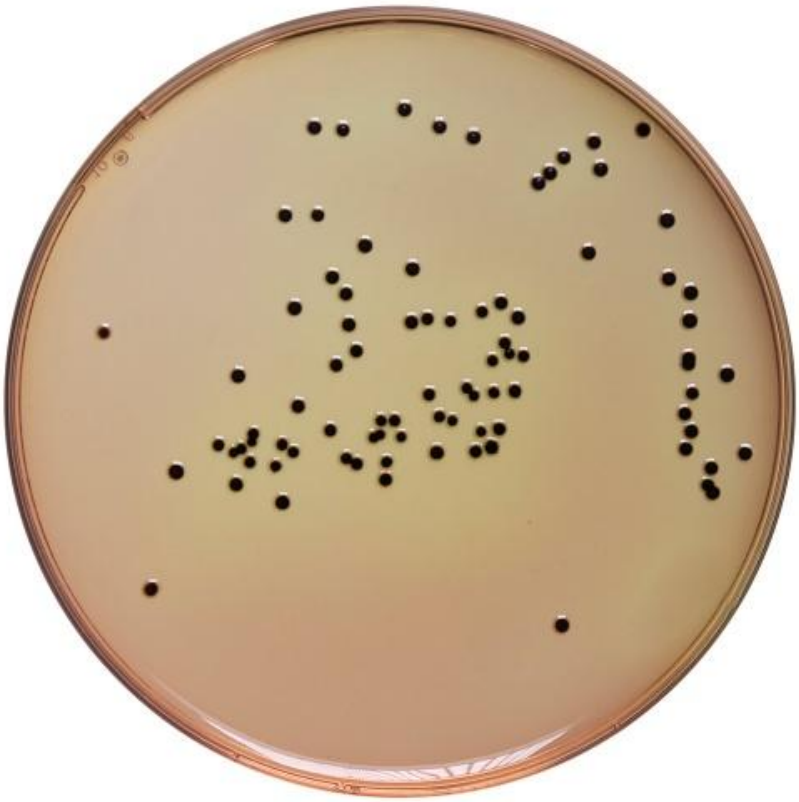
Shigella

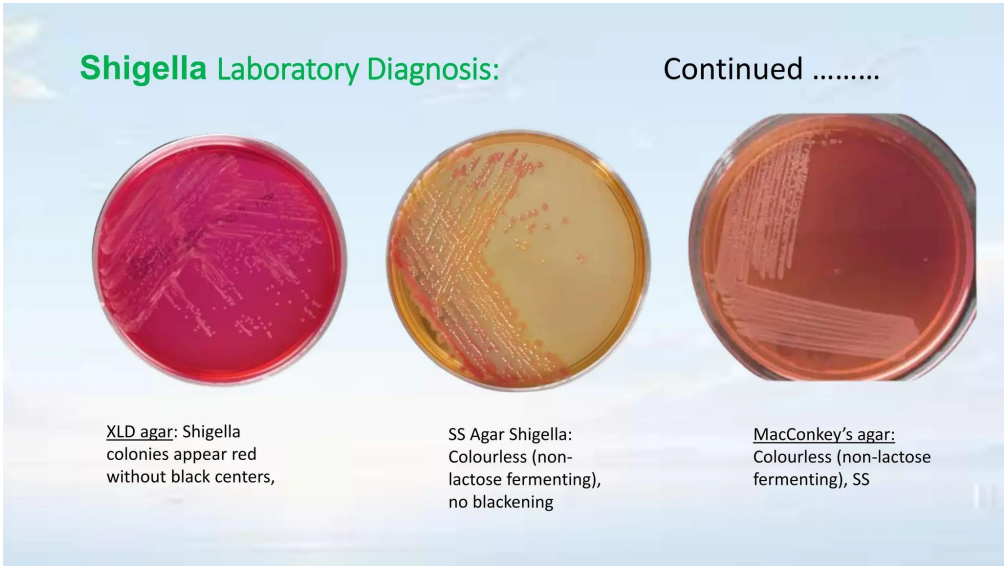
Salmonella

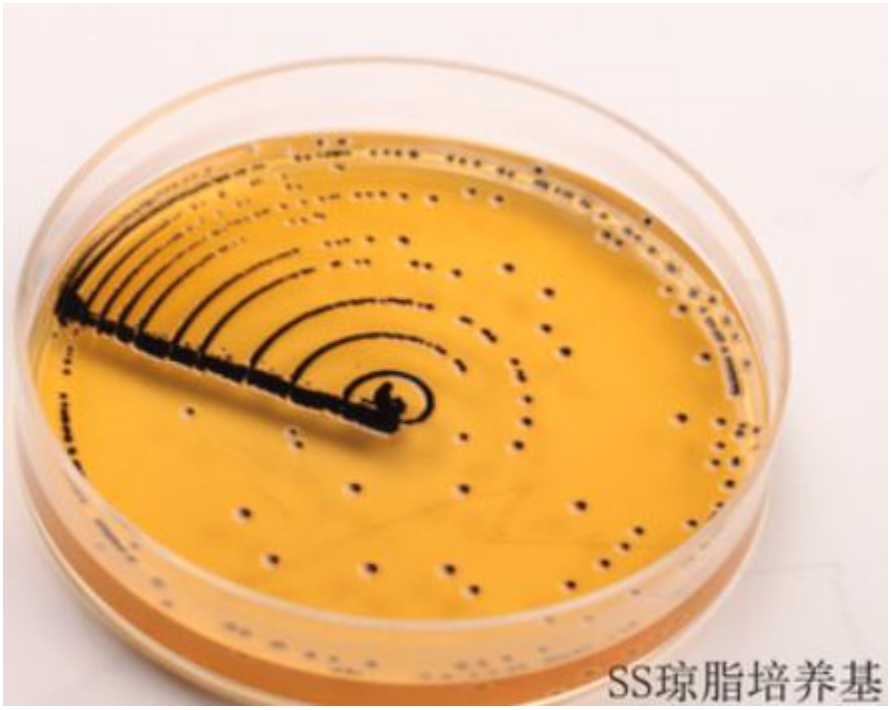


Black, non-lactose fermenter colonies of Salmonellae on SS Agar

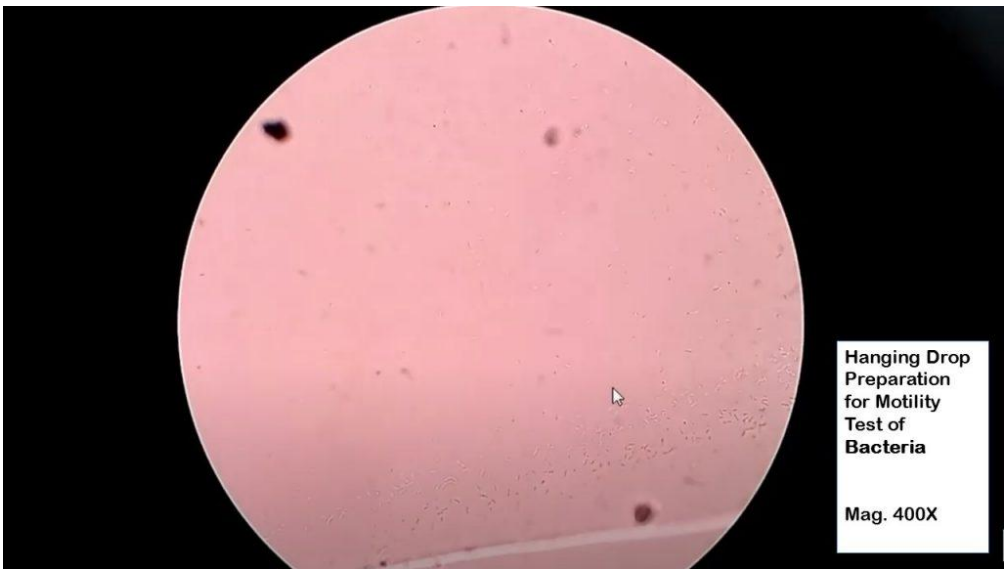
Black, non-lactose fermenter colonies of Salmonellae on hektoen enteric agar





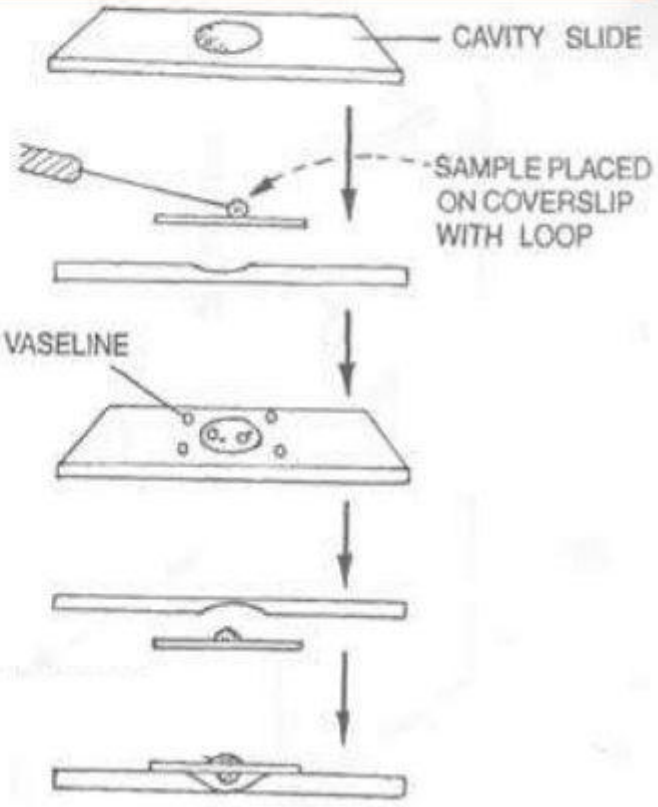


Motility test

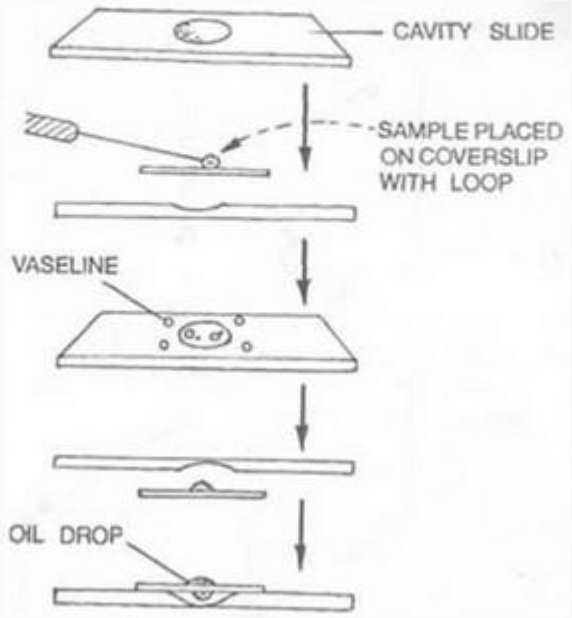


HANGING DROP TEST

- Place a drop stool in the centre of a coverslip.
- Place a drop of water / vaseline at each corner of the coverslip.
- Invert a slide with a central depression over the coverslip.
- The coverslip will stick to the slide and when the slide is inverted the drop of bacterial culture will be suspended in the central depression of the slide.
- Examine microscopically (X100) for motile organisms.



The hanging Drop Method



HANGING DROP PREPARATION

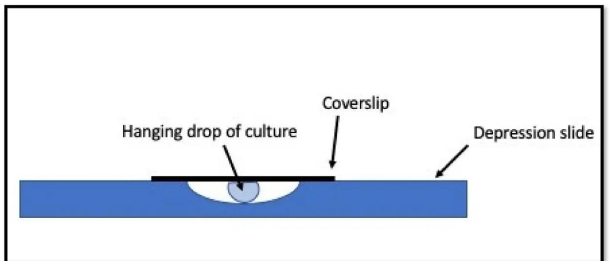
Result and Interpretations

- ***Directional purposeful motility is a positive test.***
- Motile organisms change position with respect to one another.
- Brownian movement (random jiggling or shaking due to molecular bombardment),

METHODS FOR DEMONSTRATING BACTERIAL MOTILITY

3. Hanging drop method

- This method involves preparing a wet mount of a bacterial culture on a hollow-ground slide and cover glass. We can then examine the drop under a microscope.



