STAPHYLOCOCCI

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STAPHYLOCOCCI

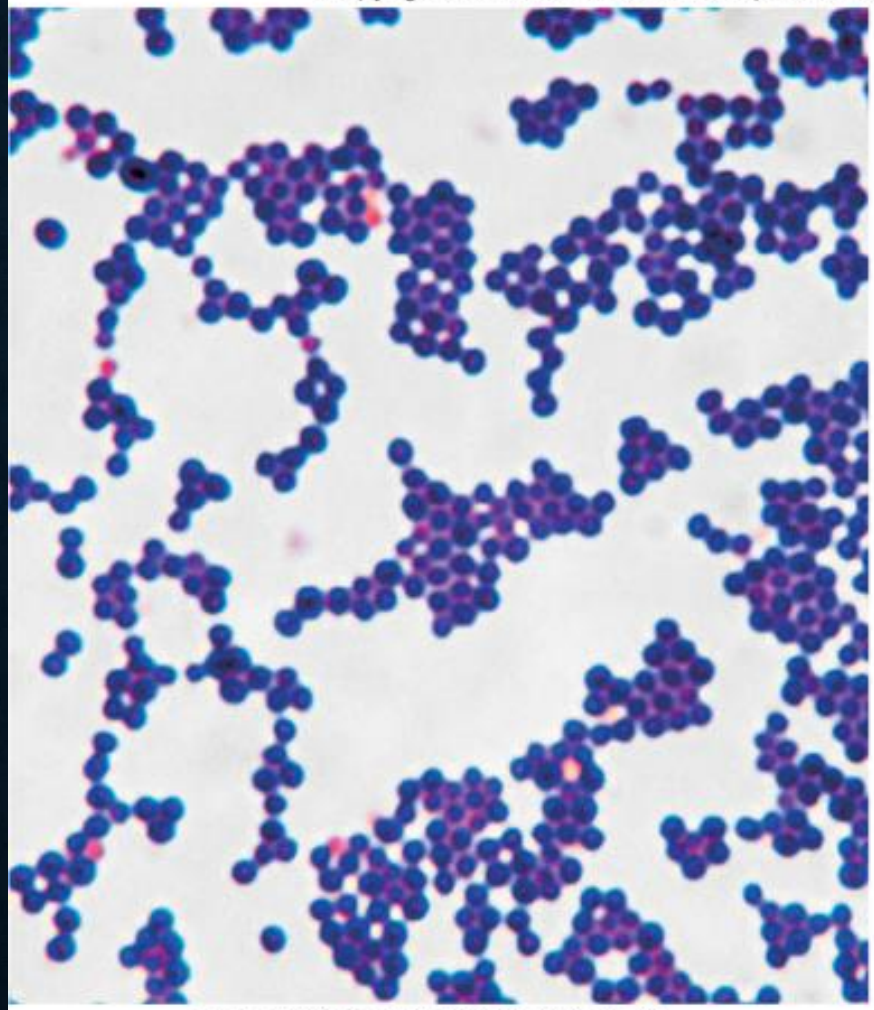
Coagulase-negative staphylococcus; frequently involved in nosocomial and opportunistic infections

- *S. epidermidis* – lives on skin and mucous membranes; endocarditis, bacteremia, UTI
- *S. hominis* – lives around apocrine sweat glands
- *S. capitis* – live on scalp, face, external ear
- All 3 may cause wound infections by penetrating through broken skin
- *S. saprophyticus* – infrequently lives on skin, intestine, vagina; UTI

GENERAL CHARACTERISTICS OF THE STAPHYLOCOCCI

- Common inhabitant of the skin and mucous membranes
- Spherical cells arranged in irregular clusters
- Gram-positive
- Lack spores and flagella
- May have capsules
- 31 species

S. *AUREUS* MORPHOLOGY



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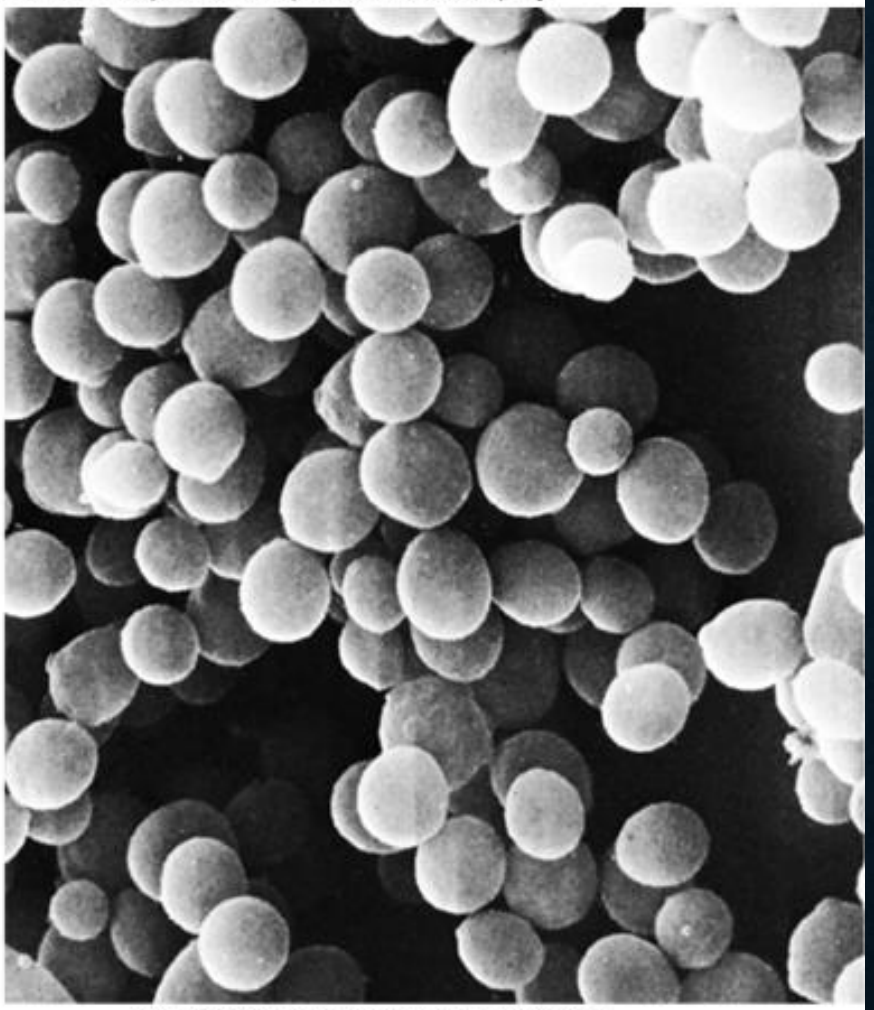

