

MICROBIOLOGY FOR MRCS

Claire Edwards

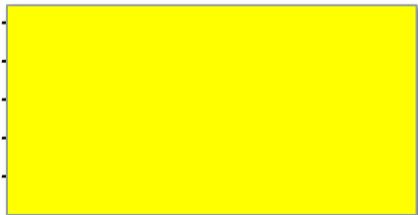
Norfolk and Norwich University Hospital

Overview

- Know your enemy:
 - Organisms
 - Pathology of sepsis
- Prevent the attack:
 - Immunisation
 - Disinfection/sterilisation
 - Surgical prophylaxis
- Fight back
 - Antibiotics
- Special infections
 - C.Diff, gas gangrene, tetanus, necrotizing fasciitis

Overview of Bacterial infections

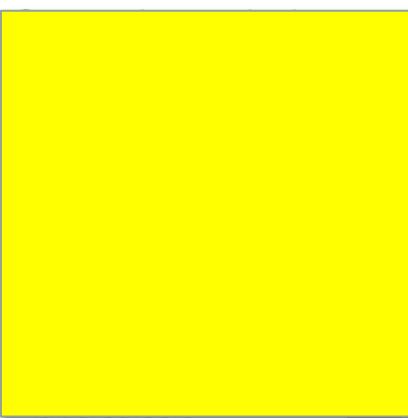
Bacterial meningitis



Otitis media



Pneumonia



Skin infections



Sexually transmitted
diseases



Eye infections



Sinusitis



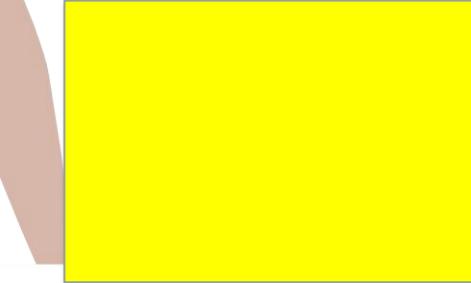
Upper respiratory tract
infection



Gastritis



Food poisoning



Urinary tract infections



Overview of Bacterial infections

Bacterial meningitis

- *Streptococcus pneumoniae*
- *Neisseria meningitidis*
- *Haemophilus influenzae*
- *Streptococcus agalactiae*
- *Listeria monocytogenes*

Otitis media

- *Streptococcus pneumoniae*

Pneumonia



Skin infections

- *Staphylococcus aureus*
- *Escherichia coli*
- *Corynebacterium diphtheriae*

Sexually transmitted diseases

Eye infections



Sinusitis



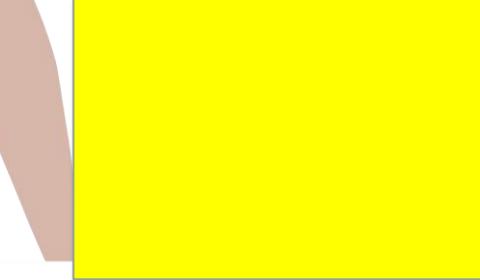
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Sinusitis



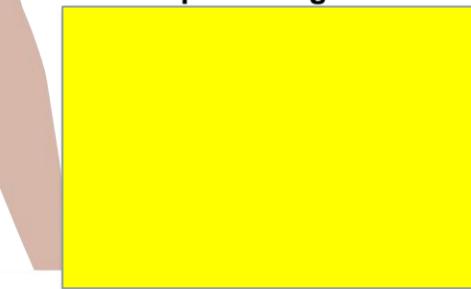
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Urinary tract infections



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Pneumonia

Community-acquired:

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- *Staphylococcus aureus*

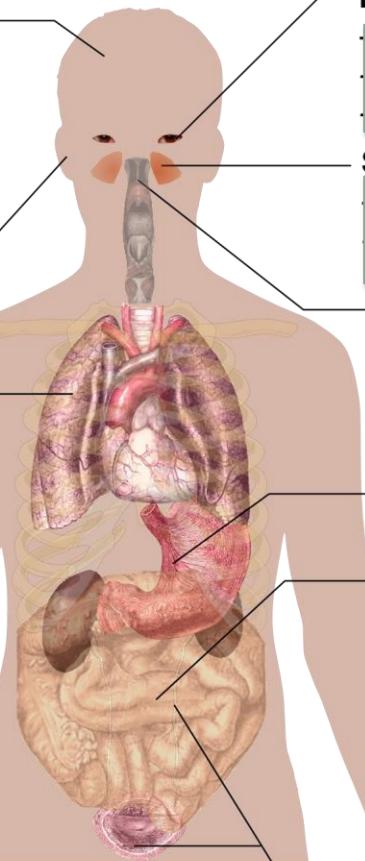
Atypical:

- *Mycoplasma pneumoniae*
- *Chlamydia pneumoniae*
- *Legionella pneumophila*

Tuberculosis

- *Mycobacterium tuberculosis*

Skin infections



Eye infections



Sinusitis



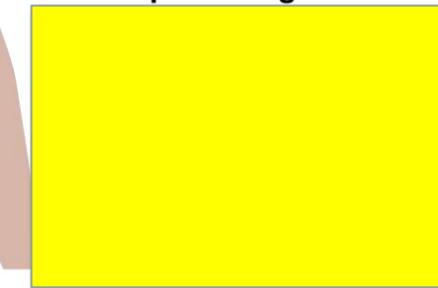
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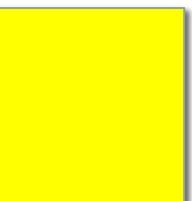
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Eye infections

Sinusitis

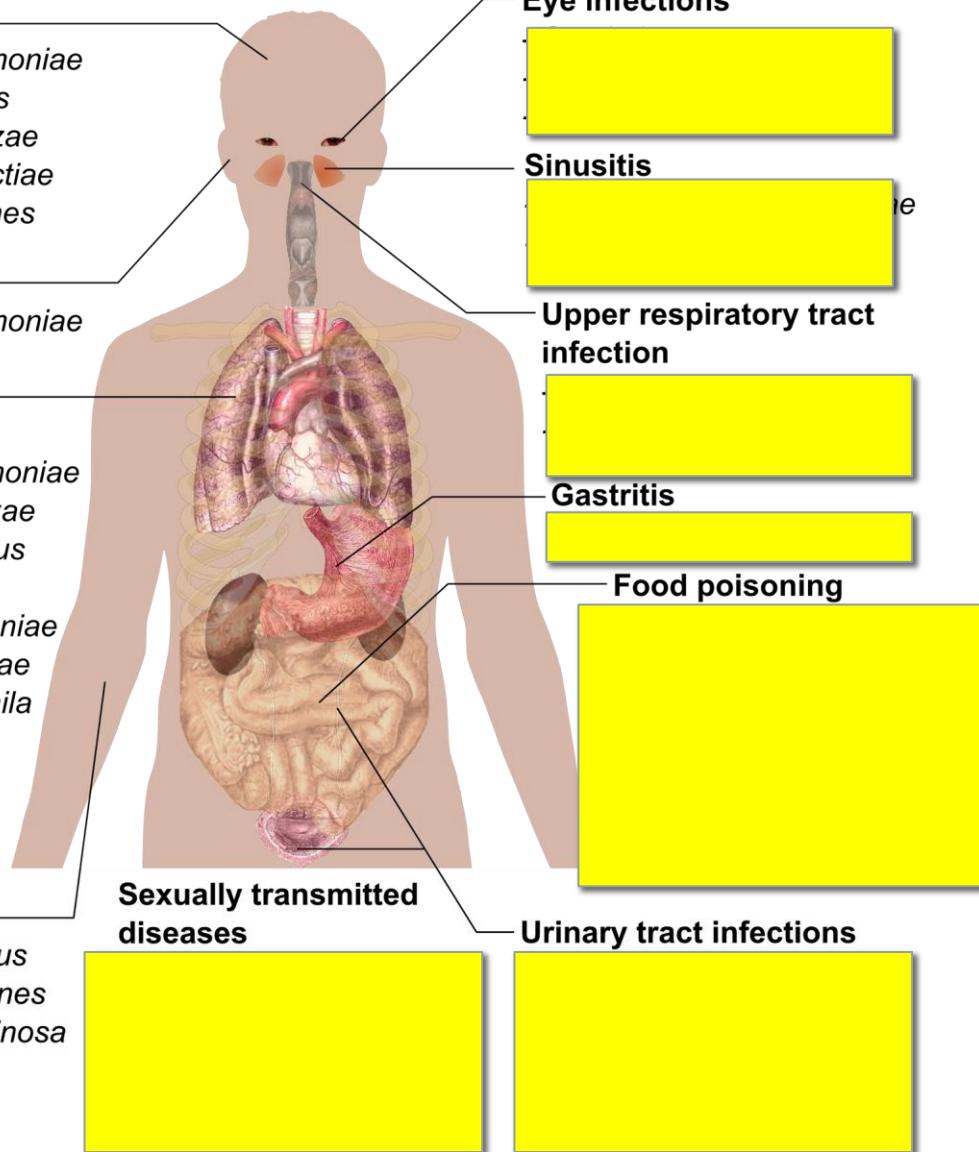
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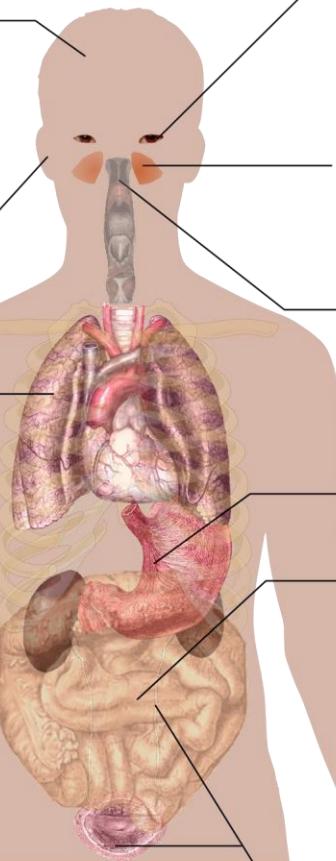
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Eye infections

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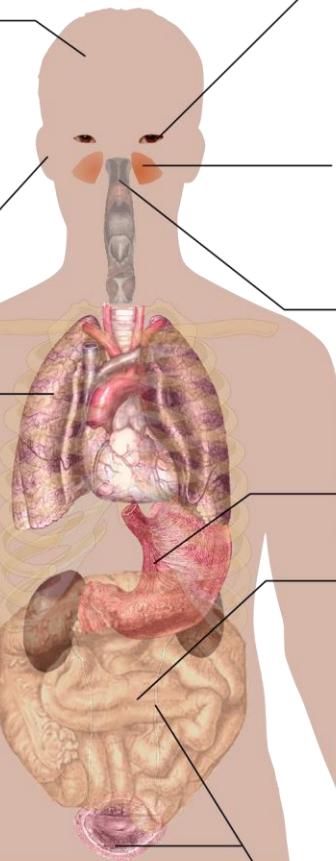
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Eye infections

- *Staphylococcus aureus*
- *Neisseria gonorrhoeae*
- *Chlamydia trachomatis*

Sinusitis

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- *Neisseria gonorrhoeae*

Upper respiratory tract infection

- *Streptococcus pneumoniae*
- *Haemophilus influenzae*
- *Neisseria gonorrhoeae*

Gastritis

- *Helicobacter pylori*
- *Escherichia coli*
- *Campylobacter jejuni*

Food poisoning

- *Salmonella enterica*
- *Escherichia coli*
- *Campylobacter jejuni*
- *Clostridium perfringens*
- *Clostridium botulinum*

Sexually transmitted diseases

- *Chlamydia trachomatis*
- *Neisseria gonorrhoeae*
- *Treponema pallidum*
- *Ureaplasma urealyticum*
- *Haemophilus ducreyi*

Urinary tract infections

- *Escherichia coli*
- *Staphylococcus saprophyticus*
- *Enterococcus faecalis*
- *Proteus mirabilis*
- *Klebsiella pneumoniae*