? DIAGRAMS / FLOWCHARTS

? Stepwise Lab Diagnosis Algorithm

Specimen
?
Transport medium (Cary-Blair)
?
Culture on selective media
?
Colony morphology
?
Biochemical tests (IMViC, TSI)
?
Identification
?
Antibiotic sensitivity

? TSI Reaction Interpretation

Glucose fermentation
?
Acid butt (yellow)

If lactose/sucrose ferment ? Entire tube yellow (A/A)

If not ? Slant red, butt yellow (K/A)

H?S production ? Black precipitate

Gas production ? Cracks / bubbles

? DISEASES CAUSED BY ENTEROBACTERIACEAE (EXCLUDING SALMONELLA & SHIGELLA)

? ESCHERICHIA COLI

Types (Pathotypes)

- **ETEC (Enterotoxigenic)** ? Traveler’s diarrhea
- **EPEC (Enteropathogenic)** ? Infantile diarrhea
- **EHEC (Enterohemorrhagic)** ? Hemorrhagic colitis, HUS
- **EIEC (Enteroinvasive)** ? Dysentery-like illness
- **EAEC (Enteroaggregative)** ? Persistent diarrhea

Virulence Factors

- **LT toxin (Heat-labile)**
    - ? cAMP ? secretory diarrhea

- **ST toxin (Heat-stable)**
    - ? cGMP ? secretory diarrhea
- **Verotoxin (Shiga-like toxin)**
    - Inhibits protein synthesis ? endothelial damage
- **Adhesins (fimbriae)**
    - Attachment to intestinal mucosa

Mechanisms of Diarrhea

- **Secretory** ? ETEC (LT, ST)
- **Invasive** ? EIEC
- **Hemorrhagic** ? EHEC

Clinical Features

- Traveler’s diarrhea
- Hemorrhagic colitis
- Watery diarrhea (children)

Other Important Syndromes

- **Uropathogenic E. coli (UPEC)**
    - Ascending UTI
- **Neonatal meningitis**

- K1 antigen (capsule)

? KLEBSIELLA

Key Features

- Prominent **capsule** ? major virulence
- **Hypermucoviscosity (string test positive)**

Diseases

- **Pneumonia**
  - Thick “currant jelly” sputum
- **UTI**
- **Rhinoscleroma**

Resistance

- ESBL-producing strains
- MDR hospital pathogens

? PROTEUS

Key Features

- **Swarming motility**

- **Urease positive**
- **H?S production**
- **Dienes phenomenon** (strain differentiation)

Clinical Importance

- **UTI**
- **Renal stone formation**
    - Urease ? ammonia ? alkaline urine ? stones

? ENTEROBACTER, CITROBACTER, SERRATIA

Features

- Opportunistic pathogens
- Cause **nosocomial infections**
- High **drug resistance**

Clinical Importance

- UTI
- Pneumonia
- Septicemia

? TABLES (VERY HIGH-YIELD)

? Types of E. coli and Diseases

TYPE	DISEASE	MECHANISM
ETEC	Traveler’s diarrhea	Secretory (LT, ST)
EPEC	Infantile diarrhea	Adherence
EHEC	Hemorrhagic colitis	Verotoxin
EIEC	Dysentery	Invasion
EAEC	Persistent diarrhea	Aggregation

? E. coli Toxin Comparison

TOXIN	MECHANISM	EFFECT
LT	? cAMP	Watery diarrhea
ST	? cGMP	Watery diarrhea
Verotoxin	Ribosomal inhibition	Bloody diarrhea

? Enterobacteriaceae Causing UTI

ORGANISM	FEATURE
E. coli	Most common

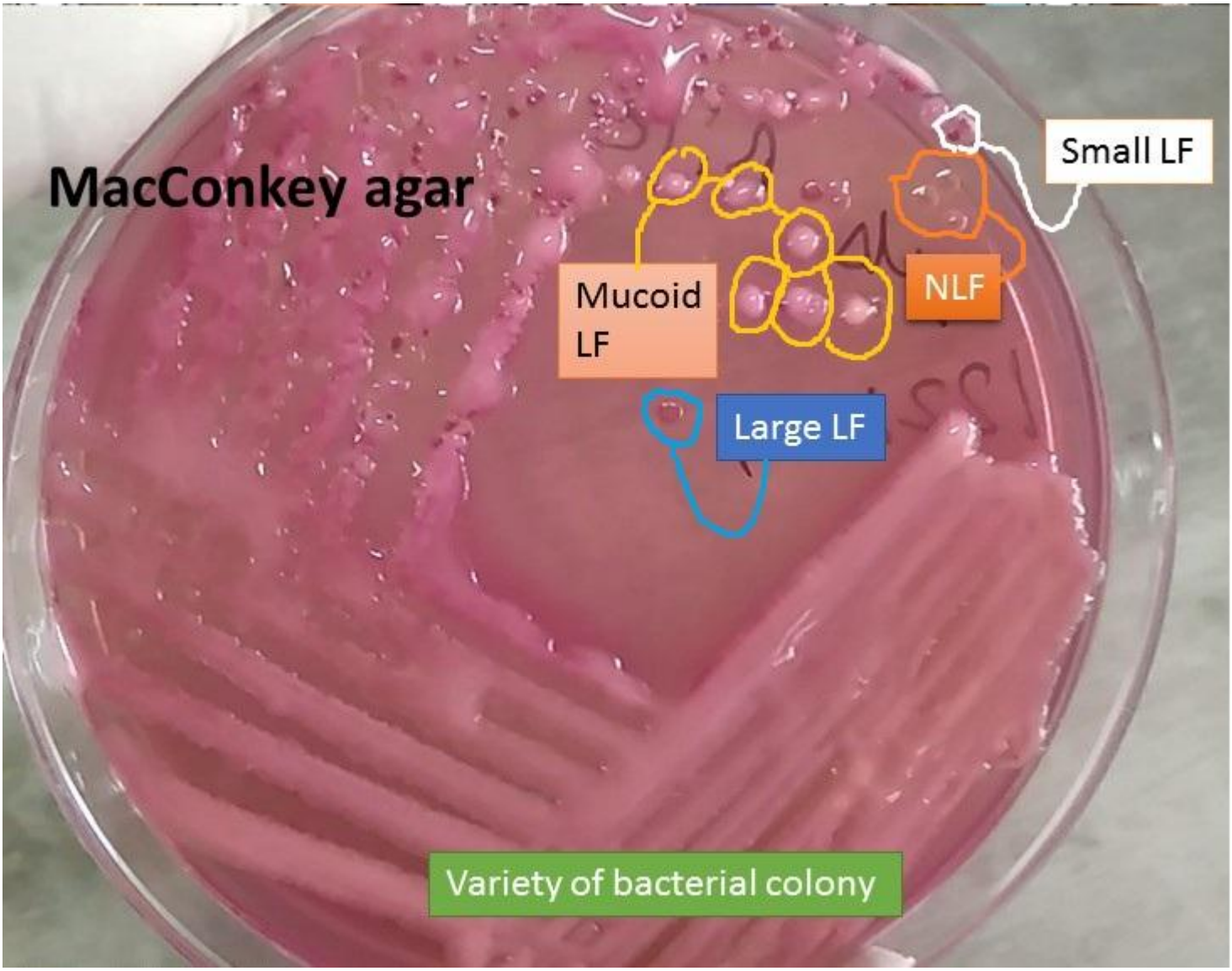
ORGANISM	FEATURE
Klebsiella	Capsule
Proteus	Stones (urease)

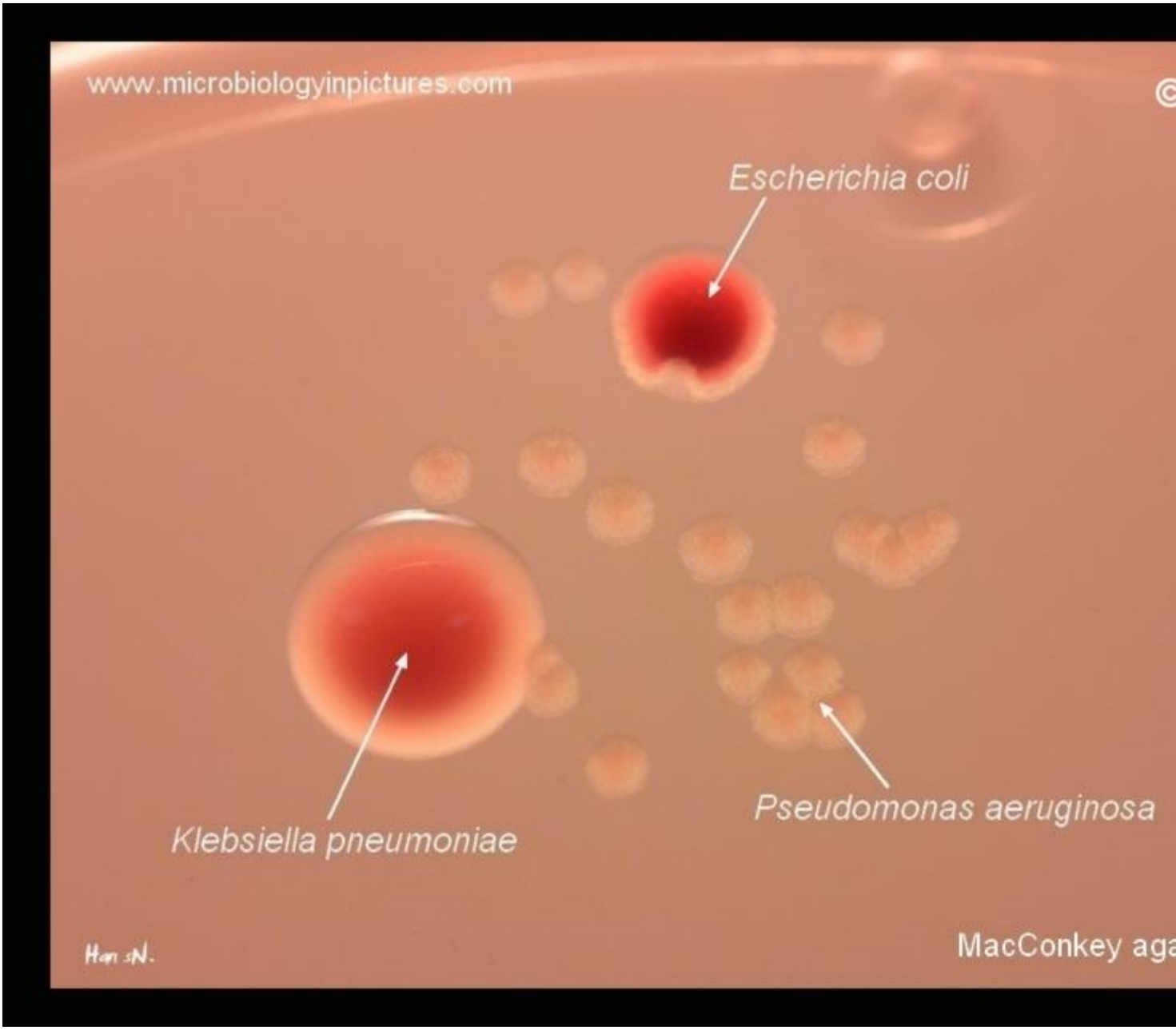
? Nosocomial Pathogens Comparison

ORGANISM	KEY FEATURE
Enterobacter	Opportunistic
Serratia	Red pigment (sometimes)
Klebsiella	MDR, ESBL

? SLIDES (EXAM FAVORITE)