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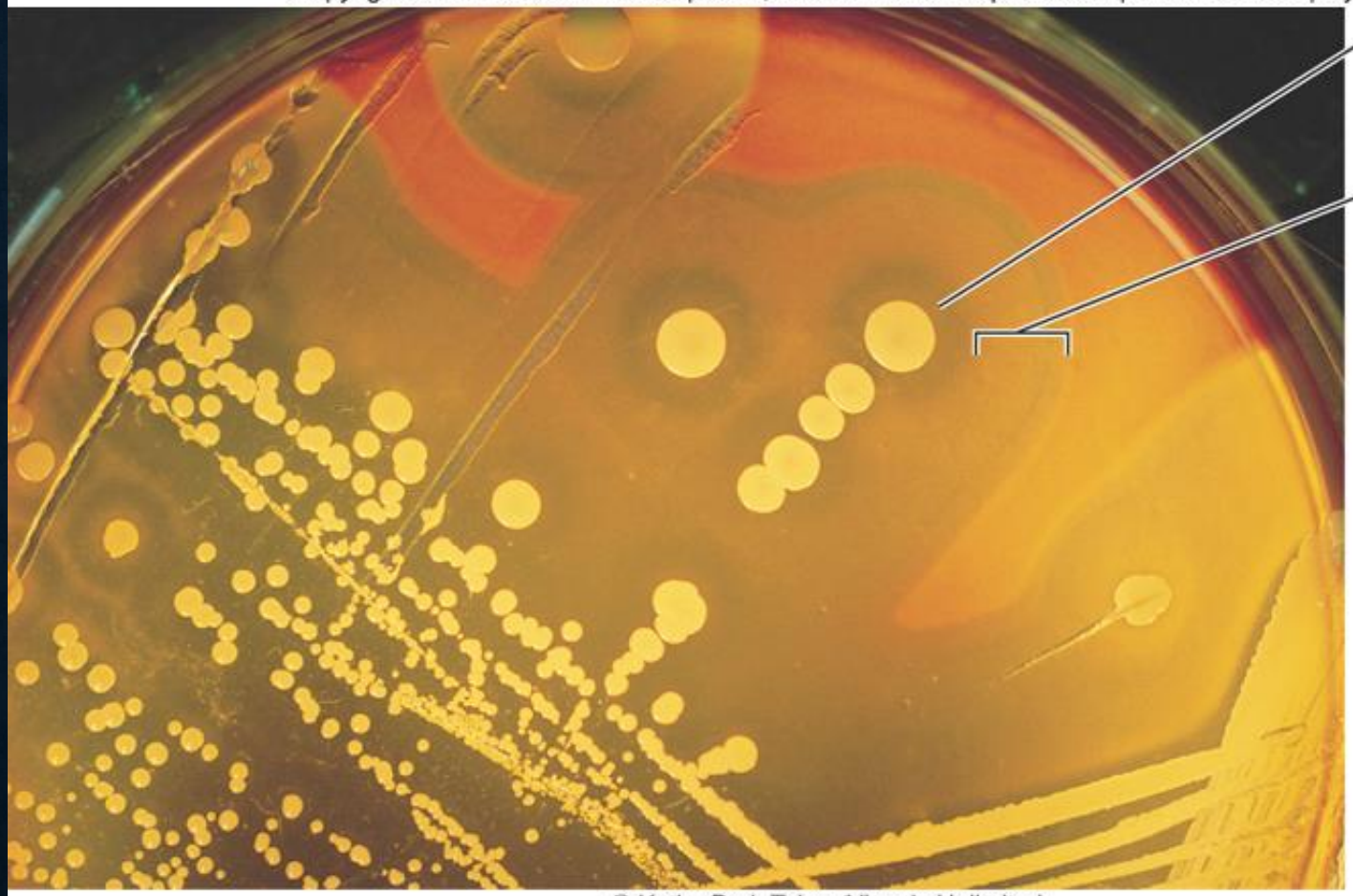
STAPHYLOCOCCUS AUREUS