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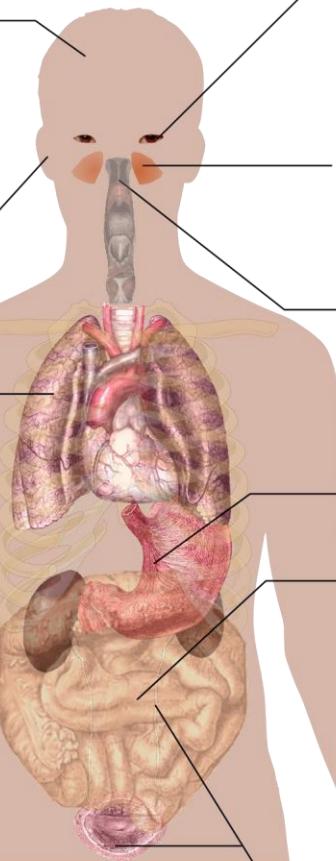
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Food poisoning

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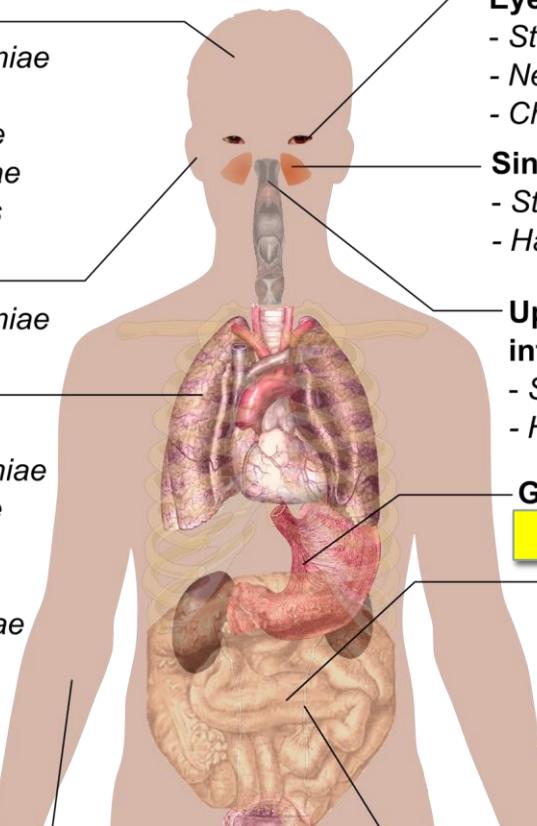
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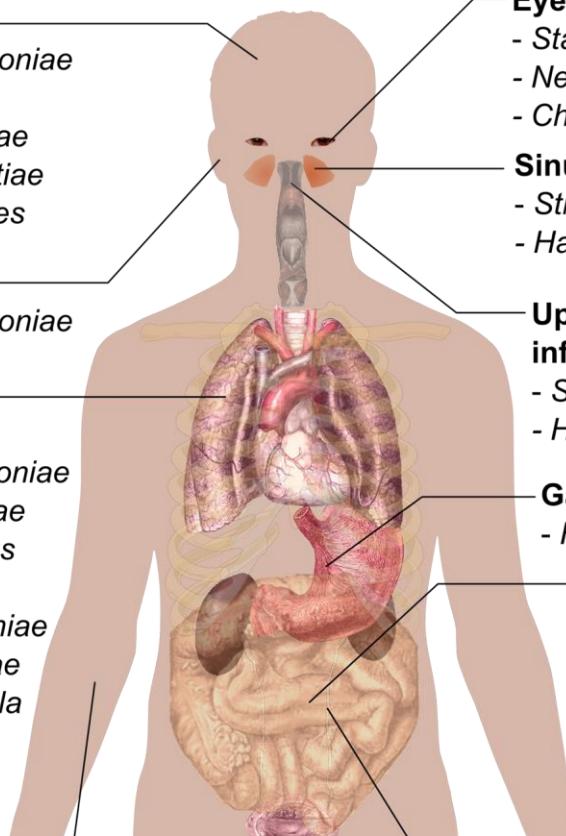
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Eye infections

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Sinusitis

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Upper respiratory tract infection

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Gastritis

- *Helicobacter pylori*

Food poisoning

- *Campylobacter jejuni*
- *Salmonella*
- *Shigella*
- *Clostridium*
- *Staphylococcus aureus*
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Sexually transmitted diseases

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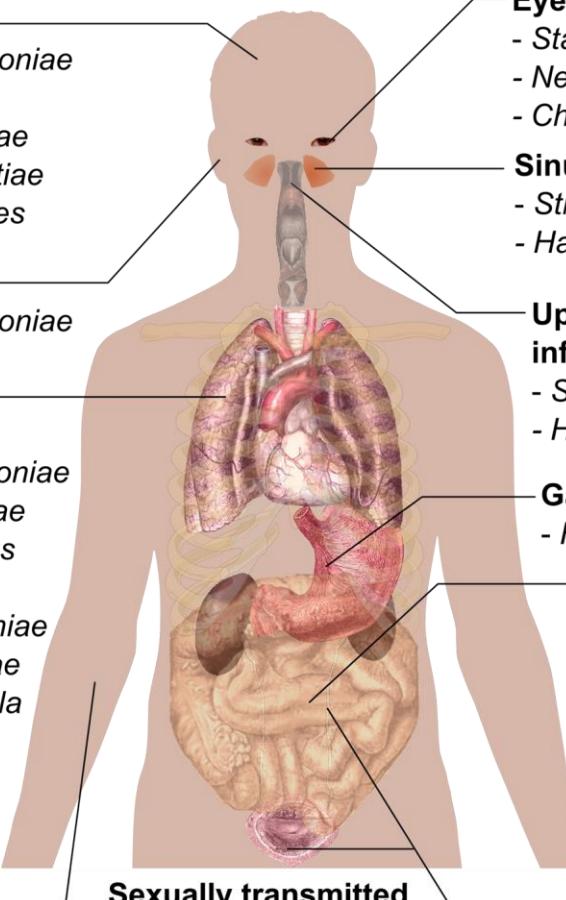
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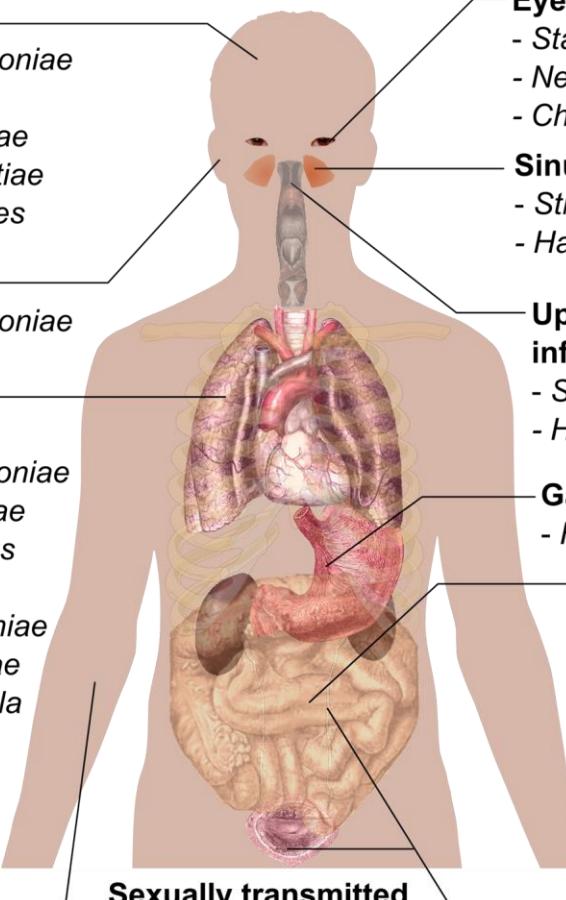
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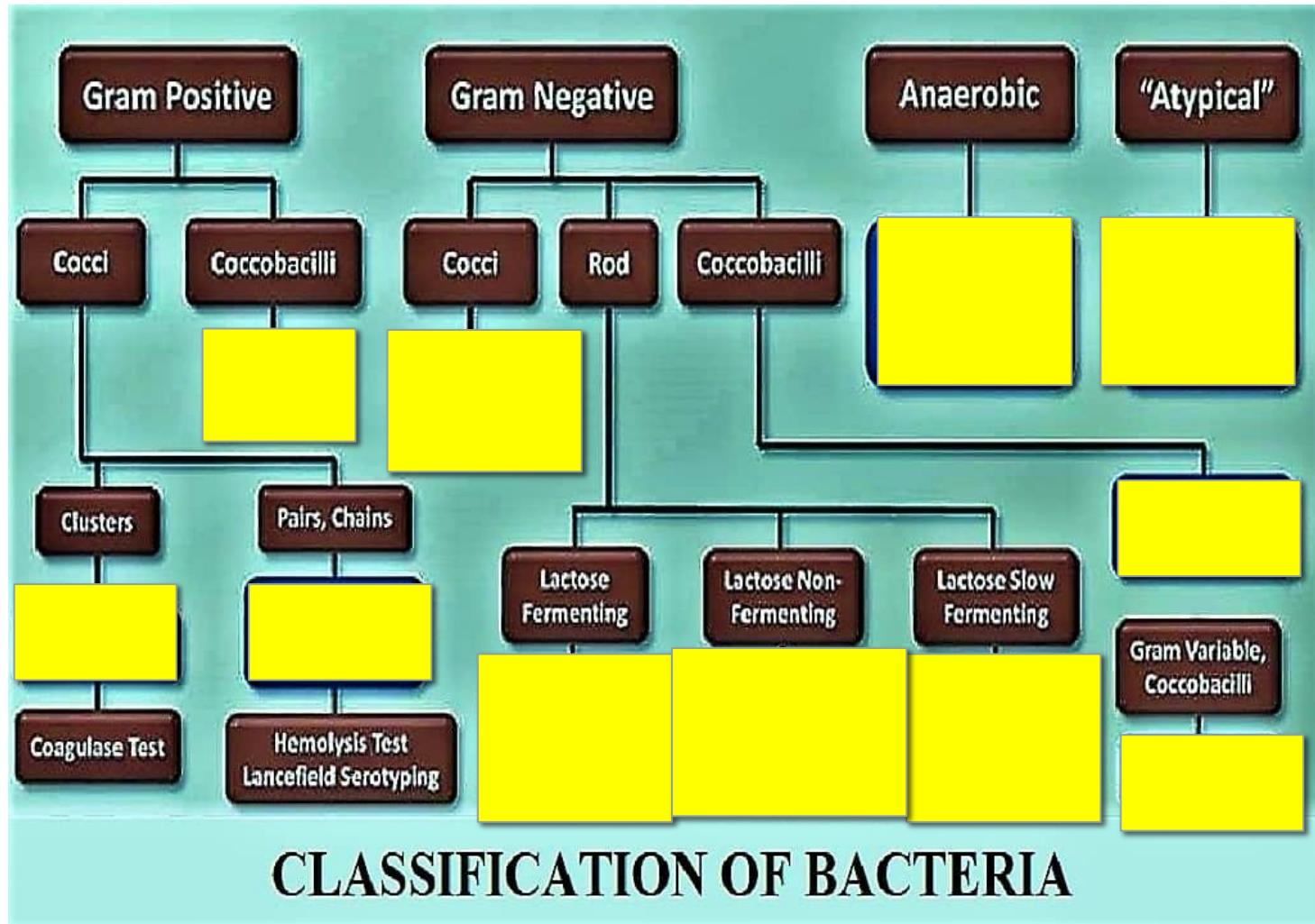
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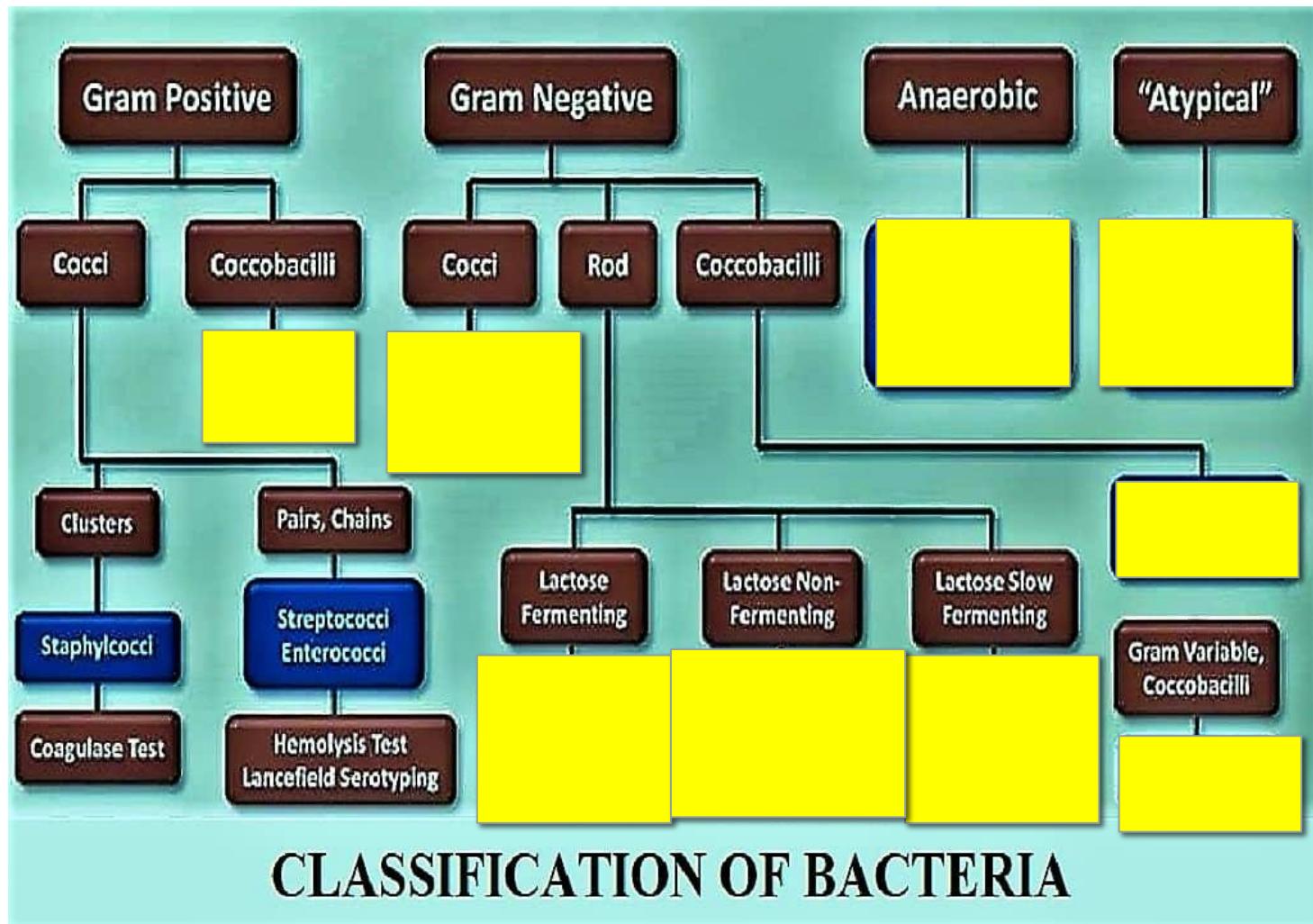
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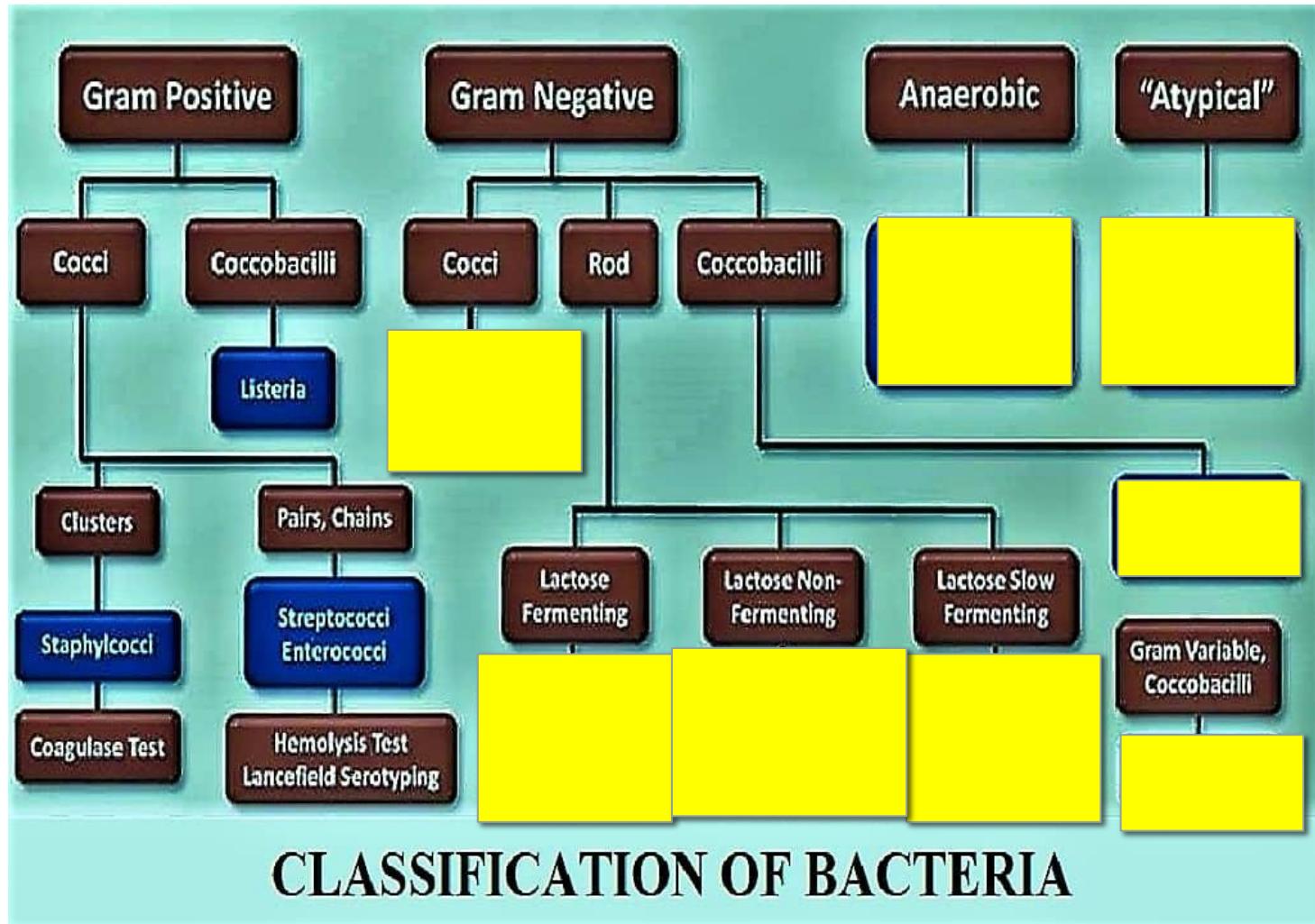
Classification of microorganisms