E. coli colonies


MacConkey agar
Small LF
NLF
Mucoid LF
Large LF
Variety of bacterial colony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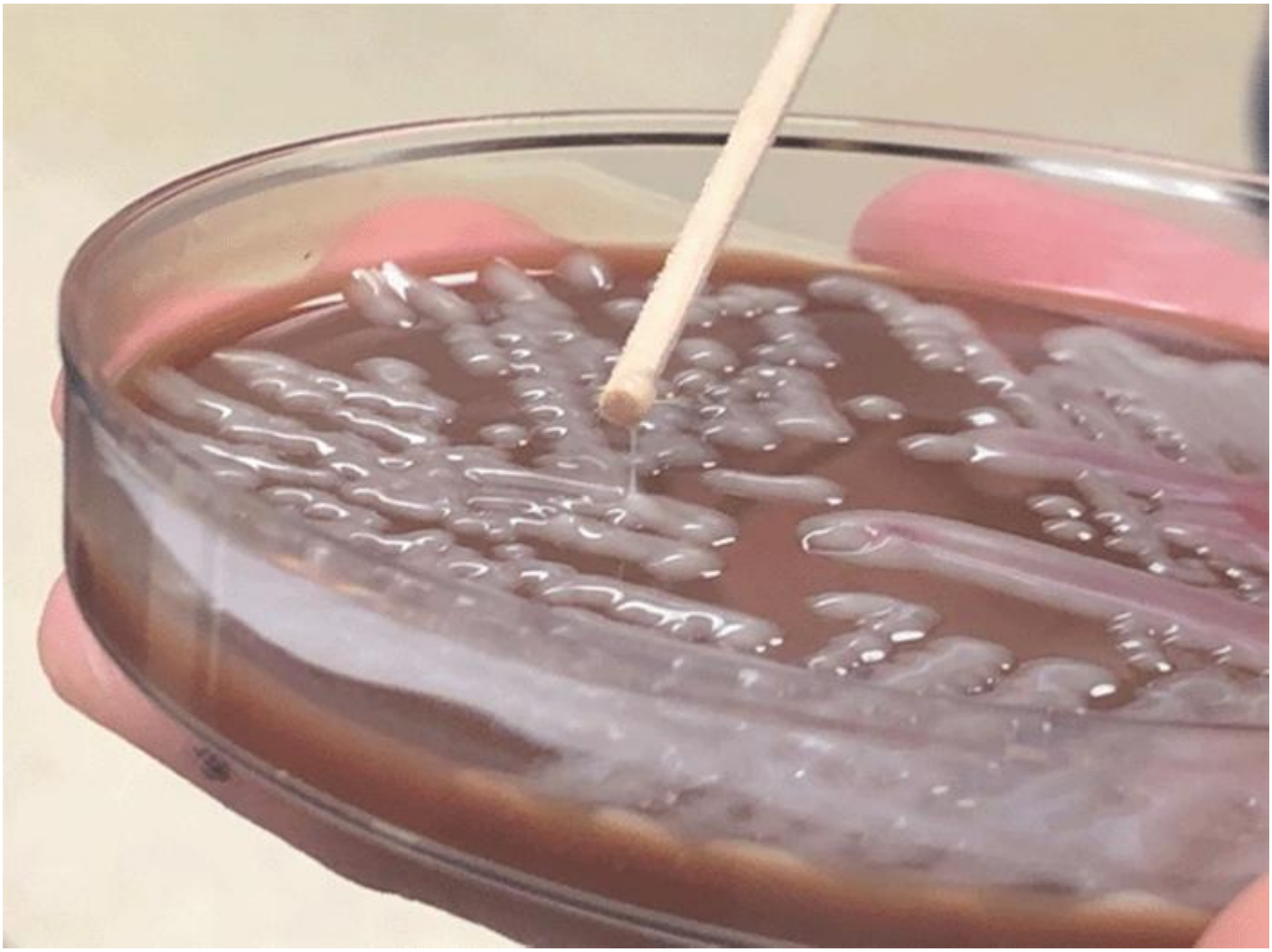
Escherichia coli
Klebsiella pneumoniae
Pseudomonas aeruginosa
MacConkey aga

Klebsiella mucoid colonies



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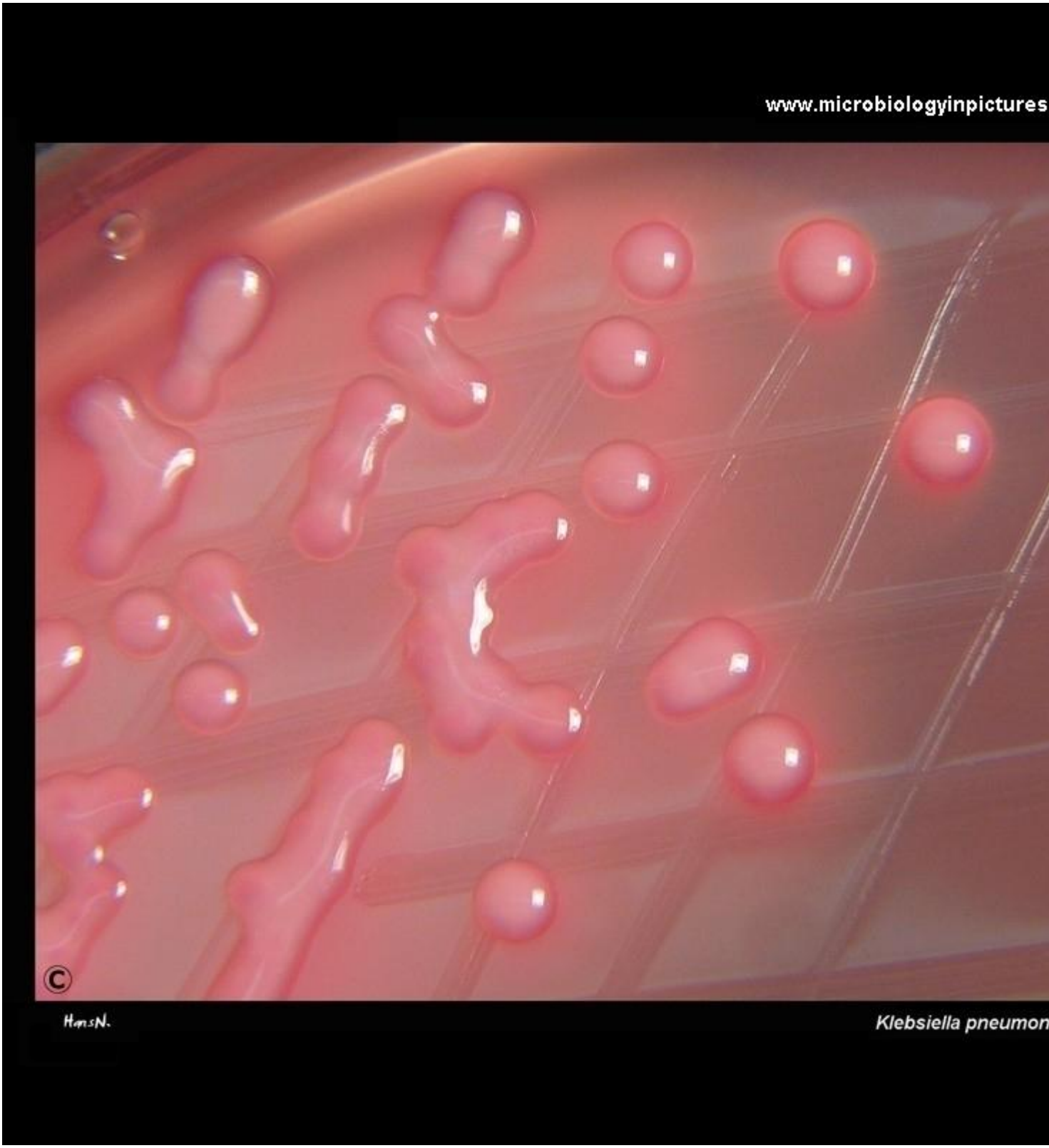
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Tryptic soy agar
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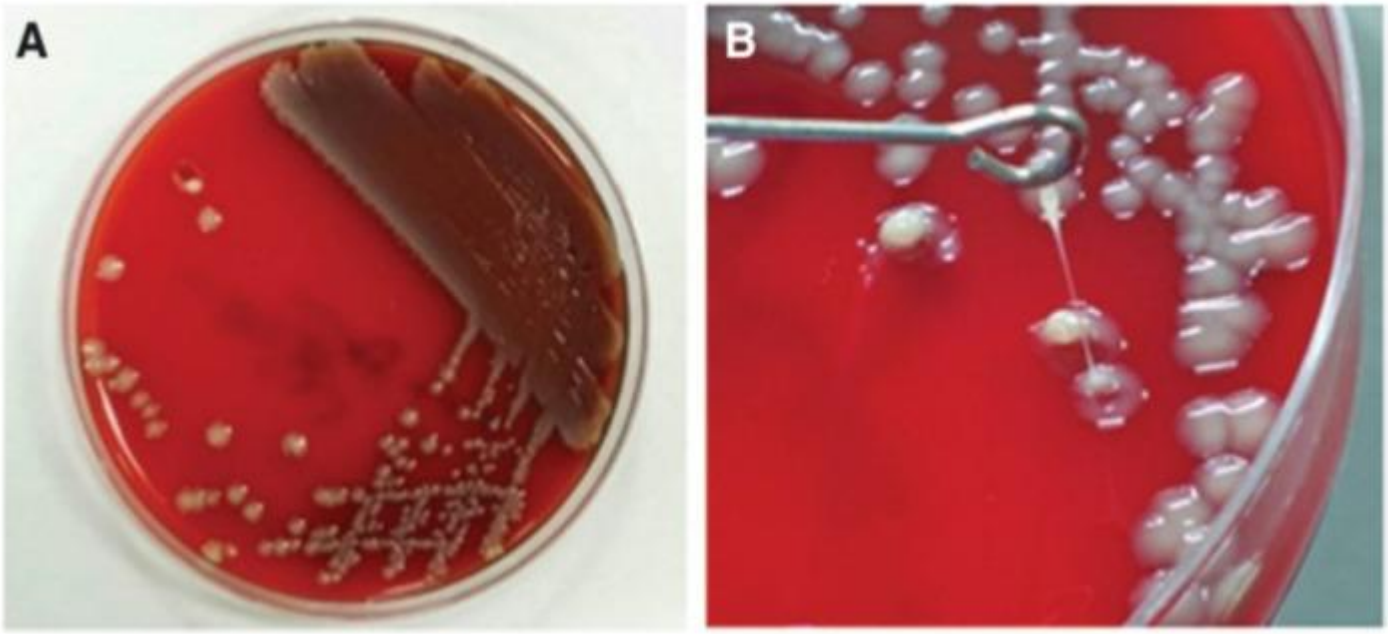