- Grows in large, round, opaque colonies
- Optimum temperature of 37°C
- Facultative anaerobe
- Withstands high salt, extremes in pH, and high temperatures
- Produces many virulence factors

BLOOD AGAR PLATE, S. *AUREUS*



VIRULENCE FACTORS OF *S. AUREUS*

Enzymes:

- Coagulase – coagulates plasma and blood; produced by 97% of human isolates; diagnostic
- Hyaluronidase – digests connective tissue
- Staphylokinase – digests blood clots
- DNase – digests DNA
- Lipases – digest oils; enhances colonization on skin
- Penicillinase – inactivates penicillin

VIRULENCE FACTORS OF *S. AUREUS*

Toxins:

- **Hemolysins** (α, β, γ, δ) – lyse red blood cells
- **Leukocidin** – lyses neutrophils and macrophages
- **Enterotoxin** – induce gastrointestinal distress
- **Exfoliative toxin** – separates the epidermis from the dermis
- **Toxic shock syndrome toxin** (TSST) – induces fever, vomiting, shock, systemic organ damage

TABLE 18.1 Major Virulence Factors of *Staphylococcus aureus*

Name	Enzyme/Toxin	Effect
Coagulase	Enzyme	Coagulates blood plasma
Hyaluronidase	Enzyme	Digests connective tissue of the host
Staphylokinase	Enzyme	Digests blood clots
Lipase	Enzyme	Digests oils, allowing bacteria to more easily colonize the skin
Penicillinase	Enzyme	Inactivates penicillin, rendering the bacterium resistant
Hemolysins (α, β, γ, δ)	Toxin	Lyse red blood cells
Leukocidin	Toxin	Lyses neutrophils and macrophages
Enterotoxins	Toxin	Induce nausea, vomiting, and diarrhea
Exfoliative toxins (A, B)	Toxin	Cause desquamation of the skin
Toxic shock syndrome toxin	Toxin	Induces fever, vomiting, rash, organ damage

EPIDEMIOLOGY AND PATHOGENESIS

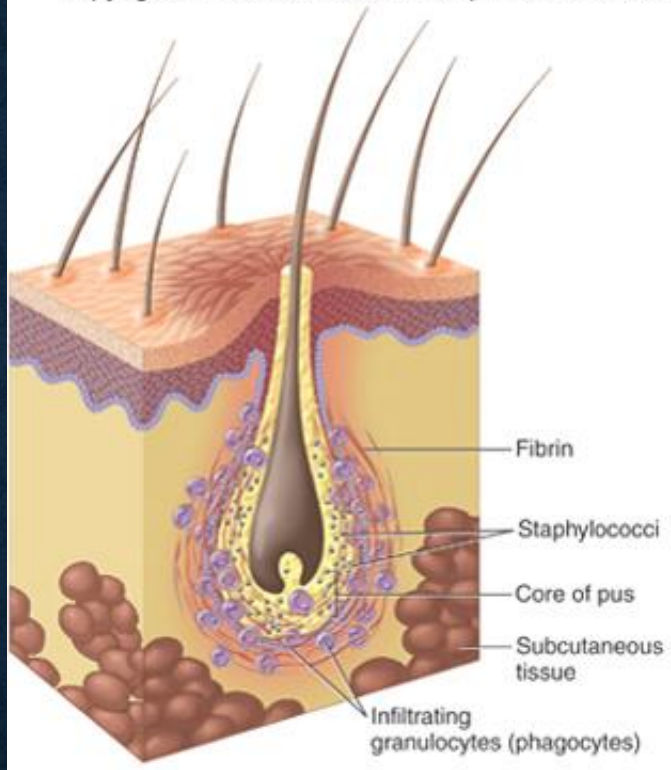
- Present in most environments frequented by humans
- Readily isolated from fomites
- Carriage rate for healthy adults is 20-60%
- Carriage is mostly in anterior nares, skin, nasopharynx, intestine
- Predisposition to infection include: poor hygiene and nutrition, tissue injury, preexisting primary infection, diabetes, immunodeficiency
- Increase in community acquired methicillin resistance - MRSA

STAPHYLOCOCCAL DISEASE

Range from localized to systemic

- **Localized cutaneous infections** – invade skin through wounds, follicles, or glands
  - **Folliculitis** – superficial inflammation of hair follicle; usually resolved with no complications but can progress
  - **Furuncle** – boil; inflammation of hair follicle or sebaceous gland progresses into abscess or pustule
  - **Carbuncle** – larger and deeper lesion created by aggregation and interconnection of a cluster of furuncles
  - **Impetigo** – bubble-like swellings that can break and peel away; most common in newborns

Cutaneous lesions of *S. aureus*



(a) Sectional view of a boil or furuncle, a single pustule that develops in a hair follicle or gland and is the classic lesion of the species. The inflamed infection site becomes abscessed when masses of phagocytes, bacteria, and fluid are walled off by fibrin.

(b) A furuncle on the back of the hand. This lesion forms in a single follicle.

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(c) A carbuncle on the back of the neck. Carbuncles are massive deep lesions that result from multiple, interconnecting furuncles. Swelling and rupture into the surrounding tissues can be marked.