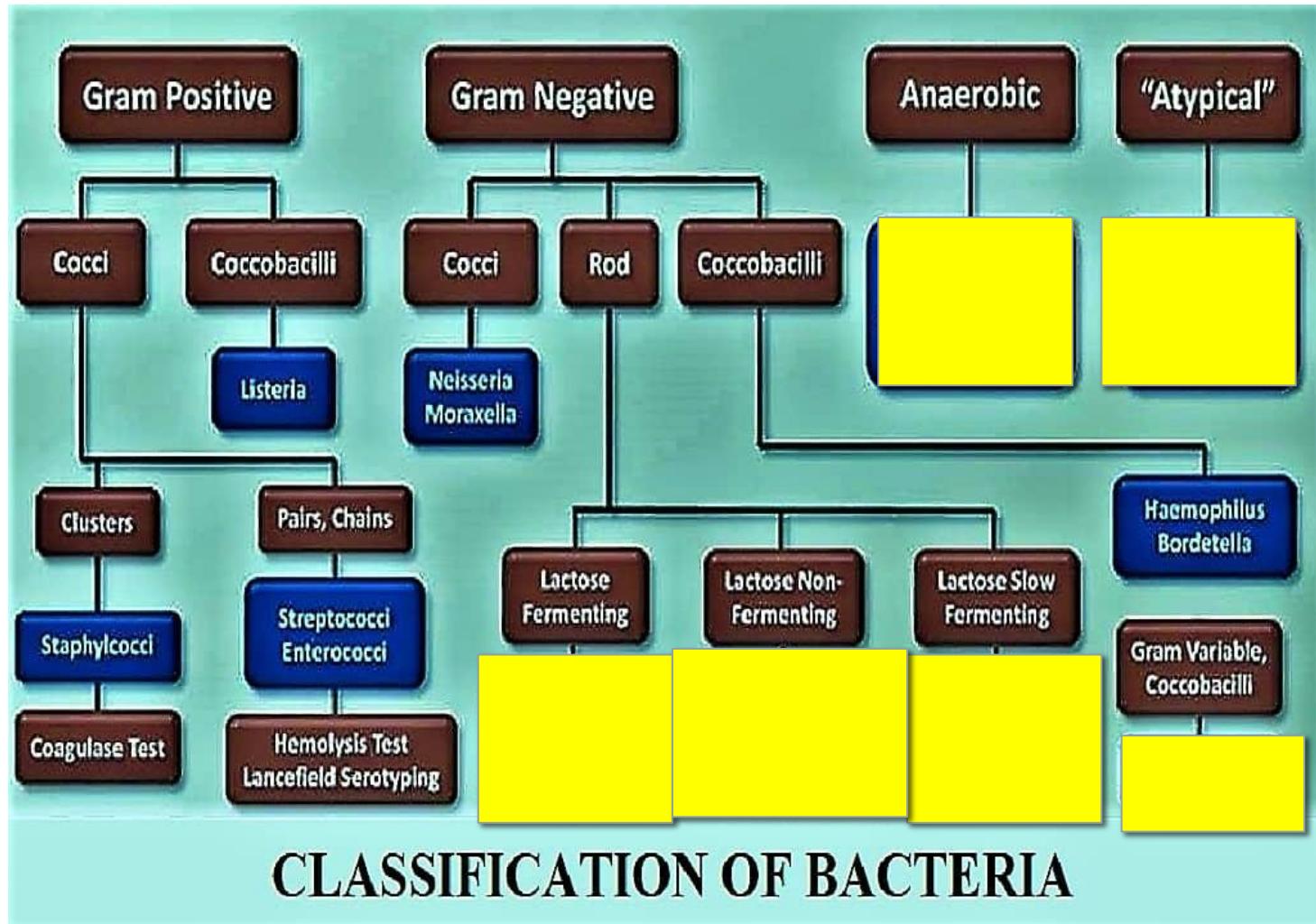
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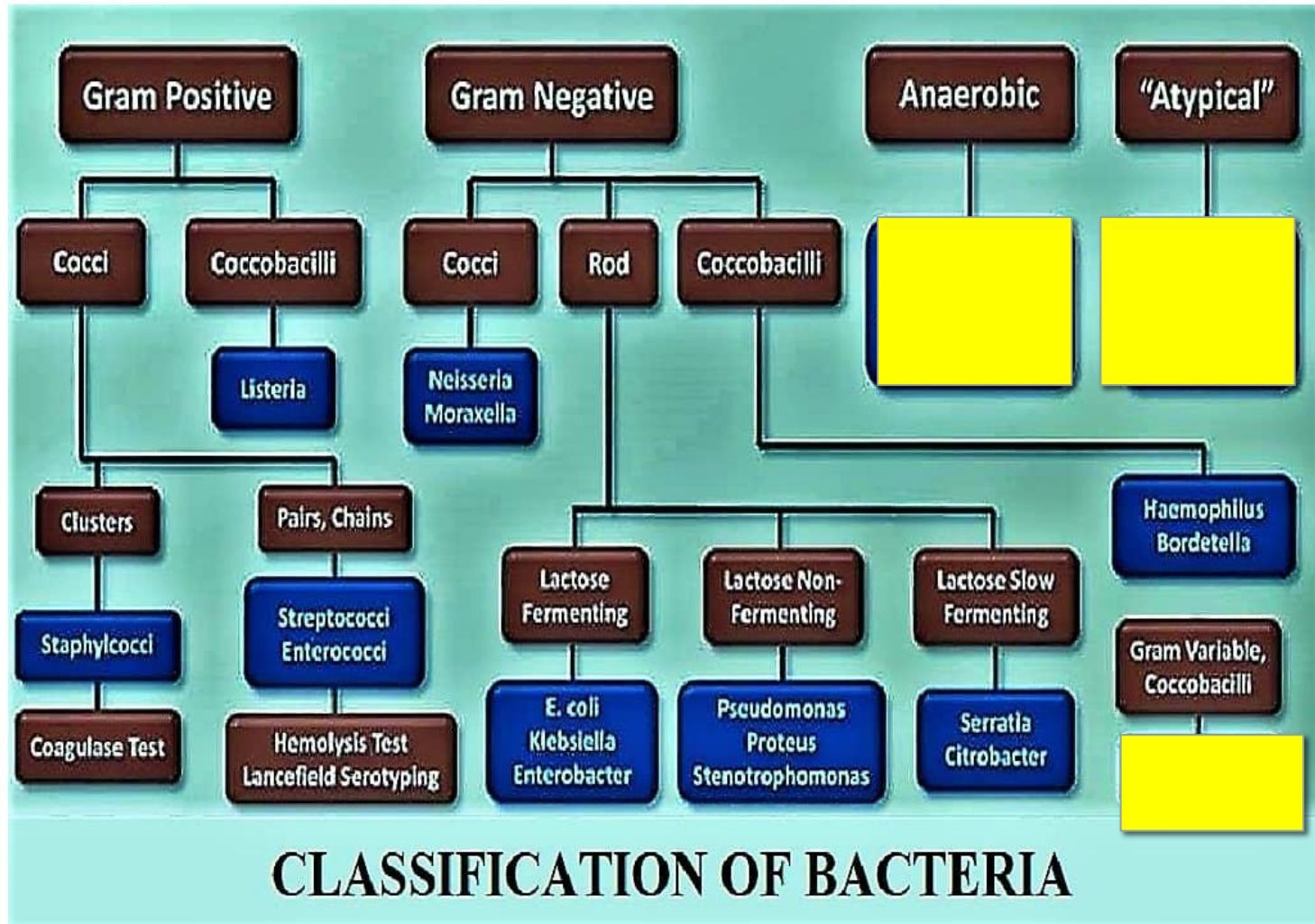
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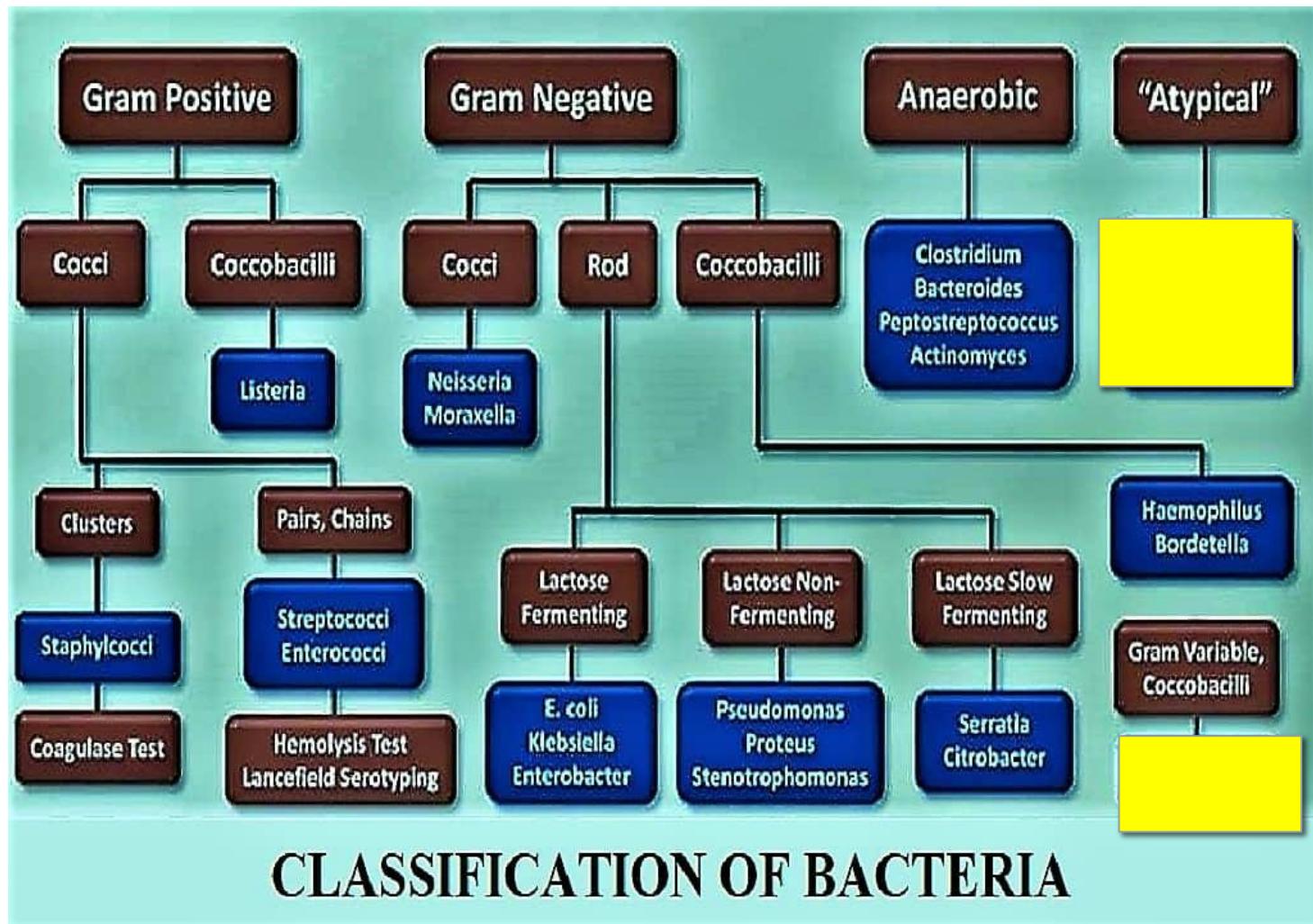