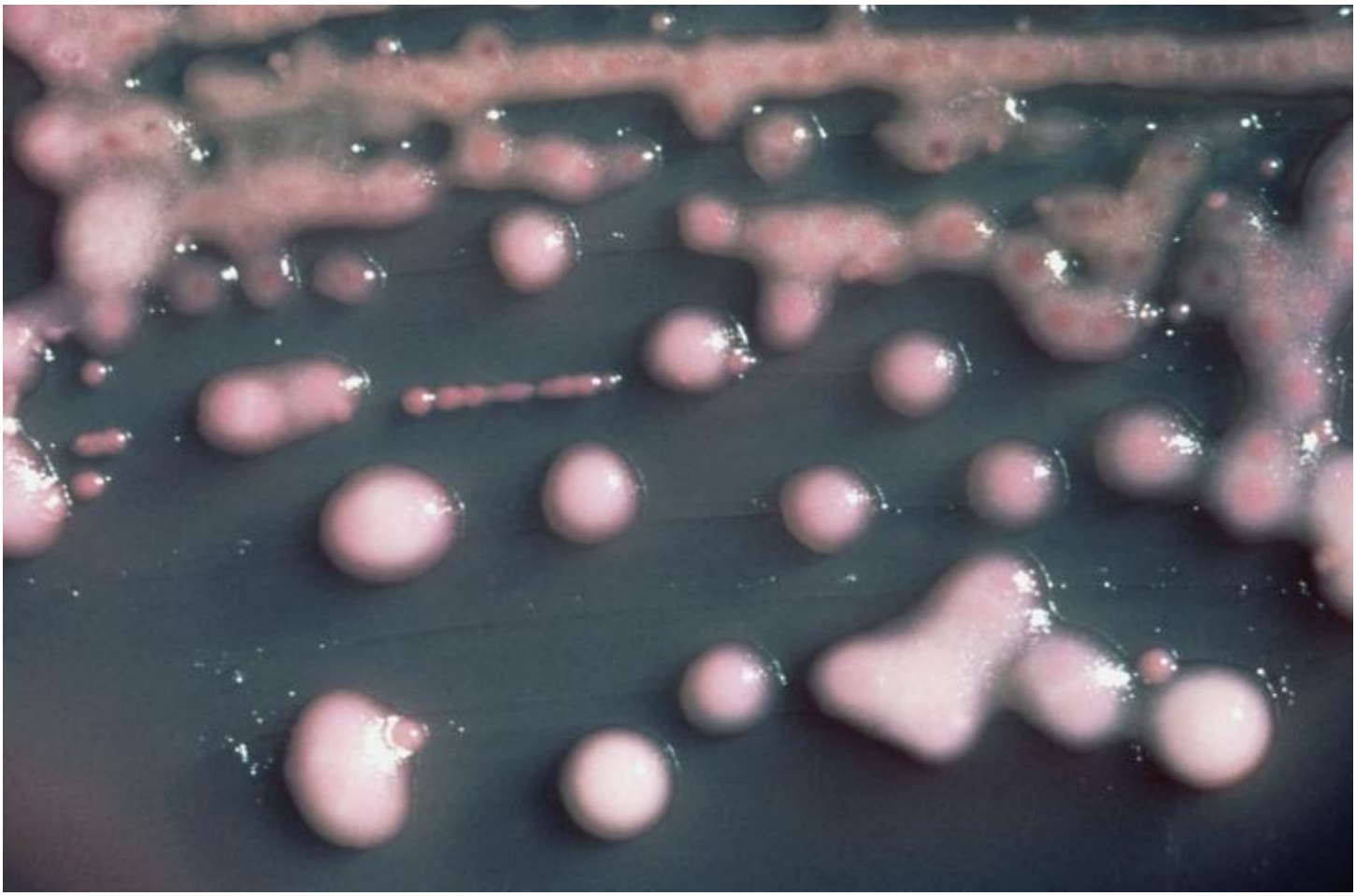

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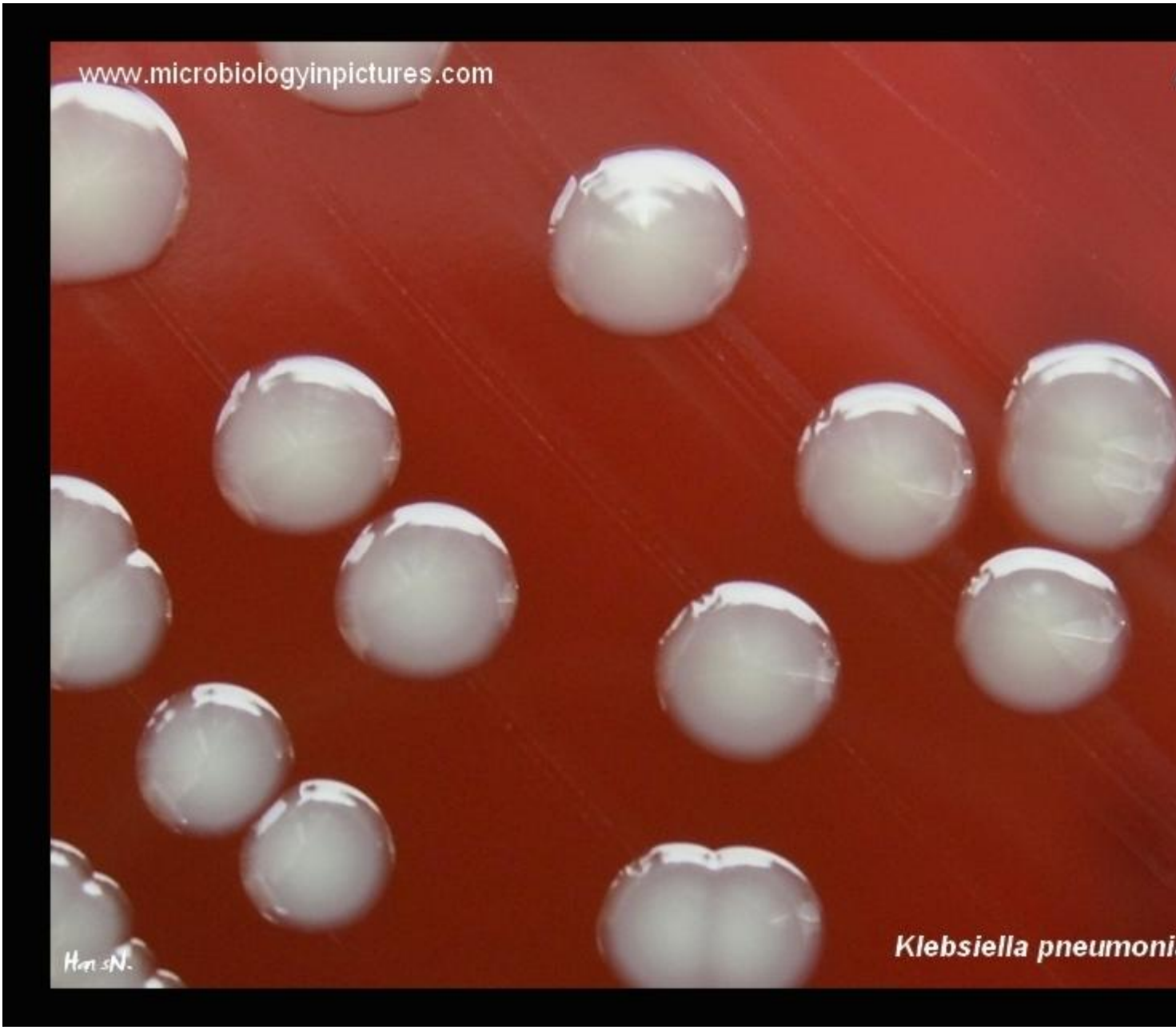
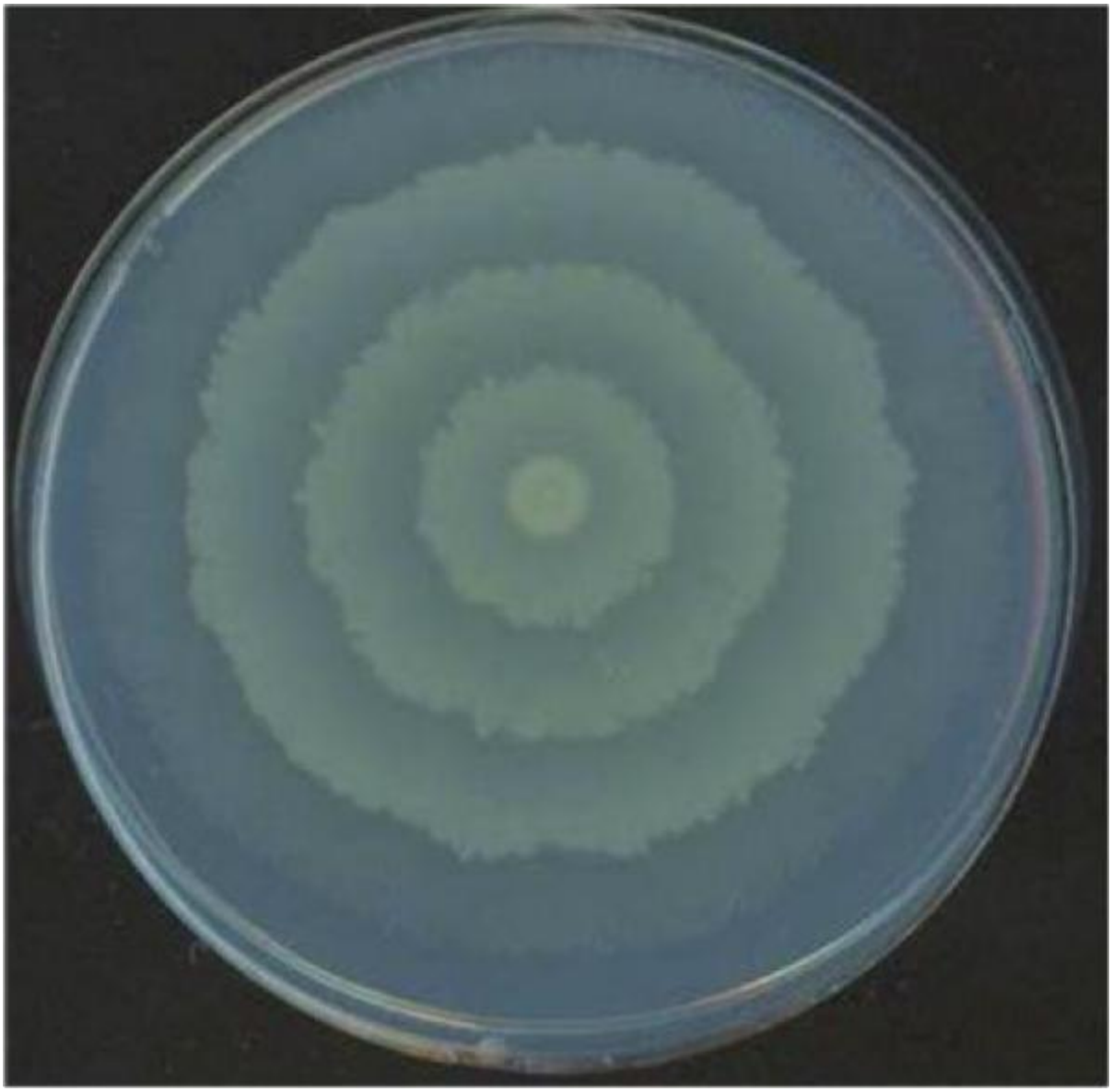
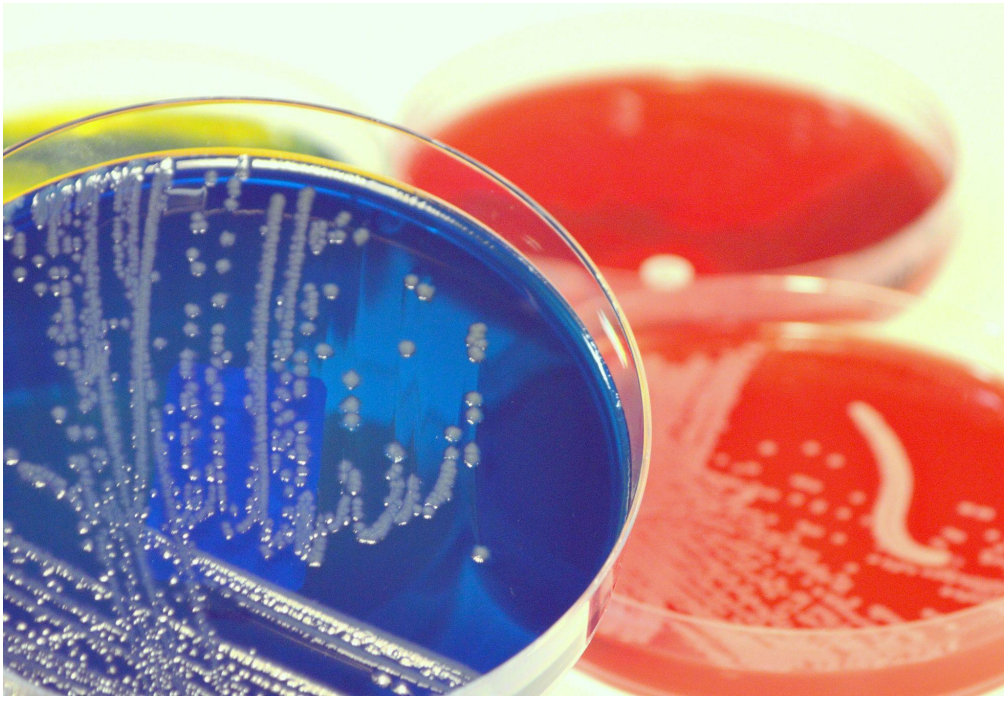
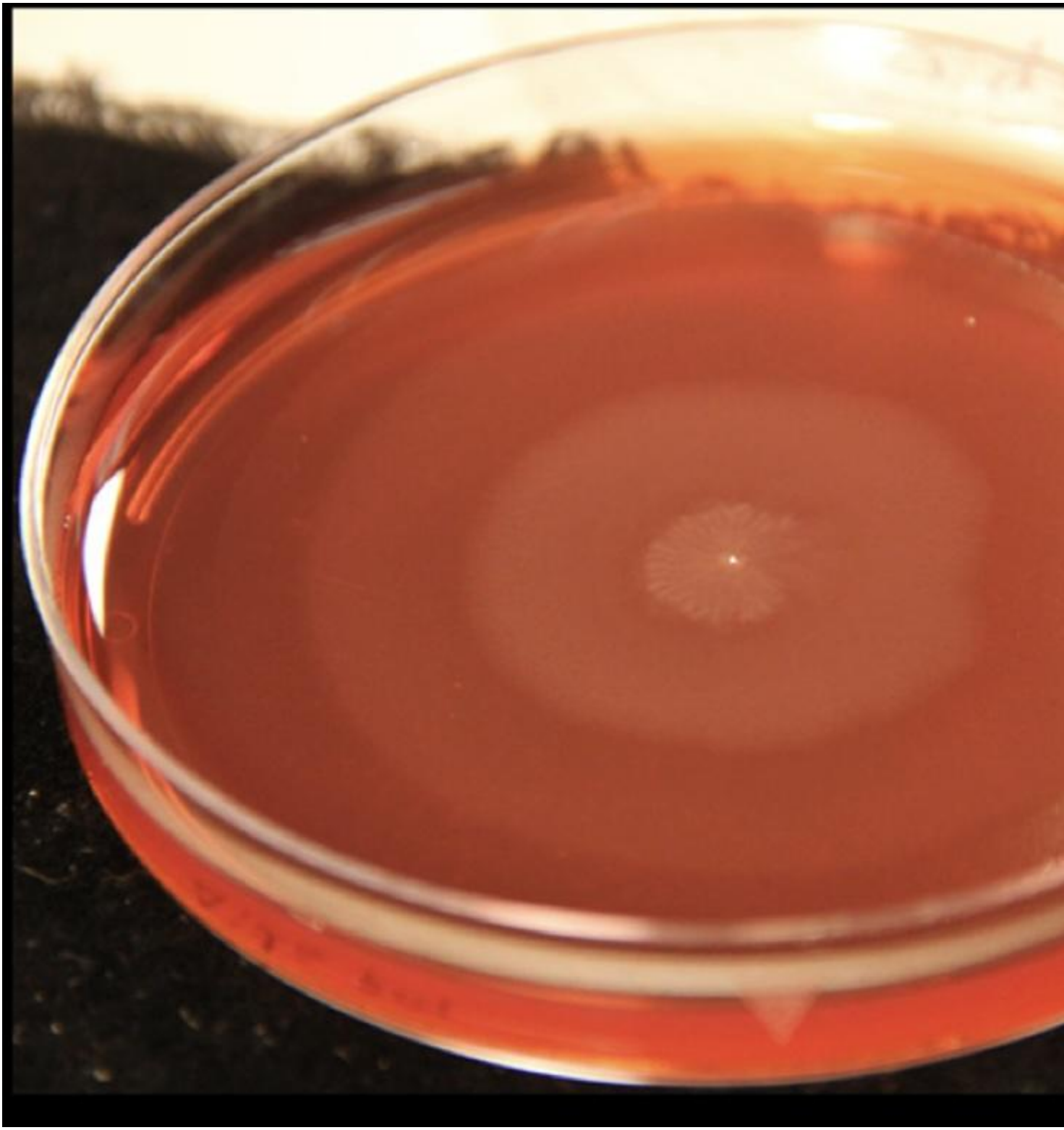
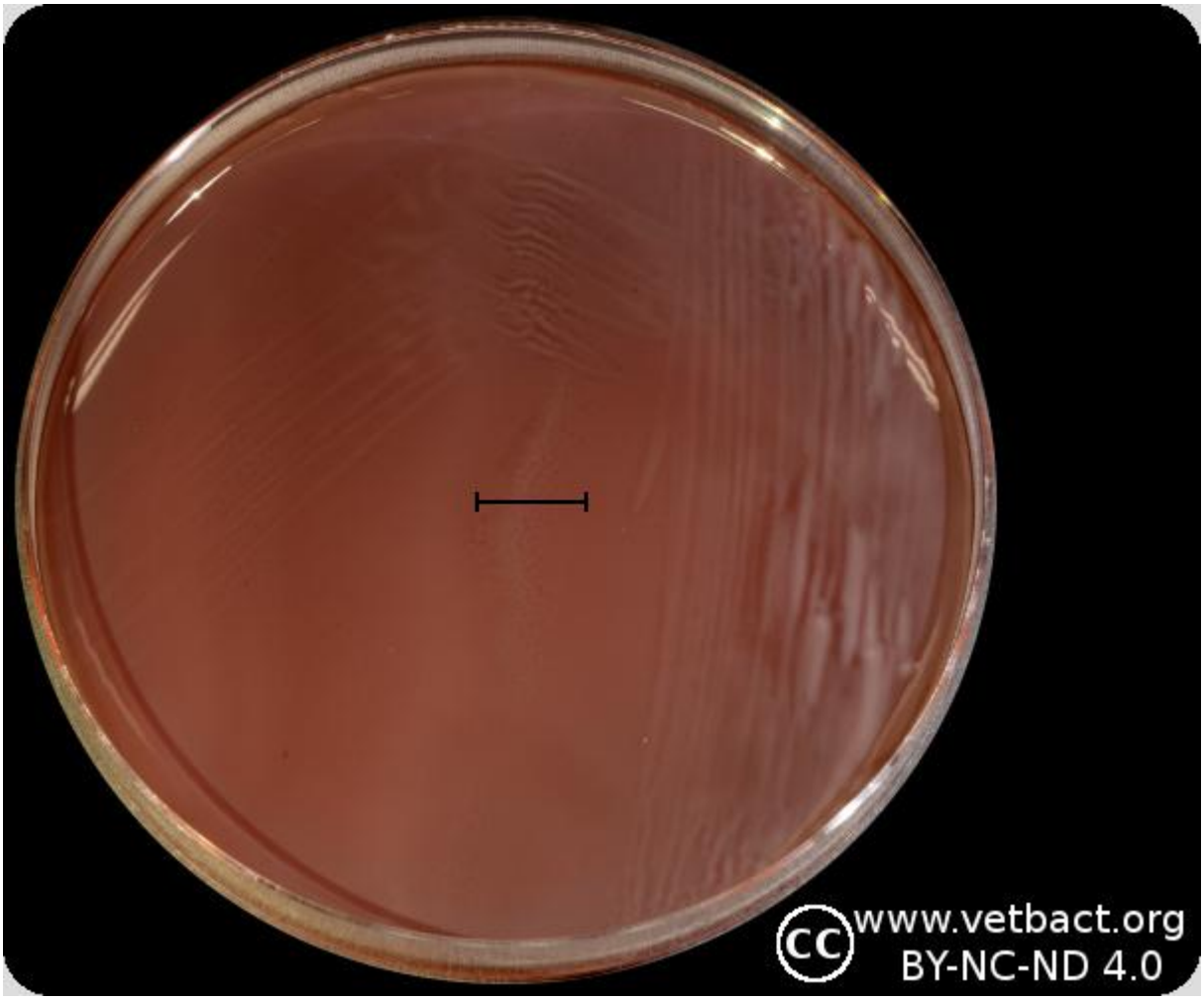