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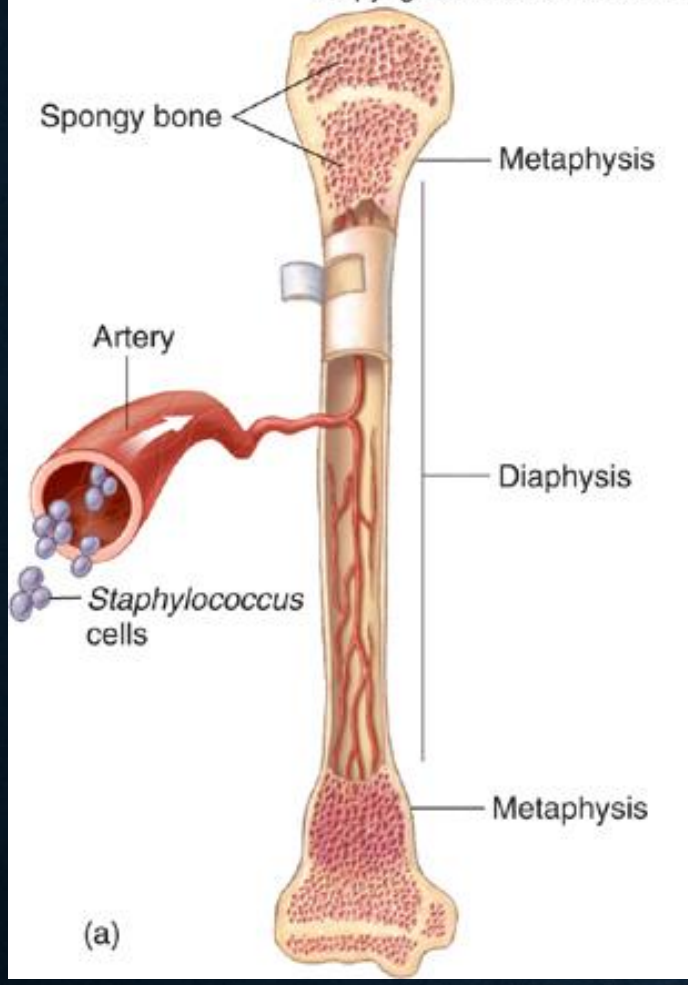
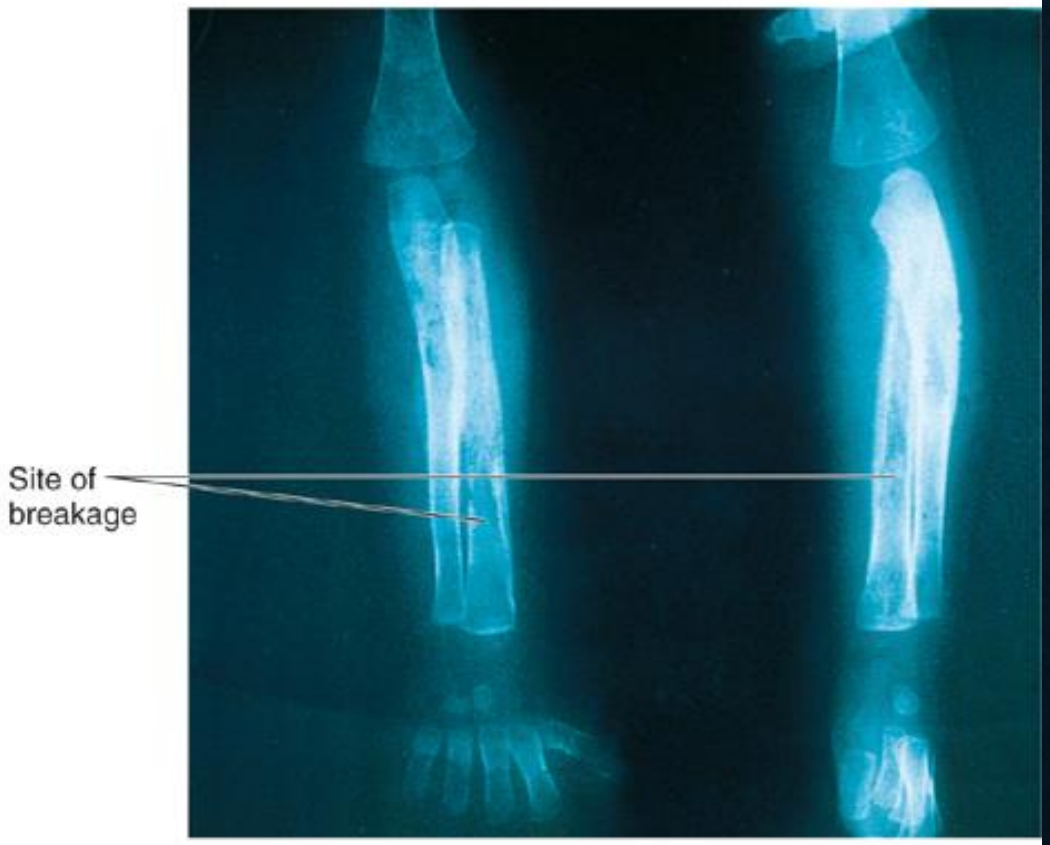
STAPHYLOCOCCAL DISEASE