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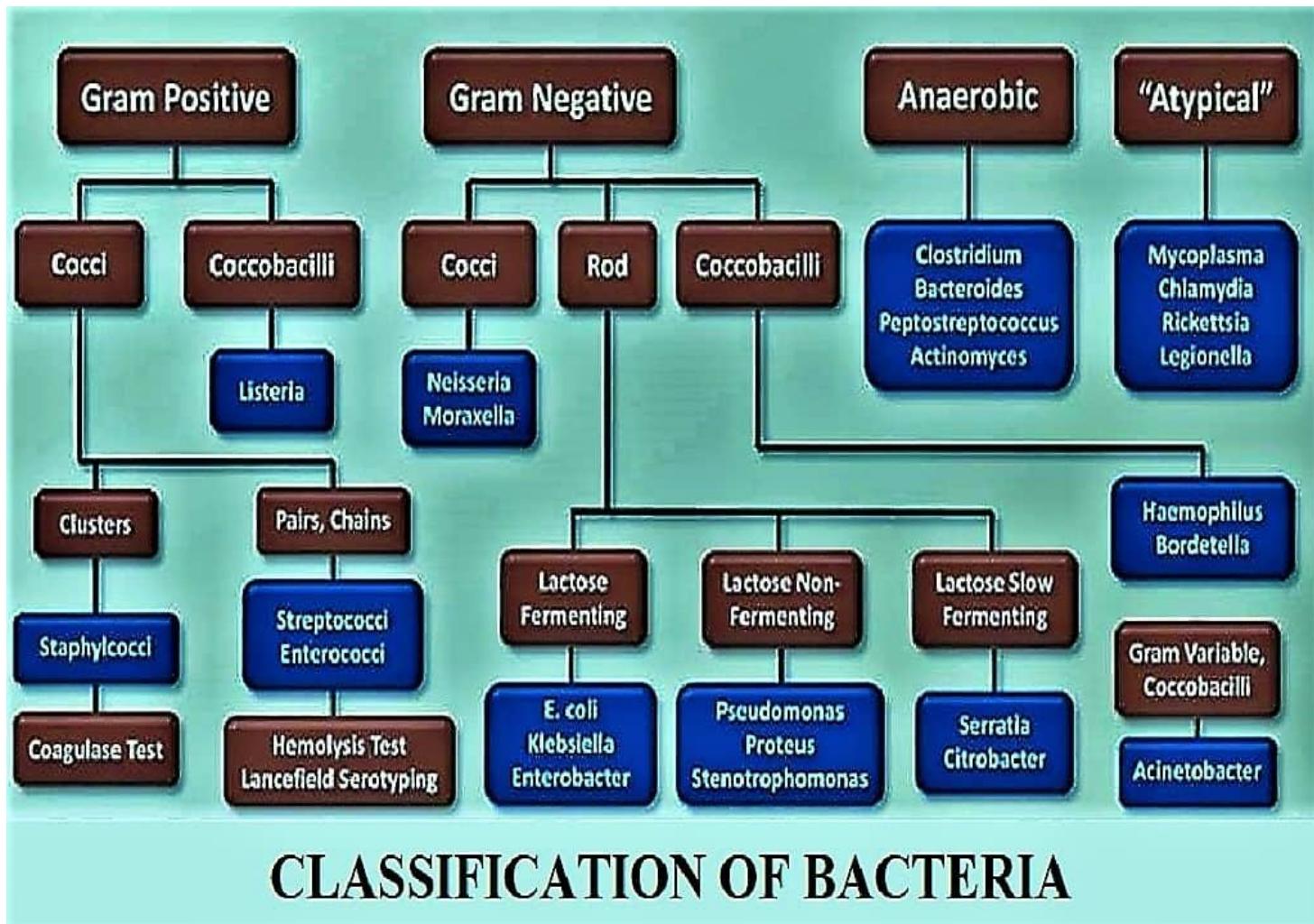
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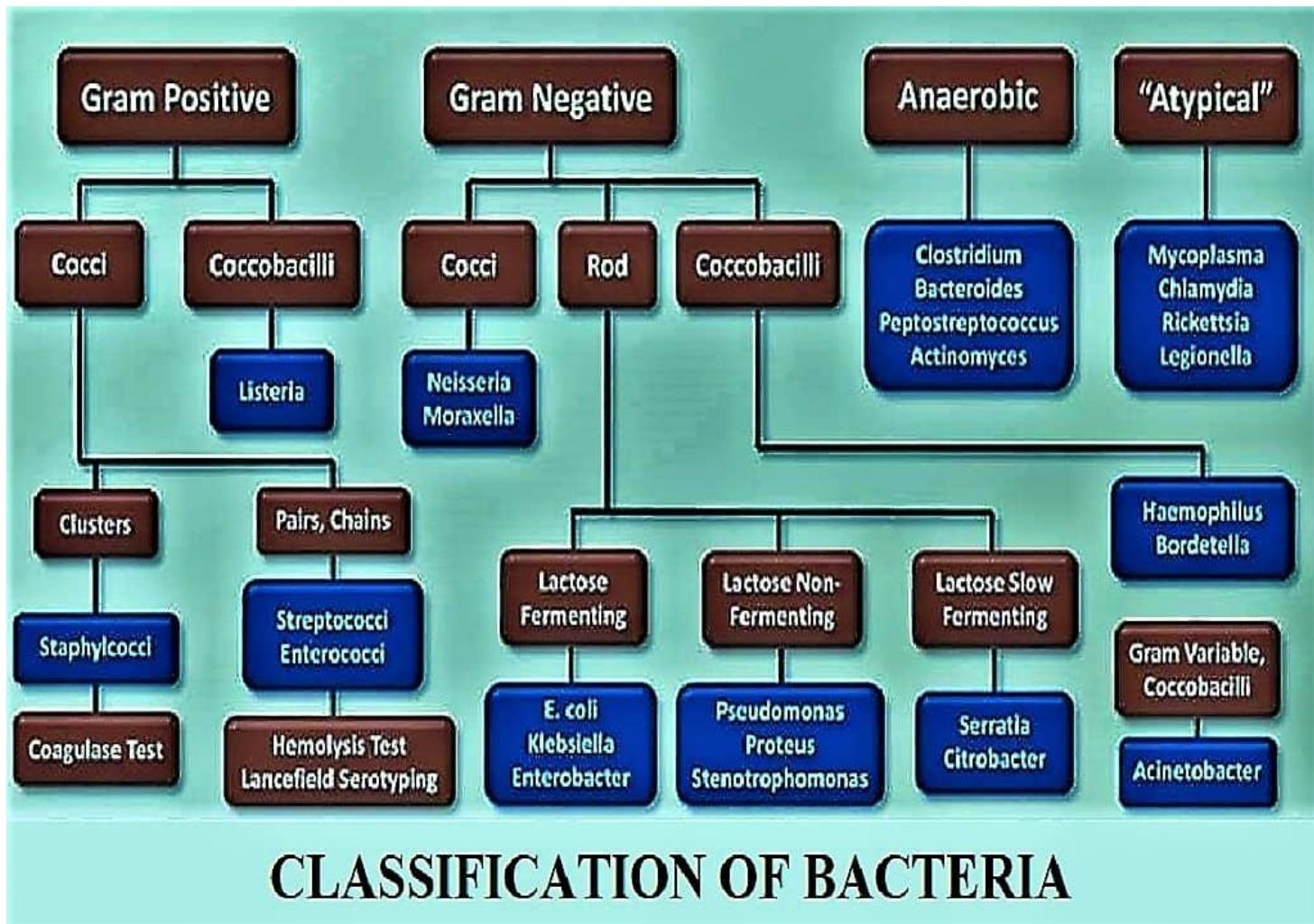
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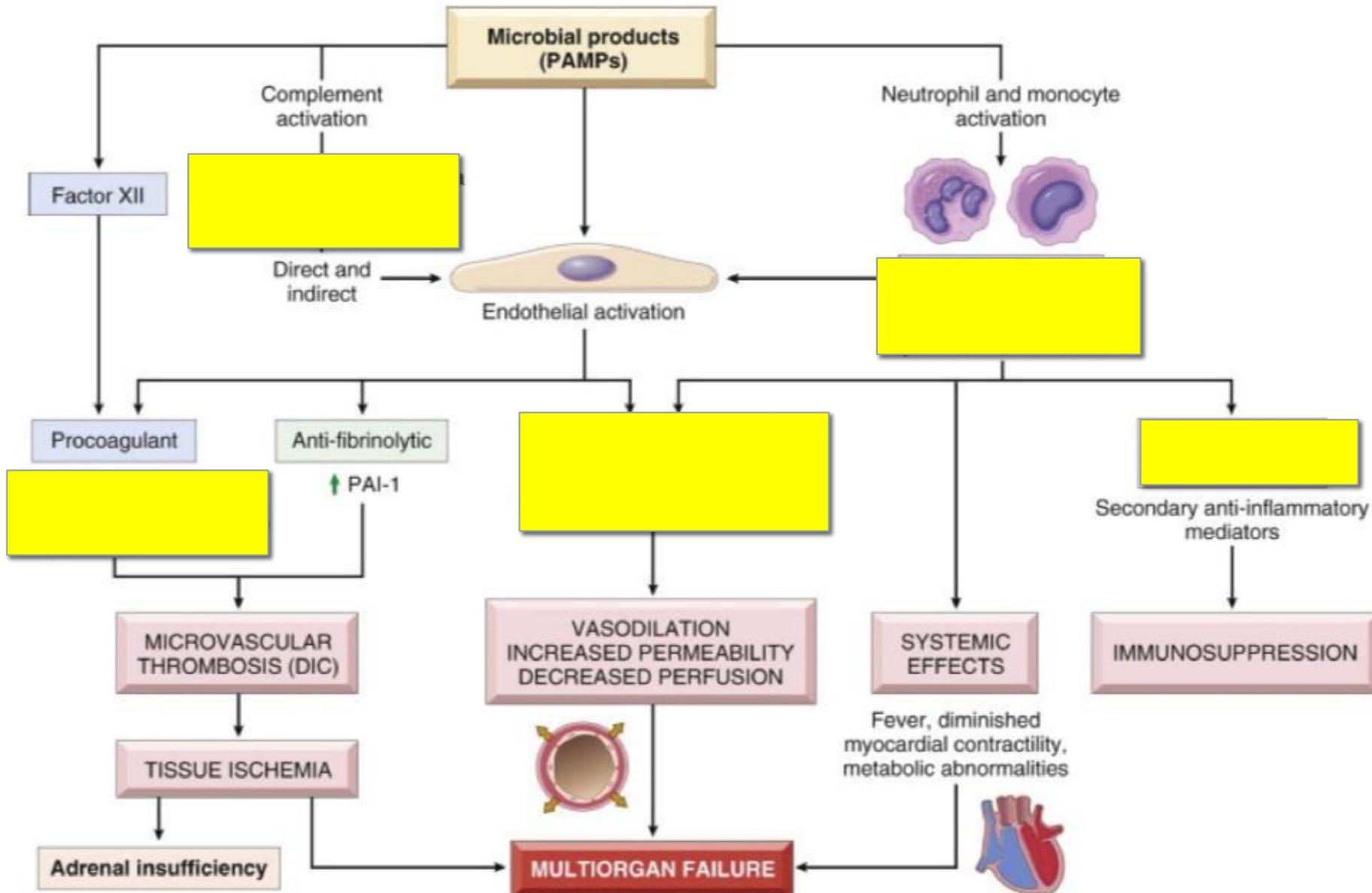