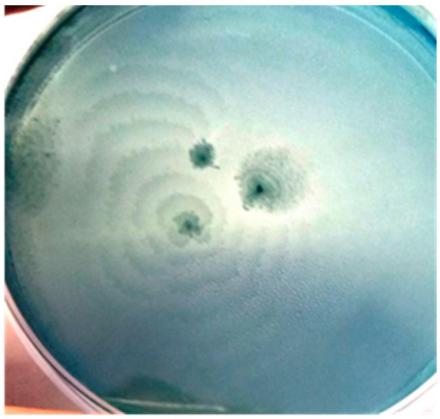
Proteus swarming











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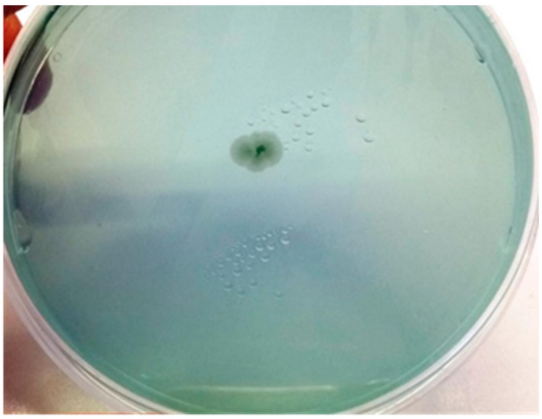


B

? DIAGRAMS / FLOWCHARTS

? E. coli Diarrheal Mechanism

Adhesion
?
Toxin production / invasion
?
Electrolyte imbalance
?
Diarrhea

? UTI Pathogenesis (Ascending)

Perineal flora (E. coli)
?
Urethra
?
Bladder
?
Kidney (pyelonephritis)

? Proteus Stone Formation

Urease
?
Urea ? Ammonia
?
Alkaline urine
?
Struvite stones

? THE SHIGELLAE

? Classification

- **S. dysenteriae**
- **S. flexneri**
- **S. boydii**
- **S. sonnei**

? Morphology

- Gram-negative bacilli
- **Non-motile**

? Cultural & Biochemical Features

- Non-lactose fermenter
- No H?S production
- Oxidase negative

? Antigenic Structure

- Only **O antigen** present
- No H antigen

? Infective Dose

- Very low (10–100 organisms)

? Pathogenesis

- Entry via contaminated food/water
- **M cell invasion**
- Intracellular multiplication
- Spread to adjacent cells
- **Shiga toxin ? inhibits 60S ribosome**

? Clinical Features

- **Bacillary dysentery**
    - Blood + mucus in stool
    - Tenesmus

? Complications

- **Hemolytic uremic syndrome (HUS)**

? Laboratory Diagnosis

- Stool microscopy ? RBC, pus cells
- Culture ? NLF colonies

? Treatment & Resistance

- Antibiotics (based on sensitivity)
- Increasing resistance trends

? TABLES (VERY HIGH-YIELD)

? Shigella Species Comparison

SPECIES	SEVERITY
S. dysenteriae	Severe
S. flexneri	Common
S. sonnei	Mild

? Shigella vs EIEC

FEATURE	SHIGELLA	EIEC
Motility	Non-motile	Motile
Toxin	Present	Absent
Severity	Severe	Mild

? Biochemical Reactions

TEST	RESULT
Lactose	–
H?S	–
Motility	–

? SLIDES (EXAM FAVORITE)

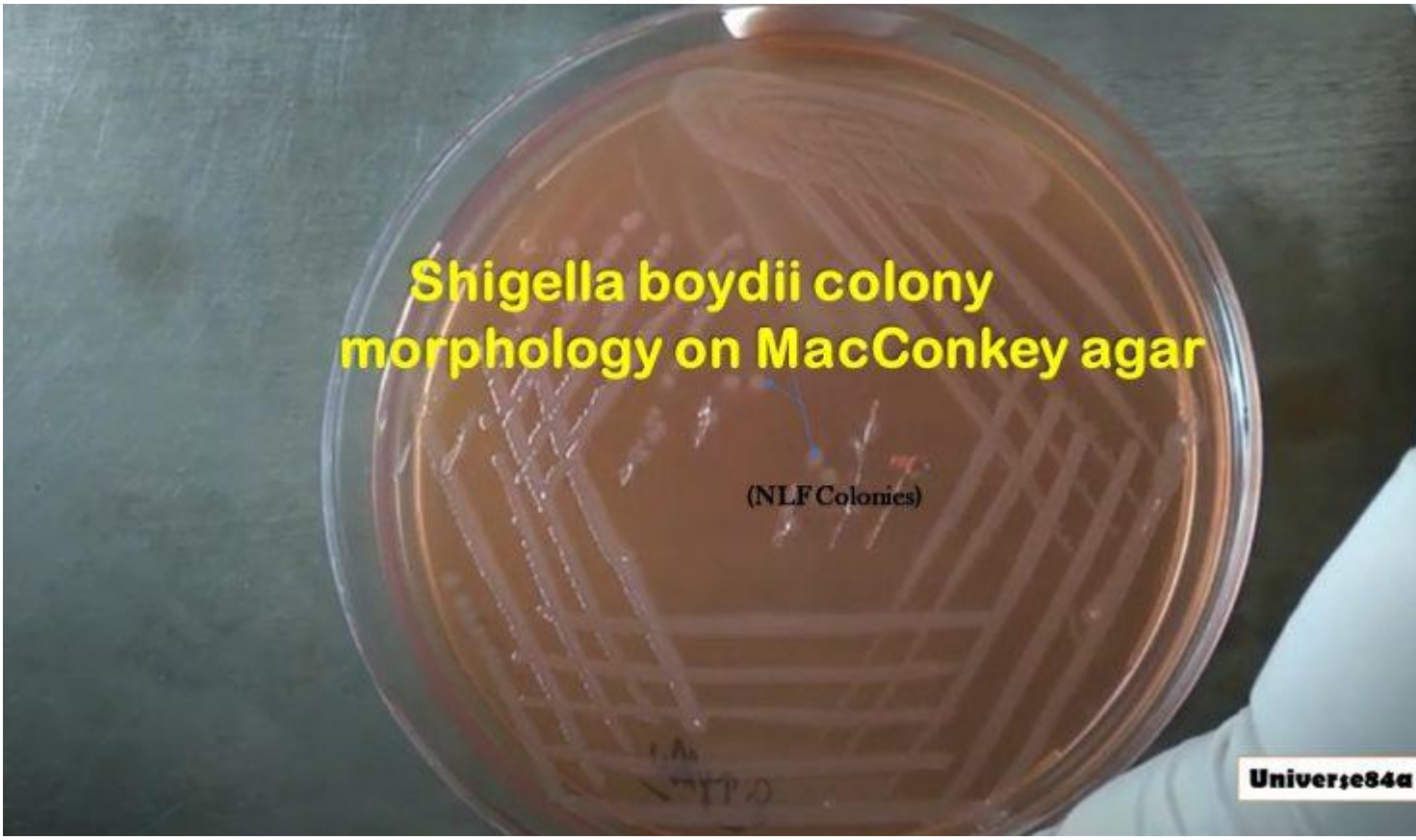
Shigella colonies


www.microbiologyinpictures.com
ID#: 17177
CDC/Dr. Todd Parker
Shigella sonnei on MacConkey agar

Shigella (culture)

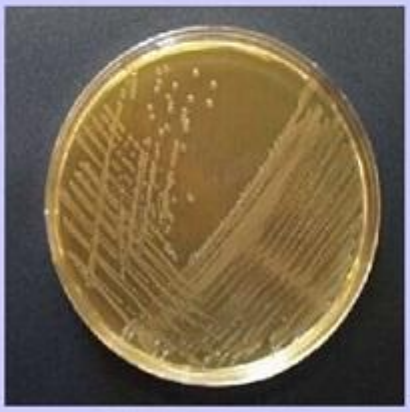
- **MacConkey's (Mac) agar:** medium sized, non-lactose fermenter colonies.