- **Systemic infections**
  - **Osteomyelitis** – infection is established in the metaphysis; abscess forms
  - **Bacteremia** – primary origin is bacteria from another infected site or medical devices; endocarditis possible

STAPHYLOCOCCAL OSTEOMYELITIS IN A LONG BONE

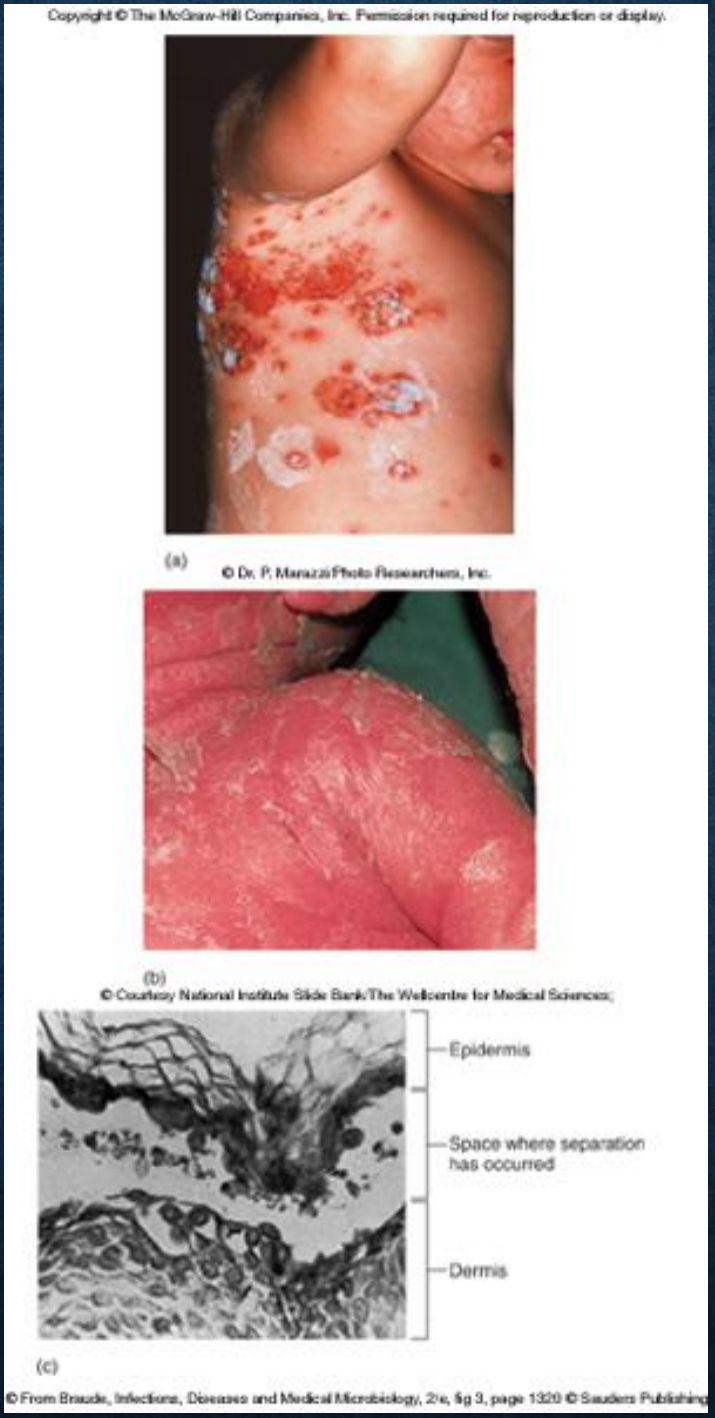




STAPHYLOCOCCAL DISEASE

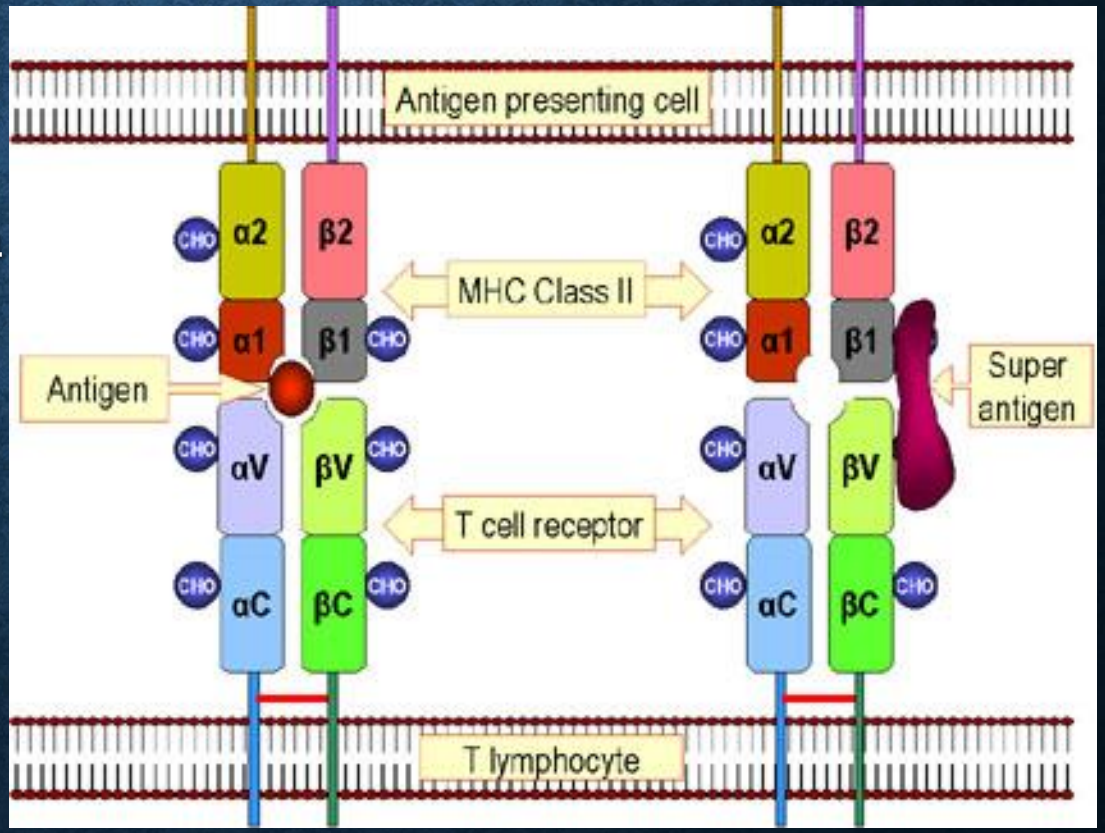
- **Toxigenic disease**
  - **Food intoxication** – ingestion of heat stable enterotoxins; gastrointestinal distress
  - **Staphylococcal scalded skin syndrome** – toxin induces bright red flush, blisters, then desquamation of the epidermis
  - **Toxic shock syndrome** – toxemia leading to shock and organ failure

Effects of staphylococcal toxins on skin



TOXIC SHOCK SYNDROME TOXIN

- Superantigen
- Non-specific binding of toxin to receptors triggers excessive immune response



TSS SYMPTOMS

- 8-12 h post infection
- Fever
- Susceptibility to Endotoxins
- Hypotension
- Diarrhea
- Multiple Organ System Failure
- Erythroderma (rash)