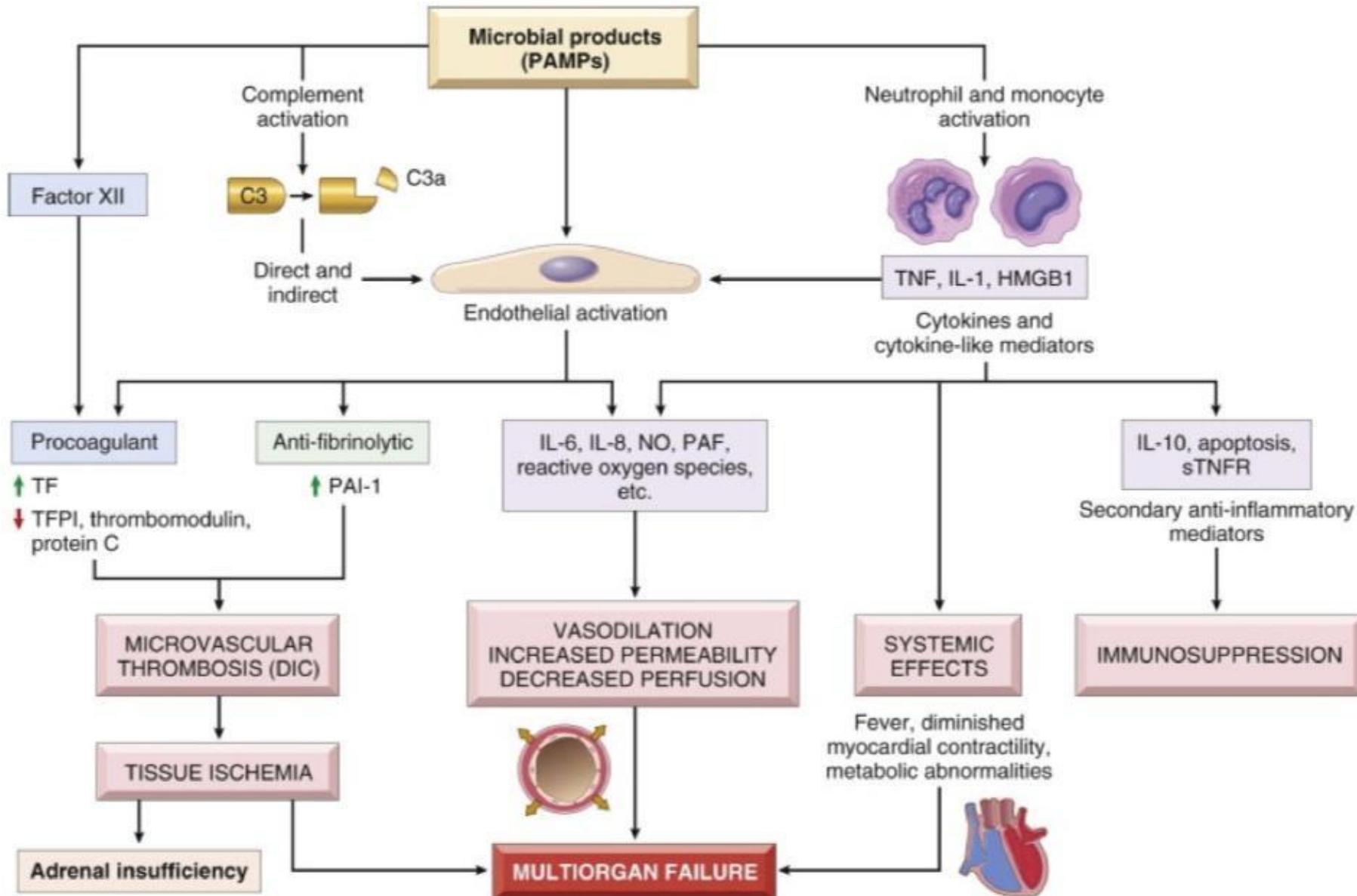
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Classification of microorganisms