8


Shigella boydii colony
morphology on MacConkey agar
(NLF Colonies)
Universe84a

Shigella spp Isolation

- *Shigella* organisms may be very difficult to distinguish biochemically from *Escherichia coli.*
- *Shigella* species are Gram-negative, facultatively anaerobic, nonsporulating, nonmotile rods in the family *Enterobacteriaceae*
- They do not decarboxylate lysine or ferment lactose within 2 day



NON-LACTOSE FERMENTERS: COLOURLESS COLONIES

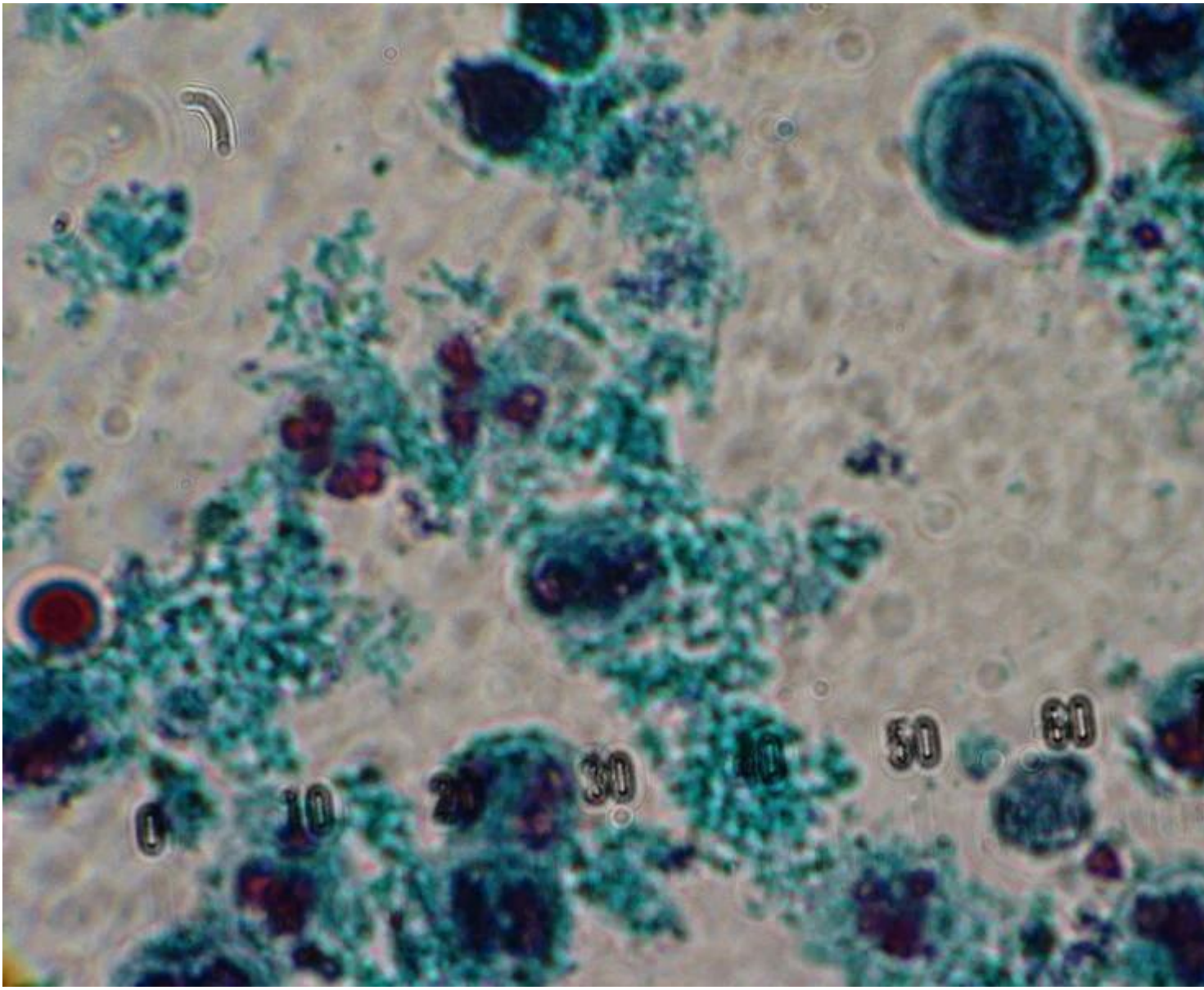
MacConkey Agar
LACTOSE FERMENTERS: RED/PINK COLONIES

Notes downloaded from **Medmentoredu** | Page 62

On MacConkey agar

Shigellae form non-lactose fermenting pale colored or colorless and transparent colonies

Stool microscopy



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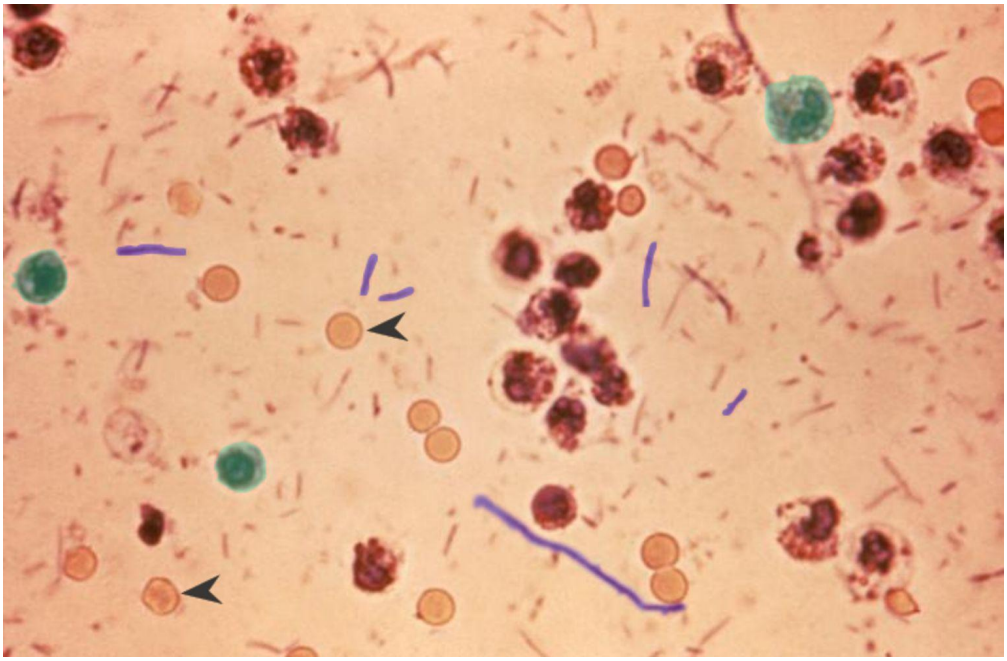

MICRO

Leukocytes (WBCs)

- Normal stool may co
  occasional (0-1) WB
- To look for WBCs, th
  should be prepared f
  of mucous or watery

Notes downloaded from **Medmentoredu** | Page 66

Positive Fecal WBC

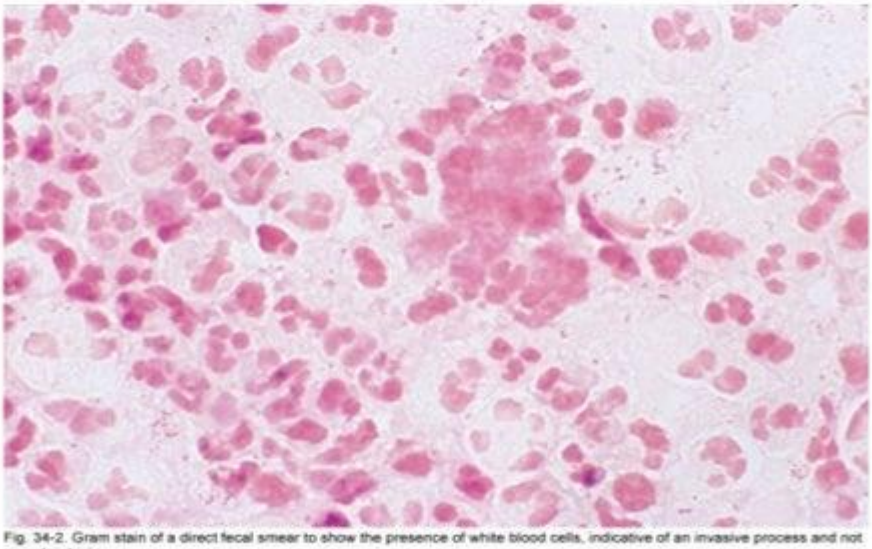

Fig. 34-2. Gram stain of a direct fecal smear to show the presence of white blood cells, indicative of an invasive process and not an enterotoxin.

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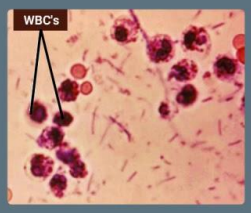
INTERPRETATION OF STOOL EXAMINATION

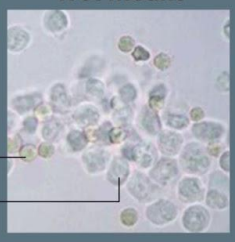
Microscopic examination

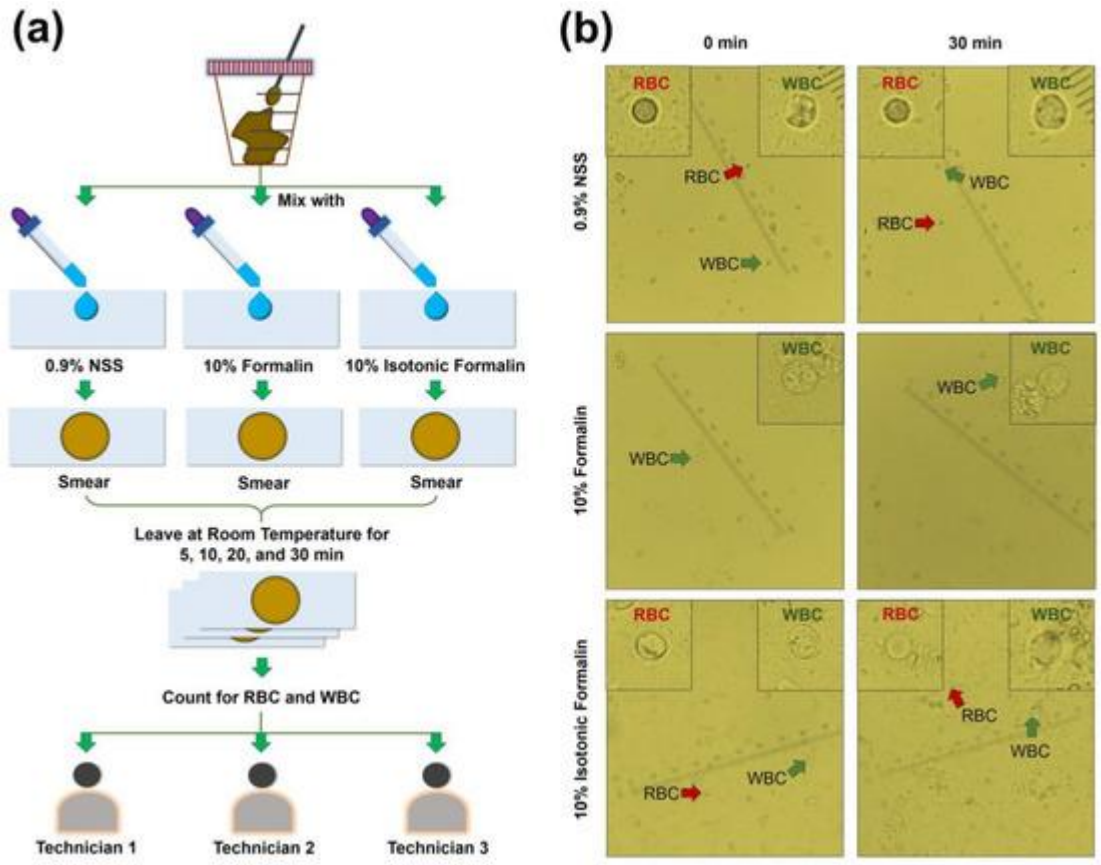
Presence of Leukocytes

- Normal stool may contain occasional **(0 – 1) WBC's**
- To look for WBC's the smears must be prepared from the area of mucus or from watery stool



Wet mount





? DIAGRAMS / FLOWCHARTS

? Pathogenesis of Shigella

Ingestion

?

M cell invasion

?

Intracellular multiplication

?

Cell destruction

?