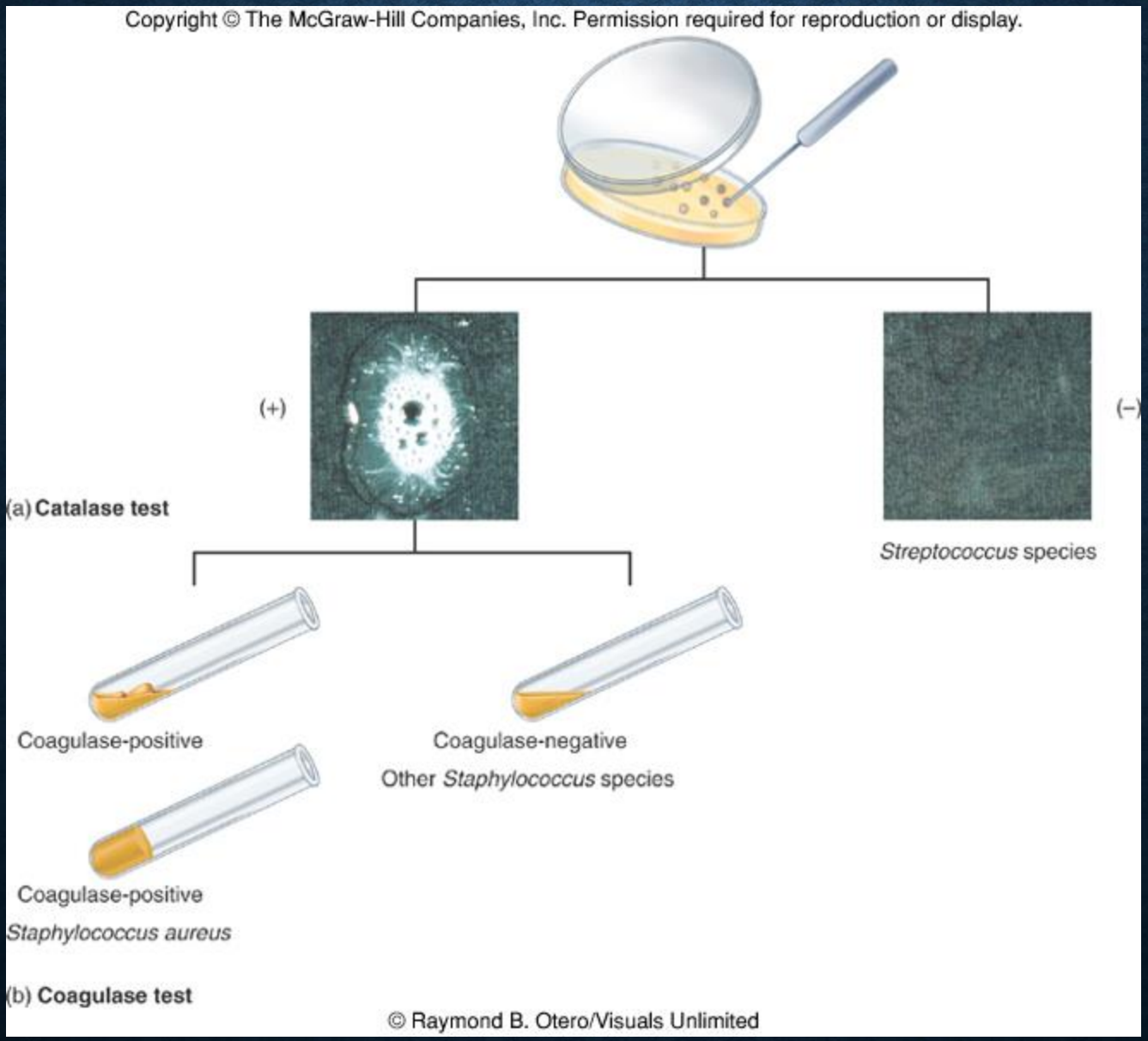
TSS TREATMENT

- Clean any obvious wounds and remove any foreign bodies
- Prescription of appropriate antibiotics to eliminate bacteria
- Monitor and manage all other symptoms, e.g. administer IV fluids
- For severe cases, administer methylprednisone, a corticosteriod inhibitor of TNF-a synthesis

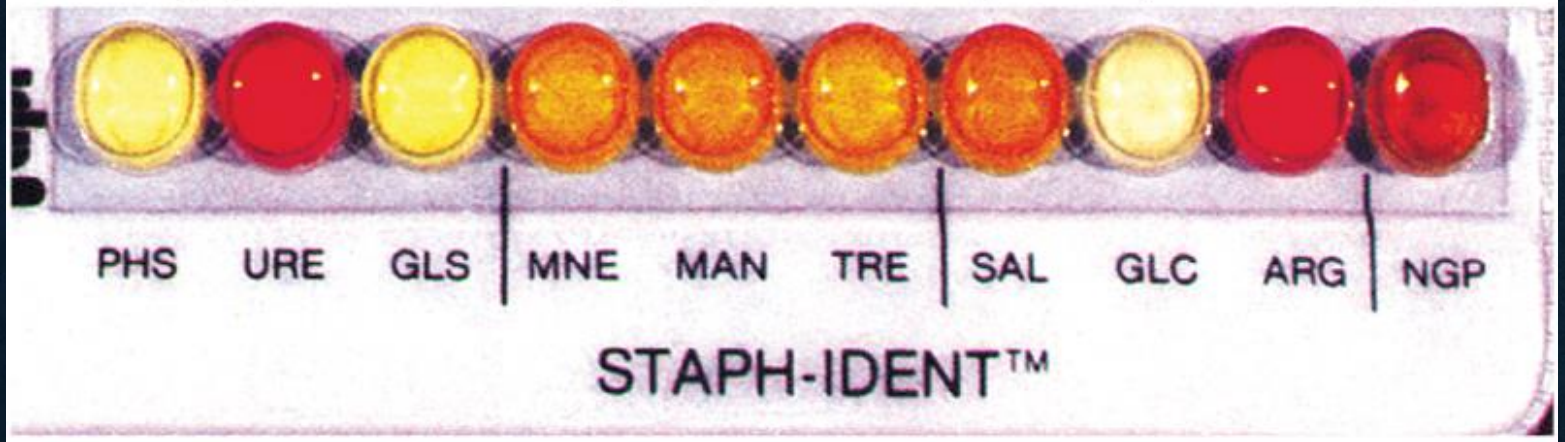
IDENTIFICATION OF *STAPHYLOCOCCUS* IN SAMPLES

- Frequently isolated from pus, tissue exudates, sputum, urine, and blood
- Cultivation, catalase, biochemical testing, coagulase