SEPSIS

- **1:GIVE O2 TO KEEPS SATS ABOVE 94%**
- **2:TAKE BLOOD CULTURES**
- **3:GIVE IV ANTIBIOTICS**
- **4:GIVE A FLUID CHALLENGE**
- **5:MEASURE LACTATE**
- **6:MEASURE URINE OUTPUT**

Optimisation to prevent infection

Immunisation

TABLE
Vaccines used worldwide

Live vaccines	Killed, inactivated and subunit vaccines
BCG ^a	Cholera
Measles ^b	Diphtheria ^b
Mumps	Haemophilus influenza
Oral poliomyelitis (Sabin) ^b	Hepatitis A
Rubella	Hepatitis B ^b
Yellow fever ^a	Inactivated polio (Salk) ^b
	Influenza
	Japanese B encephalitis
	Meningococcus
	Pertussis ^b
	Pig Bl
	Pneumococcus
	Rabies
	Tetanus ^b
	Typhoid

a: recommended in endemic countries (EPI - WHO);
b: vaccines used in the EPI (WHO).

Disinfection

Class of disinfectant	Advantages	Disadvantages	Recommended for
Alcohols Ethanol Isopropanol			
Aldehydes Glutaraldehyde Ortho-phthalaldehyde			
Oxidizing agents Sodium hypochlorite Hydrogen peroxide			
Phenolics			
Quaternary ammonium compounds			

Disinfection

Class of disinfectant	Advantages	Disadvantages	Recommended for
Alcohols Ethanol Isopropanol	Wide microbicidal activity, noncorrosive	Not universally sporicidal Limited residual activity Fire hazard	Hand disinfection in outpatient clinics
Aldehydes Glutaraldehyde Ortho-phthalaldehyde	Wide microbiocidal activity and are sporicidal and fungicidal	Glutaraldehyde is potentially a toxic health hazard	2% Glutaraldehyde with alkaline pH used for disinfecting luminated non-autoclavable equipments Ortho-phthalaldehyde replacing glutaraldehyde as a nontoxic disinfectant
Oxidizing agents Sodium hypochlorite	Wide microbiocidal activity and are sporicidal and fungicidal	Corrosive	Useful for disinfecting surfaces, water Contaminated equipments
Hydrogen peroxide	Wide microbiocidal activity and are sporicidal and fungicidal	Unstable compound; to be used in correct concentration	Used for fogging – high level disinfection of operation theater when used in concentration of over 6%
Phenolics	Easily available, cheap	Corrosive to the skin and sometimes toxic to sensitive people Household disinfectants	Resistant organisms are common Suitable for surface disinfection of residential premises
Quaternary ammonium compounds	Active against enveloped viruses	Low sporicidal activity	Low level disinfectants

Sterilisation

Table 3. Comparison of the advantages and disadvantages of primary medical device sterilisation methods

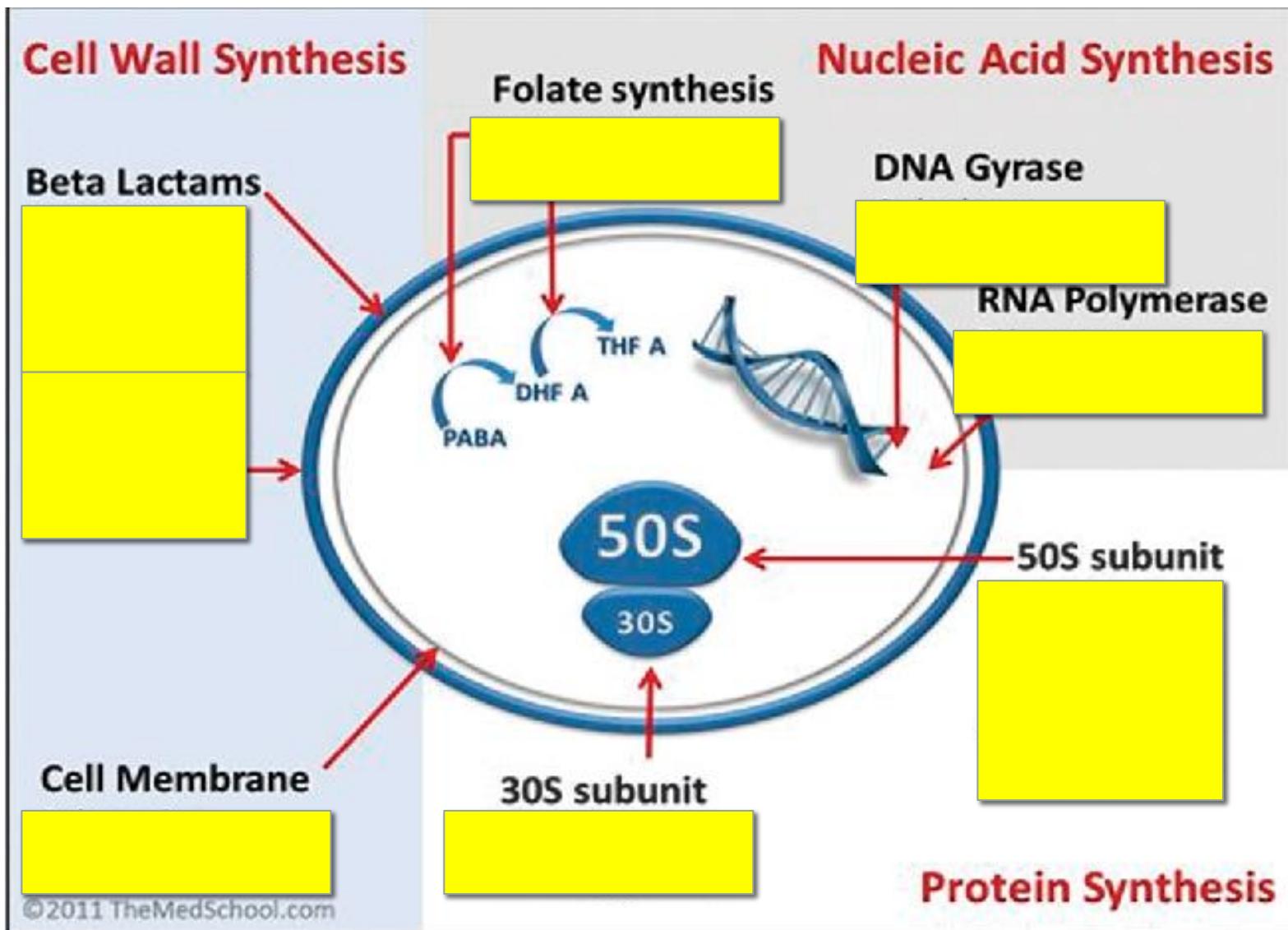
Sterilisation type	Advantages	Disadvantages
Steam	■ Fast ■ Non-toxic	■ Effective air removal key ■ Heat-stable materials only
Dry heat	■ Glassware ■ Depyrogenation	■ Heat-stable materials only ■ Long processing times
Gamma	■ Good penetration ■ Fast and efficient	■ Degradation of plastics ■ Third-party sterilisation
Electron beam	■ Lower impact on plastic degradation	■ Low penetration means uniform density is required ■ Third-party sterilisation
X-ray (high energy)	■ Fast ■ High penetration	■ May produce radioactive particles in the device ■ Safety issues due to increased shielding
X-ray (low energy)	■ Point-of-manufacture sterilisation ■ Rapid turnaround ■ Excellent dose uniformity	■ Not suitable for dense products or processing of large batches (pallets or totes) ■ Not yet commercially available
Ethylene oxide	■ Suitable for heat and irradiation-sensitive products ■ Highly flexible	■ Long cycle times ■ Requires gas ingress and egress ■ Toxic and flammable ■ Third-party sterilisation
Gas plasma	■ Low temperature ■ Non-toxic residuals	■ Penetration of lumens ■ Unsuitable for absorbent materials
Filtration	■ Suitable for liquid-sensitive products	■ Higher risk ■ Increased validation and operating controls

Sterilisation

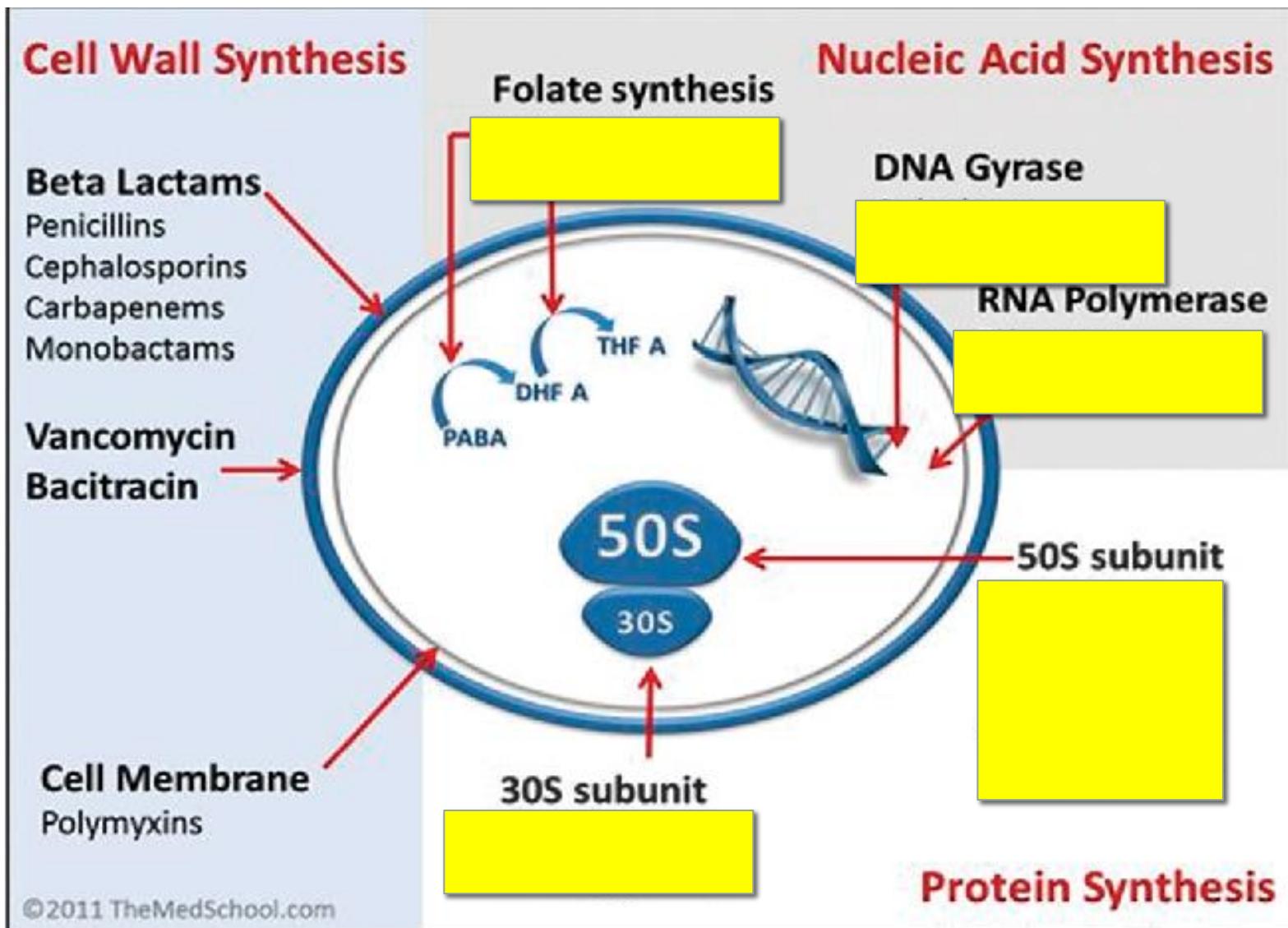
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Ethylene oxide		
Gas plasma		
Filtration		