Dysentery

? Shiga Toxin Mechanism

Toxin
?
60S ribosome inhibition
?
Protein synthesis blocked
?
Cell death

? THE SALMONELLA–ARIZONA GROUP

? Classification

- **Kauffmann–White classification**
    - Based on **O (somatic) and H (flagellar) antigens**
- Major groups:
    - **Salmonella typhi**
    - **Salmonella paratyphi (A, B, C)**
    - **Non-typhoidal Salmonella (NTS)** ? S. typhimurium, S. enteritidis

---

? Morphology

- Gram-negative bacilli

- Motile (peritrichous flagella)
- Non-spore forming

? Cultural Characteristics

- Non-lactose fermenter
- MacConkey ? pale colonies
- XLD ? red colonies with black center (H?S)
- SS agar ? colorless colonies with black center

? Biochemical Reactions

- Glucose fermentation ? positive
- Lactose ? negative
- H?S production ? positive
- Urease ? negative
- Citrate ? positive (most species)

? Antigenic Structure

ANTIGEN	FEATURE	SIGNIFICANCE

O antigen	Somatic	Early immune response
H antigen	Flagellar	Phase variation (Phase 1 & 2)
Vi antigen	Capsule (S. typhi)	Anti-phagocytic, carrier state

? Pathogenesis

- Ingestion via contaminated food/water
  ?
- Survives gastric acid
  ?
- Invades intestinal mucosa (Peyer’s patches)
  ?
- Multiplies in macrophages
  ?
- **Primary bacteremia**
  ?
- Dissemination to liver, spleen, bone marrow
  ?
- **Secondary bacteremia ? systemic disease (enteric fever)**

? Clinical Features

Enteric Fever

- Step-ladder fever

- Relative bradycardia
- Hepatosplenomegaly
- Rose spots

Food Poisoning (NTS)

- Acute gastroenteritis
- Vomiting + diarrhea

Septicemia

- Immunocompromised patients
- High mortality

? Carrier State

TYPE	SITE
Intestinal	Intestine
Biliary	Gall bladder (most important)
Urinary	Urinary tract

? Stage-wise Disease Progression

WEEK	FINDINGS
1st	Fever, bacteremia
2nd	High fever, organ involvement
3rd	Complications
4th	Recovery

? Complications

- **Intestinal perforation**
- **Hemorrhage**
- Septic shock

? Laboratory Diagnosis

- **Blood culture**
    - Best in 1st week
- **Stool culture**
    - Later stages
- **Widal test**

- Detects antibodies against O & H antigens

? Vaccines

- **Vi polysaccharide vaccine**
- **Oral Ty21a vaccine**

? TABLES (VERY HIGH-YIELD)

? Typhoidal vs Non-typhoidal Salmonella

FEATURE	TYPHOIDAL	NON-TYPHOIDAL
Example	S. typhi	S. typhimurium
Disease	Enteric fever	Gastroenteritis
Host	Humans only	Animals + humans

? Antigenic Structure Comparison

ANTIGEN	FUNCTION
O	Somatic
H	Motility

ANTIGEN	FUNCTION
Vi	Capsule

? Widal Test Interpretation

ANTIBODY	SIGNIFICANCE
O	Acute infection
H	Past infection

? Stage-wise Culture Positivity

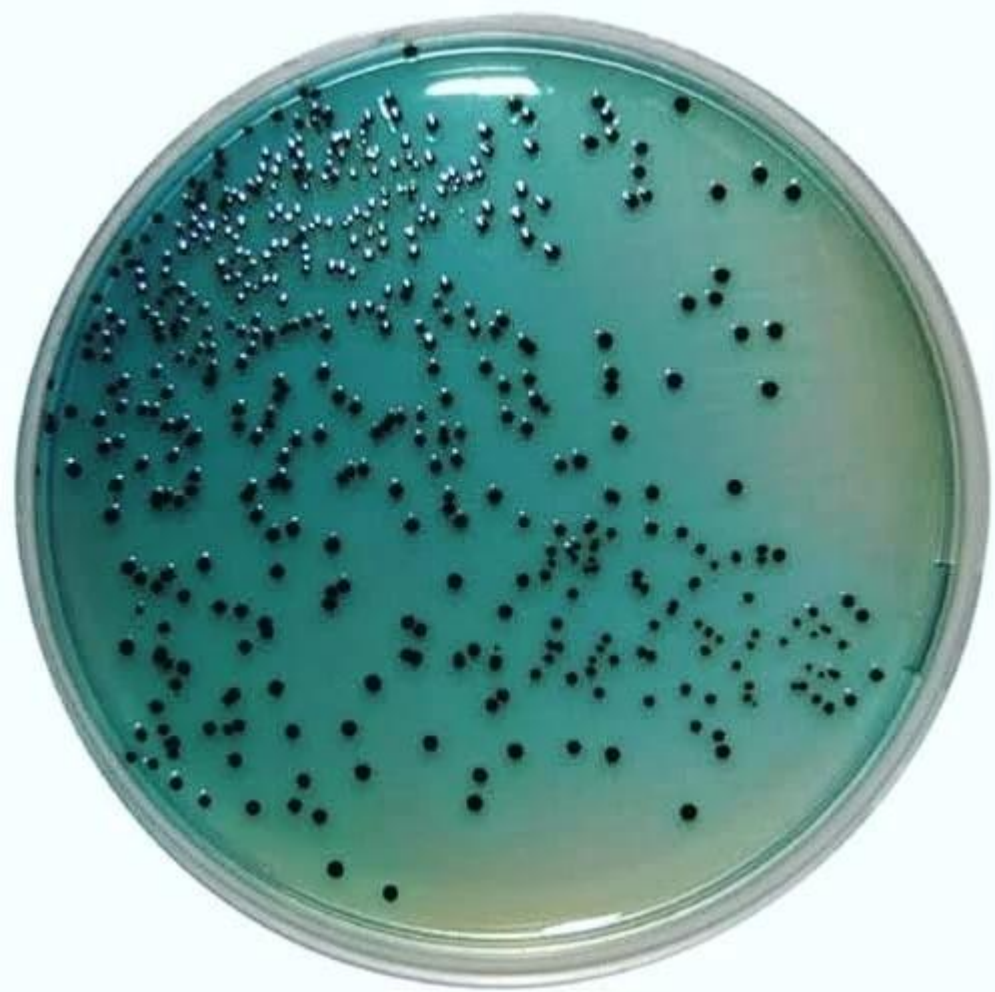
STAGE	BEST SAMPLE
Early	Blood
Late	Stool
Carrier	Stool/urine

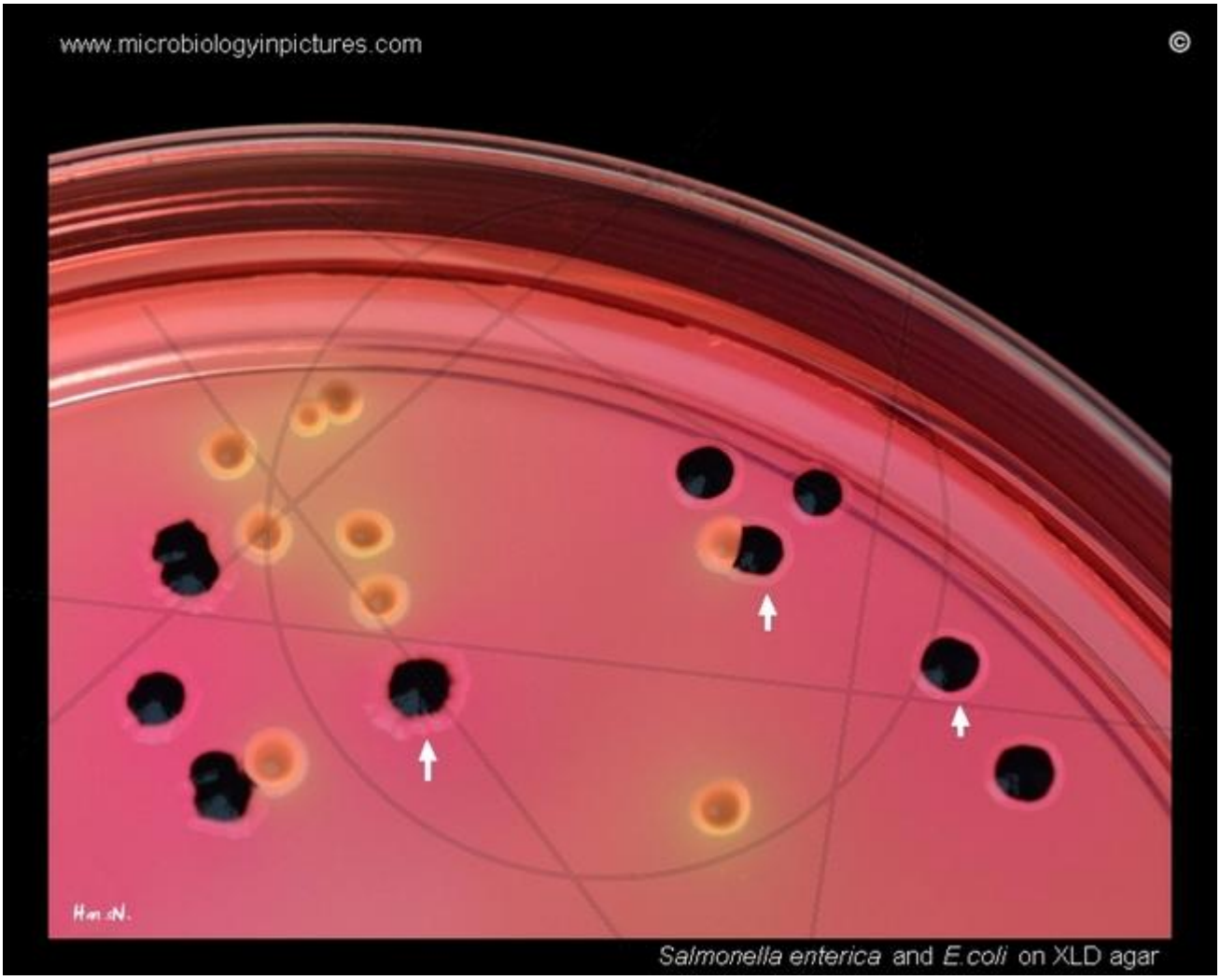
? Typhoid vs Paratyphoid

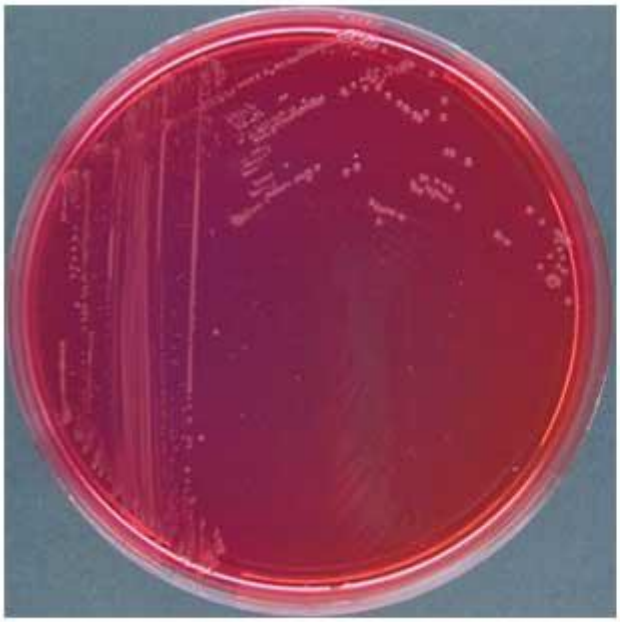
FEATURE	TYPHOID	PARATYPHOID
Severity	Severe	Mild
Organism	S. typhi	S. paratyphi

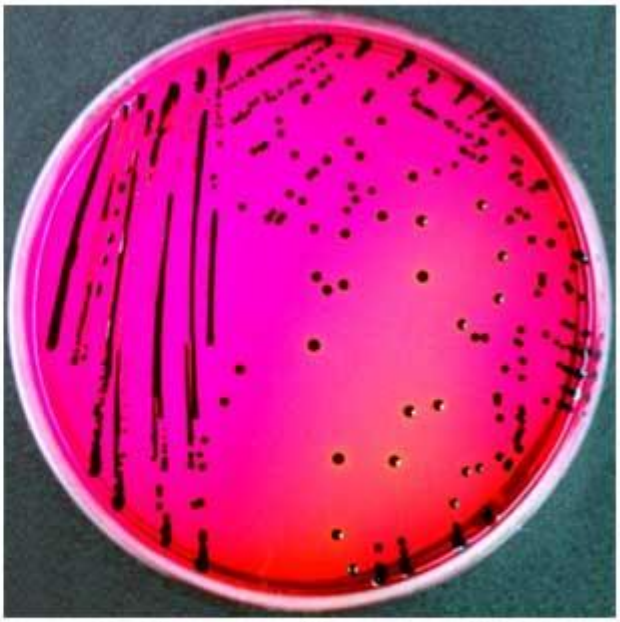
? SLIDES (EXAM FAVORITE)