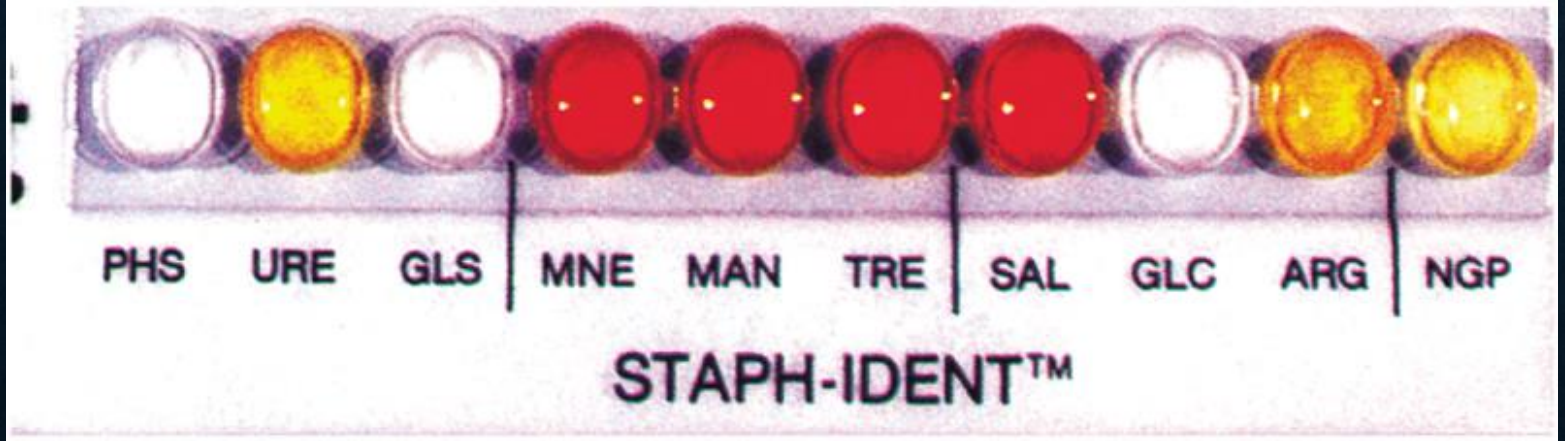
CATALASE TEST



TEST SYSTEM TO IDENTIFY *STAPHYLOCOCCUS*



All tests: positive



All tests: negative

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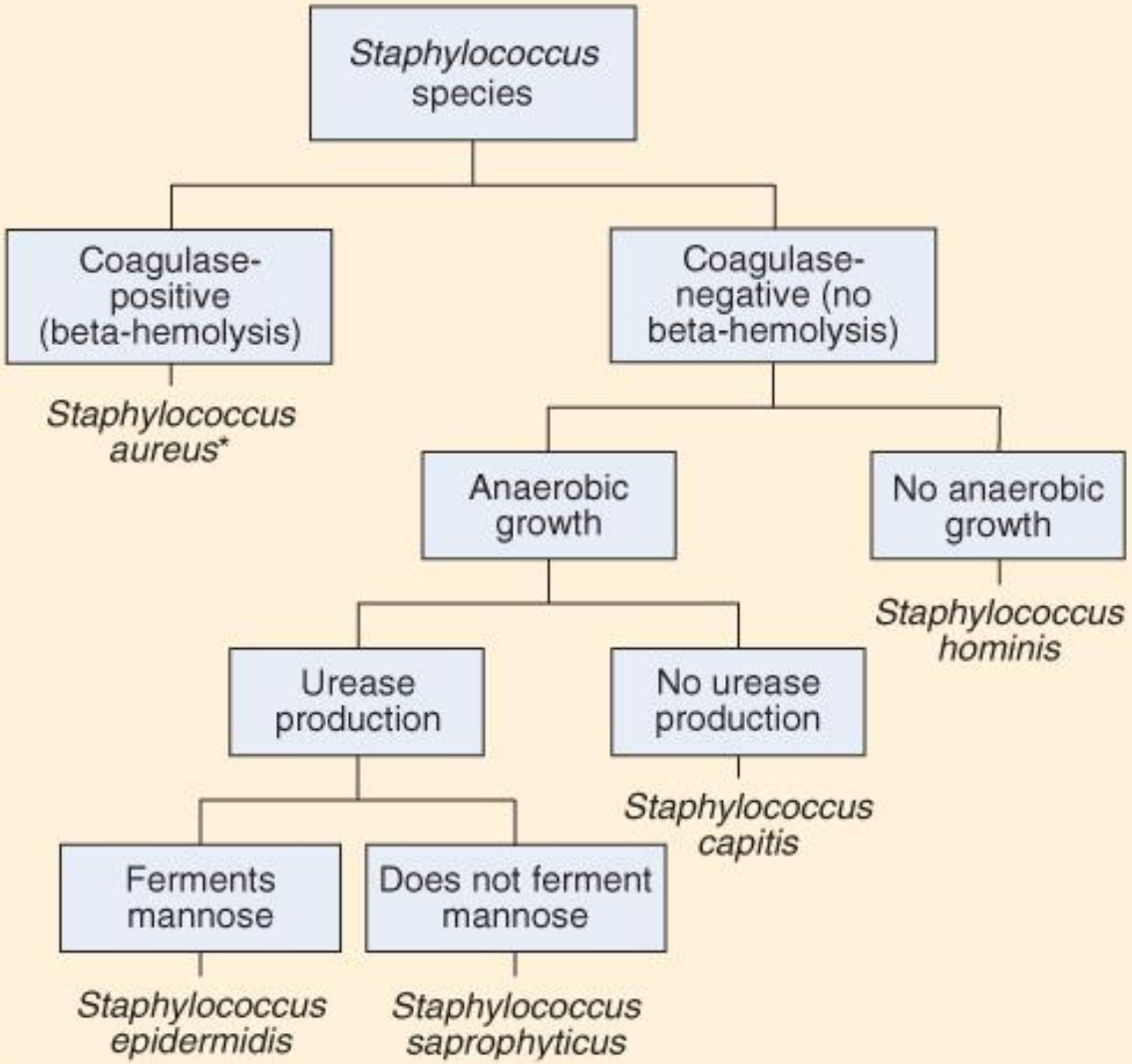
CLINICAL CONCERNS AND TREATMENT

- 95% have penicillinase and are resistant to penicillin and ampicillin
- MRSA – methicillin-resistant *S. aureus* – carry multiple resistance
  - Some strains have resistance to all major drug groups except vancomycin
- Abscesses have to be surgically perforated
- Systemic infections require intensive lengthy therapy

TABLE 18.2 Separation of Clinically Important Species of *Staphylococcus*



*A few strains of *S. aureus* are coagulase-negative.

PREVENTION OF STAPHYLOCOCCAL INFECTIONS

- Universal precautions by healthcare providers to prevent nosocomial infections
- Hygiene and cleansing