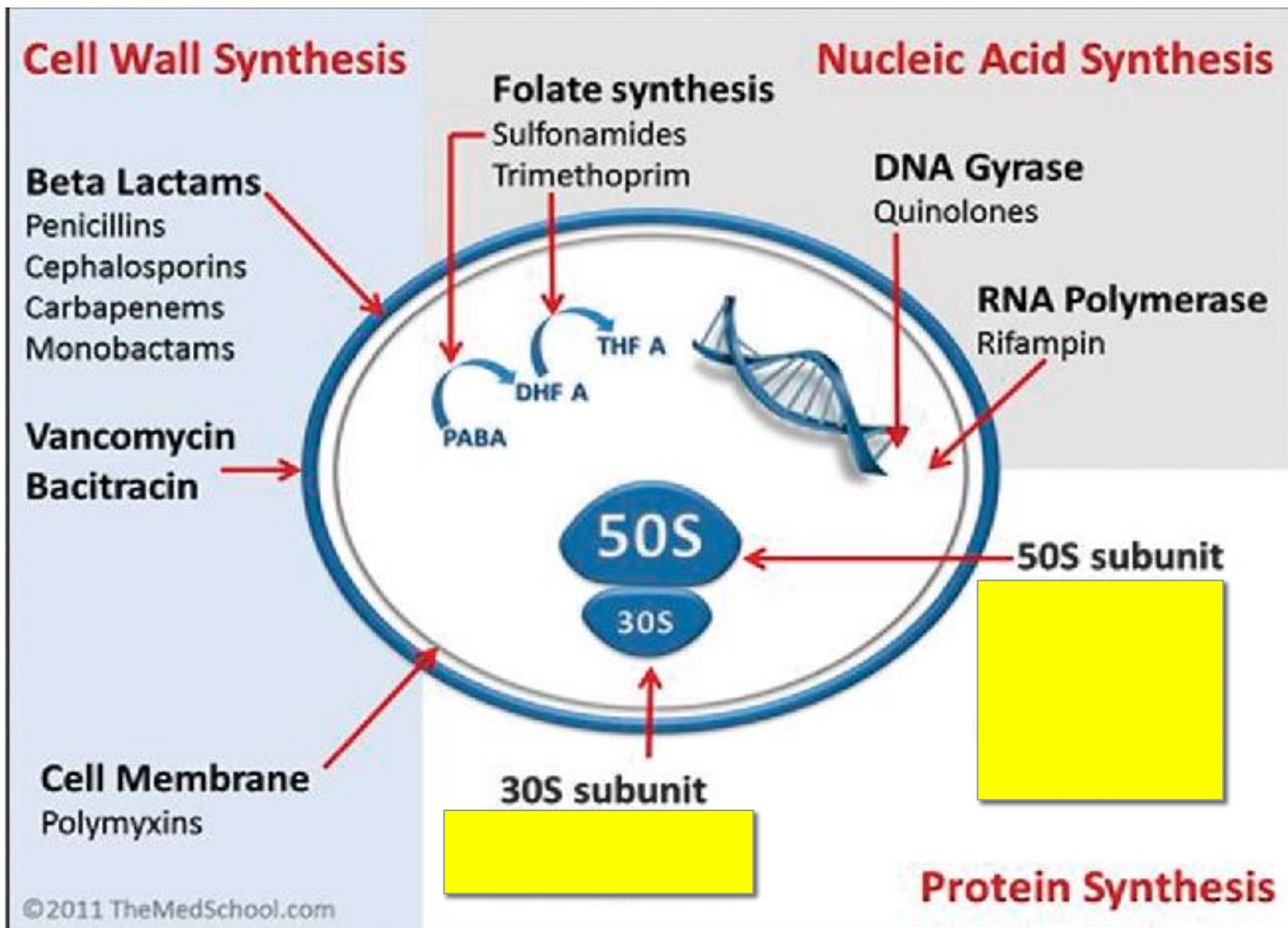
Mode of action of antibiotics



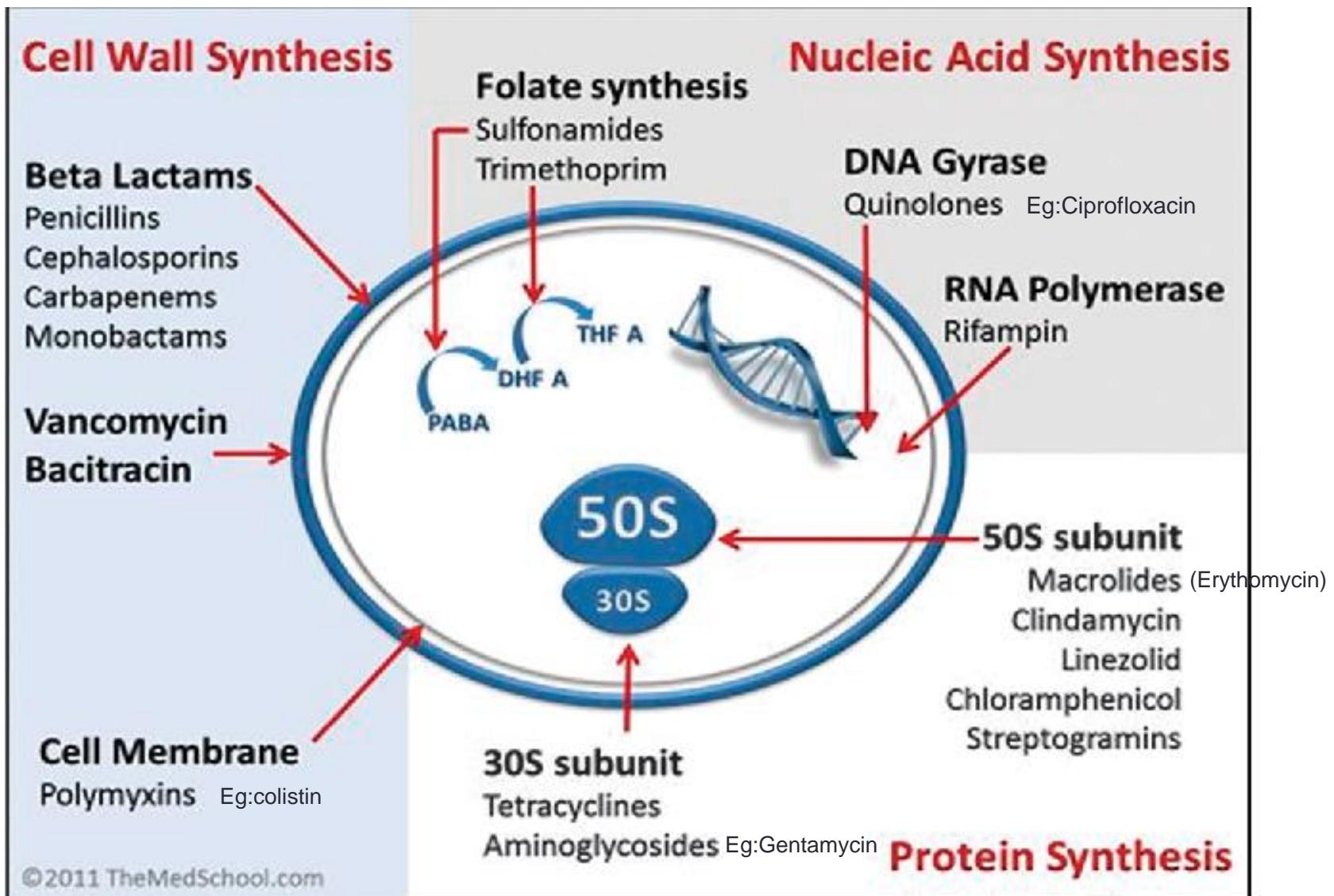
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Mode of action of antibiotics



Cephalosporins

Cephalosporins

Cephalosporins are bactericidal beta-lactam antibiotics derived from the fungus *Acremonium* — they disrupt peptidoglycan formation in the cell wall.

They have no activity against LAME: Listeria, Atypicals (Mycoplasma/Chlamydia), MRSA and Enterococci. (Only MRSA exception being 5th Generation drugs: Ceftobiprole etc.)

1 st Gen	2 nd Gen	3 rd Gen	4 th Gen	5 th Gen
Cefadroxil	Cefaclor	Cefixime	Cefepime	Ceftobiprole
Cefalexin	Cefuroxime	Cefdinir	Ceftriaxone	Ceftaroline
Cefazolin	Cefotetan	Cefotaxime	Cefodizime	Ceftolozane
Cefazedone	Cefprozil	Ceftazidime	Cefquinome	

General Rule

1st Gen are predominantly active against gram-positives, with succeeding generations progressively more active against gram-negative strains (often with reduced gram-positive activity, except 4th, which are extended spectrum agents).

Adverse Effects

Nausea, diarrhoea, rash, pain and inflammation at injection site.

Those allergic to penicillins may show cross-sensitivity with some cephalosporins, but the figure is thought to be considerably less than the 10% commonly cited.

Classes of antibiotics

Gram +

Penicillins

Amoxicillin

Gram + (Strep, Syphilis)

Disrupt synth of peptidoglycan

Macrolides

azithromycin, clarithromycin, erythromycin

Gram +, URTIs (Strep, Staph)

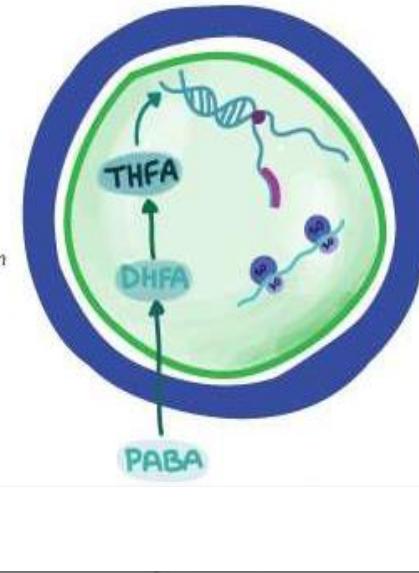
Inhibit protein synth at 50S subunit

Lincosamides

clindamycin

Strep, Staph

Inhibit protein synth at 50S subunit



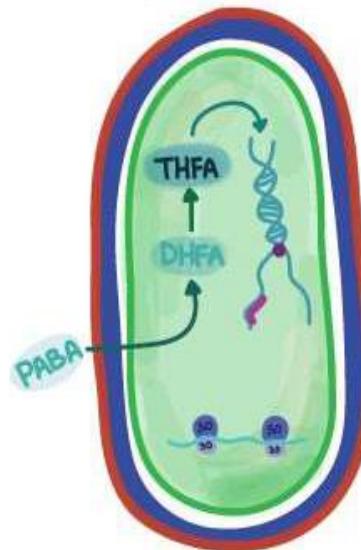
Gram -

Aminoglycosides

streptomycin, tobramycin, gentamicin

Gram -, Pseudomonas

Inhibit protein synth at 30S subunit



Gram + and -

Tetracyclines

tetracycline, doxycycline

Broad spectrum (Gram+/-, atypicals)

Inhibit protein synth at 30S subunit

Cephalosporins

Disrupt synth of peptidoglycan

1st: Gram + (Keflex)

2nd: Gram - > Gram + (Cefzil)

3rd: Gram - >> Gram +, Pseudomonas (Ceftriaxone)

4th: Pseudomonas (Ceftazidime)

5th: MRSA (Zeftera)

Fluoroquinolones

Ciprofloxacin (Gram -)

Levofoxacin/Moxifloxacin (Gram +)

Broad spectrum

Inhibit DNA gyrase or topoisomerase

Sulfonamides

Trimethoprim-sulfamethoxazole (TMP-SMX)

UTIs (E coli, S. saprophyticus)

Work together to inhibit enzyme tetrahydrofolic acid (THFA) needed for thymidine synth (and DNA)

Carbapenams

mertopenem

Broad spectrum

Disrupt synth of peptidoglycan

Nitrofurans

macrobid

UTIs (E coli, S. saprophyticus)

Damage DNA

Metronidazole

Flagyl

Anerobes, protozoa

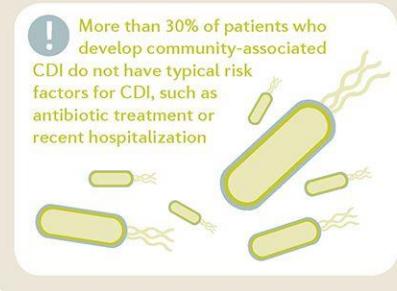
Disrupts DNA

Prophylaxis

→ *Clostridium difficile* is an obligate anaerobic Gram-positive bacterium that is the leading cause of health-care-associated infective diarrhoea. Antibiotic exposure during hospitalization and older age (>60 years) are major risk factors for developing *C. difficile* infection (CDI).

EPIDEMIOLOGY

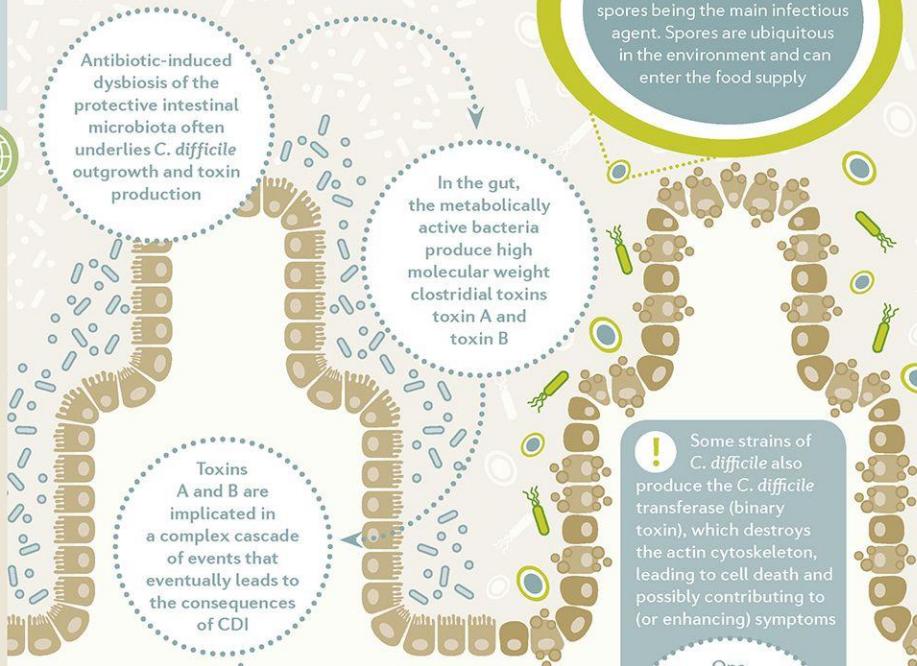
Epidemiological studies depend on standardized typing methods; PCR ribotyping is the most commonly applied typing system. PCR ribotype 027 strains have caused outbreaks globally, but other PCR ribotypes (such as PCR ribotype 010) are usually non-pathogenic because they lack the toxin genes.