Salmonella colonies



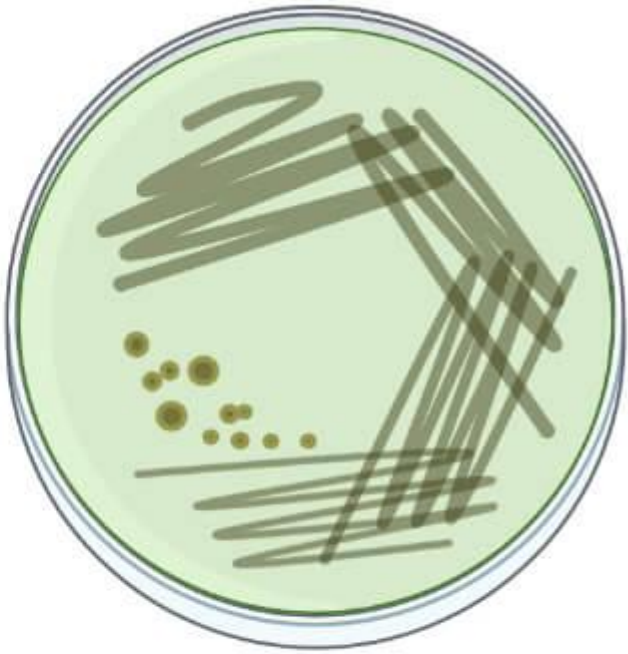

www.microbiologyinpictures.com
©
Salmonella enterica and E.coli on XLD agar





Shigella on XLD. ***Salmonella on XLD.***

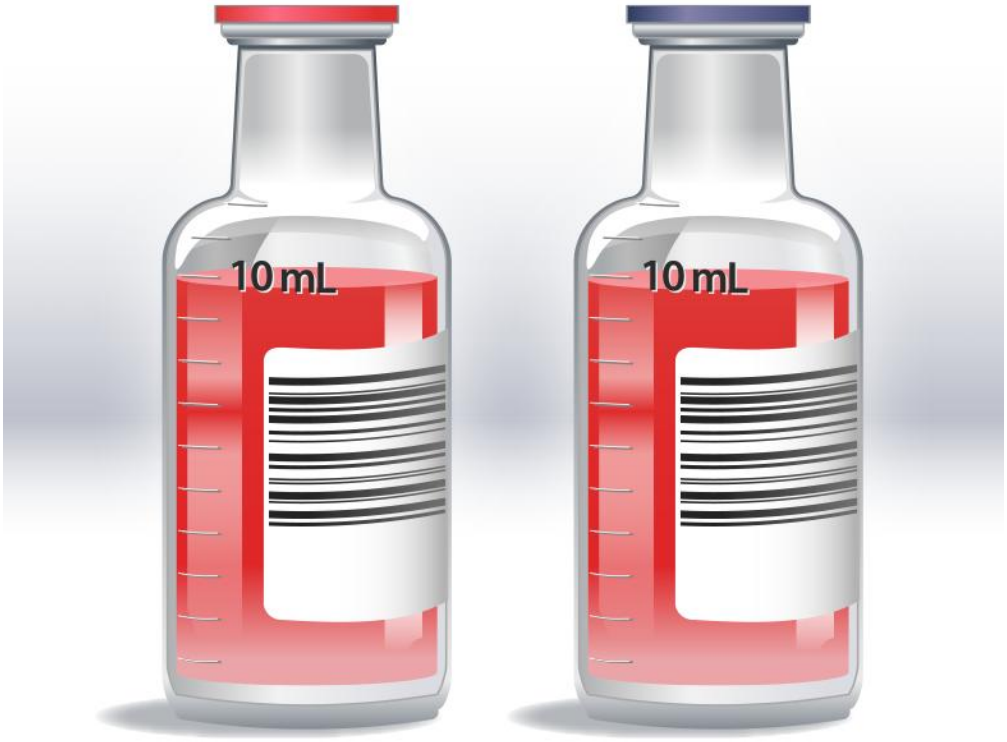
Image Source: Faculty of Health and Medical Sciences - University of Copenhagen, Denmark



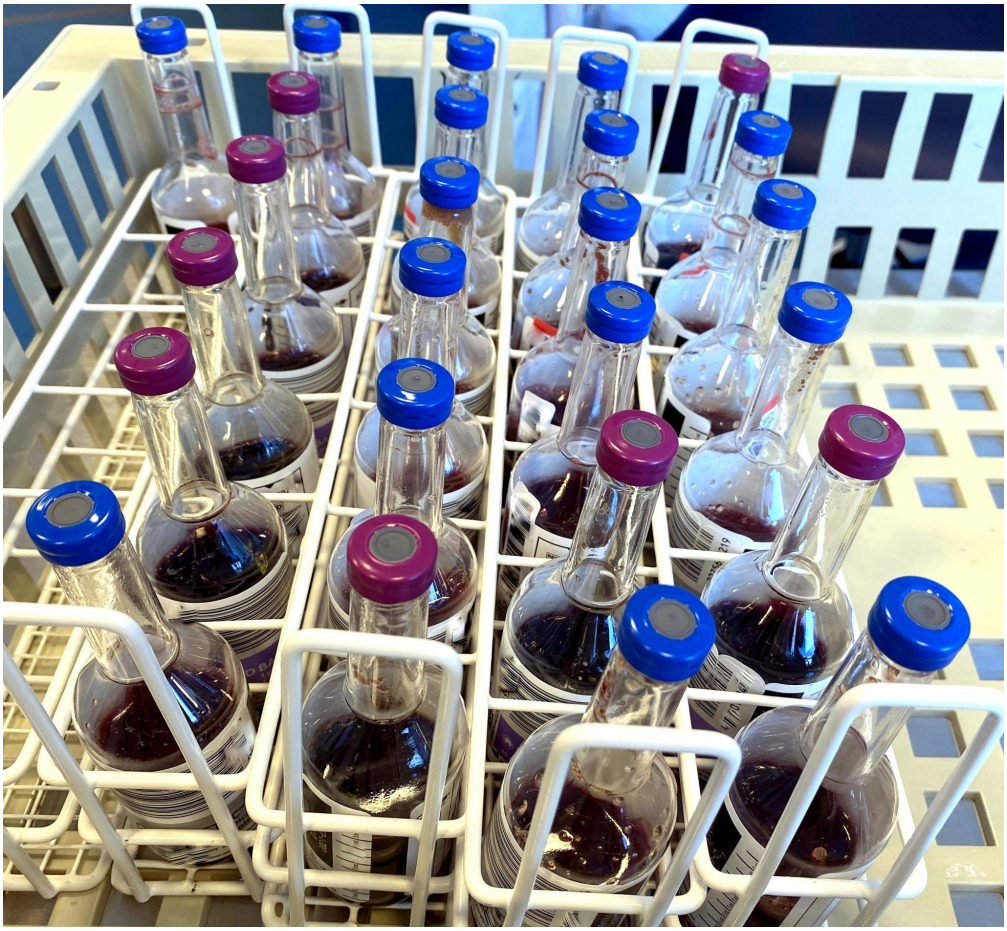
***Salmonella* spp. on XLD Agar** ***Salmonella* spp. on Bismuth Sulfite A**

Blood culture


Last, First Name
Second identifier
Collect Date/Time & Collector
IVD
Last, First Name
Second identifier
Collect Date/Time & Collector
IVD

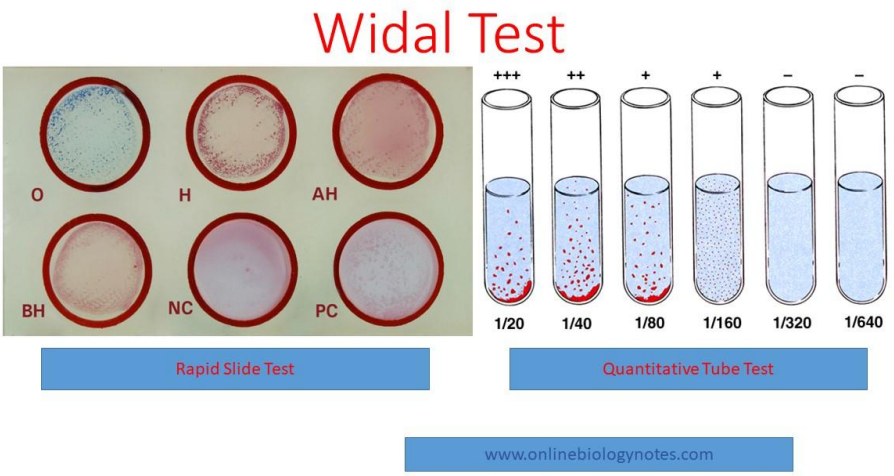

10 mL
10 mL


SP3BG6IV
SF2AIMGI
Aerobic
Blood
Culture
Bottle
SG3BCU2E
Anaerobic
Blood
Culture
Bottle

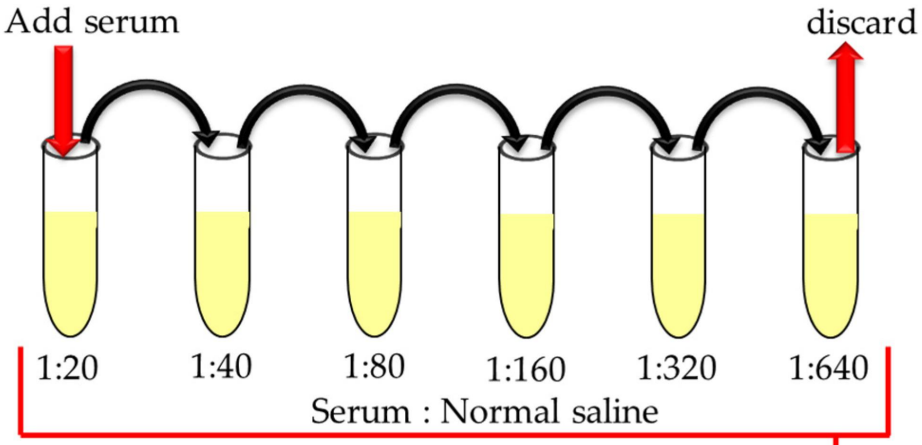



442023
10 mL

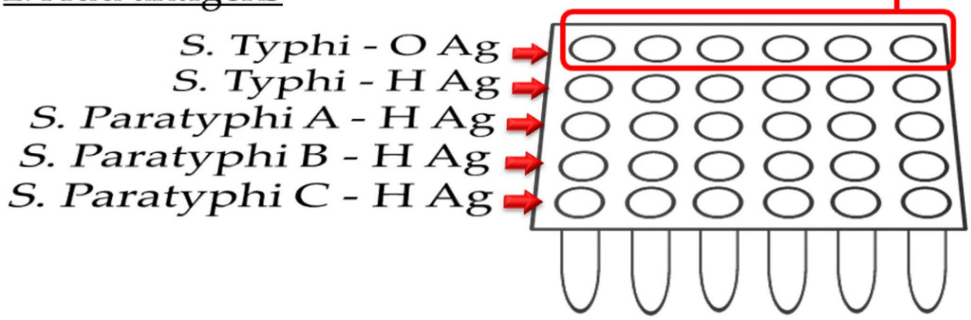
Widal test


Widal Test
O
H
AH
BH
NC
PC
+++
++
+
+
–
–
1/20
1/40
1/80
1/160
1/320
1/640
Rapid Slide Test
Quantitative Tube Test
www.onlinebiologynotes.com

1. Serial dilution



2. Add antigens



3. Mix properly, cover and incubate at 37° C overnight

4. Observe for agglutination and interpret the results

PROCEDURE OF WIDAL TEST

1.SLID AGGLUTINATION TEST:

1.REQUIREMENTS:-

Widal

Dropper

Mixture

2.SAMPLE-patient serum

3. REAGENT-

O-antigen AH-antigen

H-antigen BH-antigen

? DIAGRAMS / FLOWCHARTS

? Pathogenesis of Enteric Fever

Ingestion
?
Intestinal invasion
?
Macrophage survival
?
Primary bacteremia
?
Reticuloendothelial system
?
Secondary bacteremia
?
Systemic disease

? Carrier State (Gall Bladder)

Salmonella persistence
?
Gall bladder colonization
?
Chronic shedding
?
Carrier state

? Widal Reaction Principle

Antigen (O/H)
?
Patient serum
?
Antibody binding
?
Agglutination

? Antigen Structure Diagram

Cell wall
?
O antigen

Flagella
?
H antigen

Capsule
?
Vi antigen

? CHAPTER SUMMARY

? Key Characteristics

- Gram-negative bacilli
- Non-lactose fermenters
- H?S production
- Antigenic variation

? Important Organisms

- Salmonella typhi
- Salmonella paratyphi
- Non-typhoidal Salmonella

? Diagnostic Approach

- Blood culture (early)
- Stool culture (late)
- Widal test

? Virulence Mechanisms

- Intracellular survival
- Endotoxin
- Vi antigen (immune evasion)

? High-Yield Differentiating Points

- H?S production
- Motility
- Antigenic variation

? TABLES (VERY HIGH-YIELD)

? Organism vs Disease

ORGANISM	DISEASE
S. typhi	Enteric fever
S. paratyphi	Mild enteric fever
NTS	Gastroenteritis

? Quick Revision Table

FEATURE	SALMONELLA
Motility	+
Lactose	–
H?S	+
Urease	–

? DIAGRAMS / FLOWCHARTS

? Organism ? Disease Concept Map

Salmonella
?
Typhi ? Enteric fever
Paratyphi ? Mild fever
NTS ? Gastroenteritis

? Diagnostic Algorithm

Fever
?
Blood culture
?
Positive ? Salmonella

If negative
?
Stool culture / Widal test
?
Confirmation