DIAGNOSIS

Given that individuals can be asymptotically colonized by *C. difficile*, diagnosis requires a test for the presence of the bacteria and another for the presence of bacterial toxins in the faeces. For those with symptoms, these can include mild self-limiting diarrhoea, fulminant colitis, pseudomembranous colitis, toxic megacolon, bowel perforation, sepsis and/or multiple organ dysfunction.

MECHANISMS



QUALITY OF LIFE

The high mortality rates of CDI underline the serious consequences of the disease. As patients are typically older and

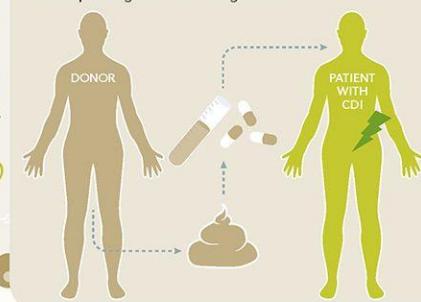
have comorbidities, the additional burden of CDI can greatly affect quality of life. Furthermore, in Europe, the median length of

Designed by Laura Marshall

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RX MANAGEMENT

Infections are commonly treated with specific antimicrobial agents that target the *C. difficile* metabolically active vegetative cells (but not the virtually inactive spores). In patients who have recurrent episodes of CDI, faecal microbiota transplantation can be an effective rescue treatment. However, this procedure — in which faeces from healthy donors are processed and transplanted into patients — is still being defined and long-term results are unknown. Fulminant CDI is a highly lethal disease (mortality rates of up to 80%) that often requires total abdominal colectomy. Given that the faeces of patients with CDI are rife with spores, treatment should always be combined with patient isolation to prevent the spread of *C. difficile* or other enteropathogenic microorganisms.



OUTLOOK

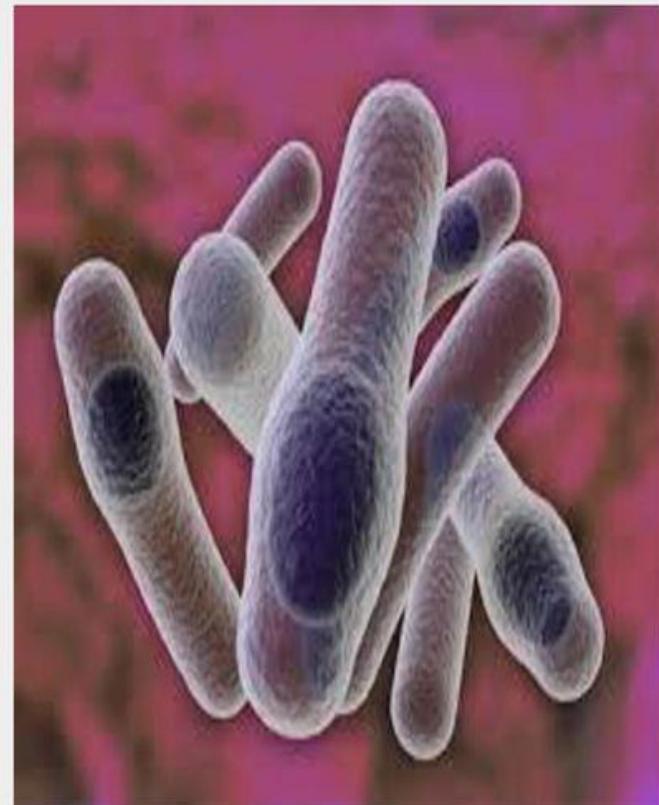
Future therapies for CDI will probably involve defined combinations of key gut microbiota to restore the bacterial environment of the gut. Treatments currently being explored also include drugs to neutralize the *C. difficile* toxins (including monoclonal antibodies), to inhibit *C. difficile* proliferation and to prevent off-target effects of antibiotic treatment on the intestinal microbiota.

Article number: 16021; doi:10.1038/nrdp.2016.21; published online 7 April 2016

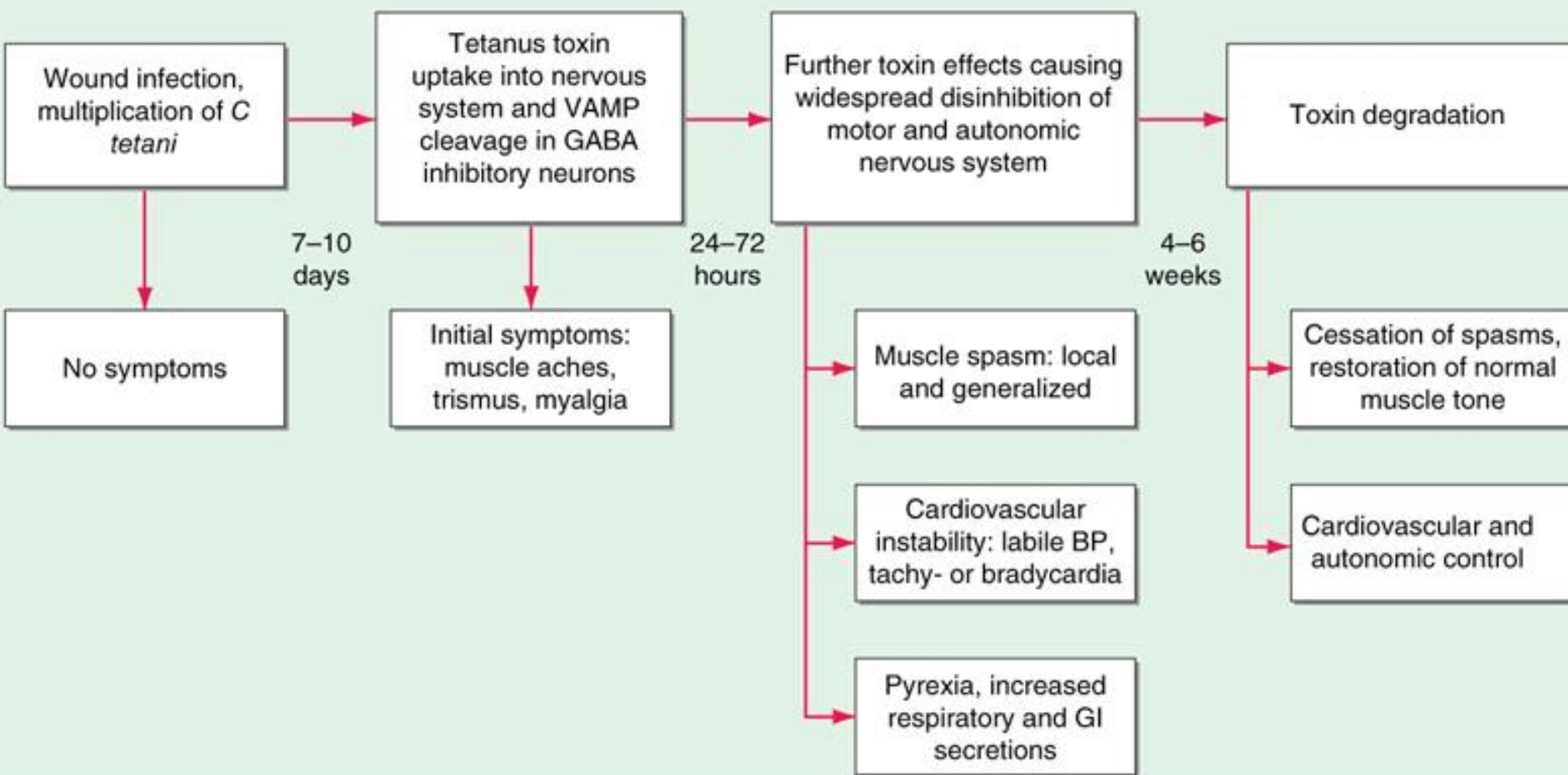
- ***Clostridium perfringens***

Most frequent clostridia involved in soft tissue and wound infections - **myonecrosis**

- Spores found in soil (sub terminal)
- Predisposing factors – surgical incisions, compound fractures, diabetic ulcers, septic abortions, puncture wounds, gunshot wounds
- Virulence factors
 - toxins : alpha toxin – causes RBC rupture, a necrotizing that cause edema and tissue destruction
 - collagenase
 - hyaluronidase
 - DNase



ALGORITHM FOR CLINICAL AND PATHOLOGIC PROGRESSION OF TETANUS



Source: D. L. Kasper, A. S. Fauci, S. L. Hauser, D. L. Longo, J. L. Jameson, J. Loscalzo: Harrison's Principles of Internal Medicine, 19th Edition.
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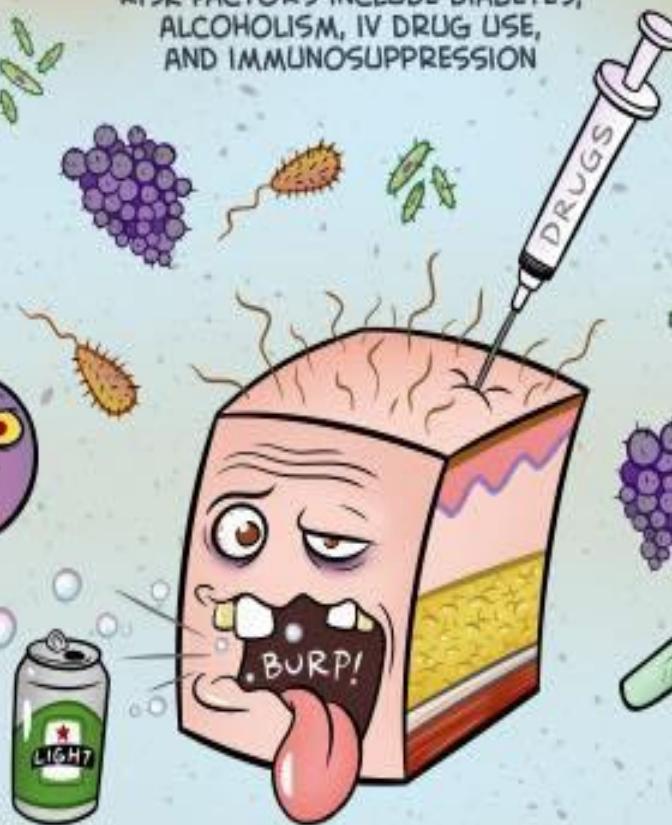
NECROTIZING FASCIITIS

RAPIDLY PROGRESSIVE AND OFTEN FATAL INFECTION OF THE SUBCUTANEOUS TISSUE AND FASCIA



INTENSE PAIN, ERYTHEMA, TISSUE CREPITUS, AND SYSTEMIC TOXICITY

RISK FACTORS INCLUDE DIABETES, ALCOHOLISM, IV DRUG USE, AND IMMUNOSUPPRESSION



MAY BE CAUSED BY A POLYMICROBIAL INFECTION CONSISTING OF BOTH AEROBIC AND ANAEROBIC ORGANISMS, OR BY A SINGLE ORGANISM SUCH AS GROUP A STREPTOCOCCI



SURGICAL EMERGENCY THAT REQUIRES AGGRESSIVE SURGICAL DEBRIDEMENT AND IV ANTIBIOTICS