

The Basic Principle of Microbiology

Chapter 1

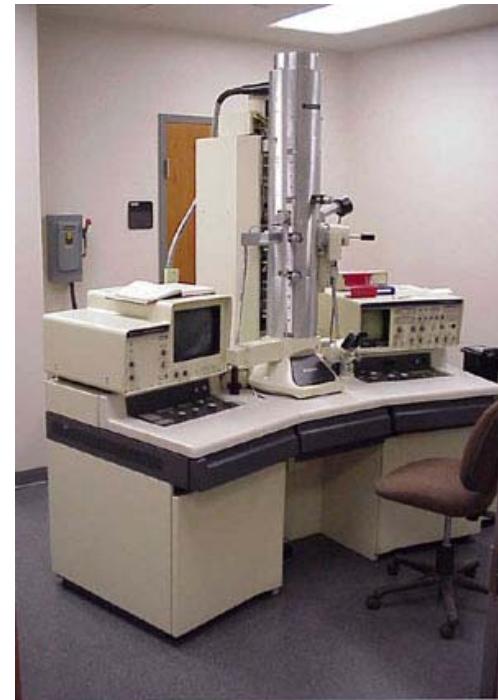
The Basic Character of Bacterium

Section 1

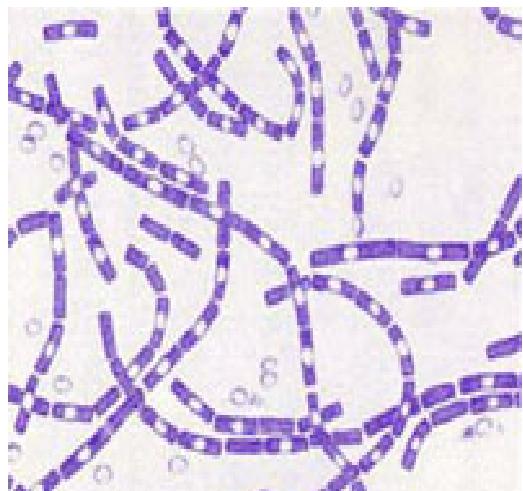
Bacterial Morphology

I. Size of bacteria

Measure unit ----- μm (micrometer)

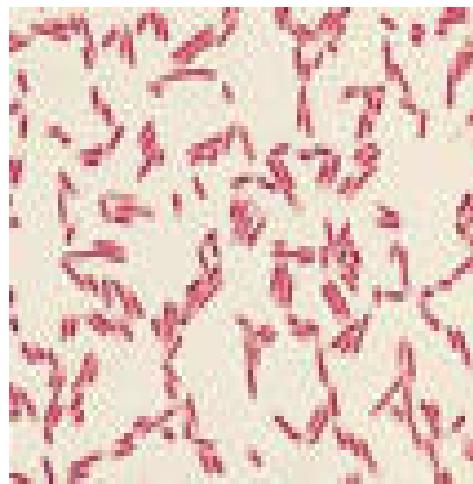


大



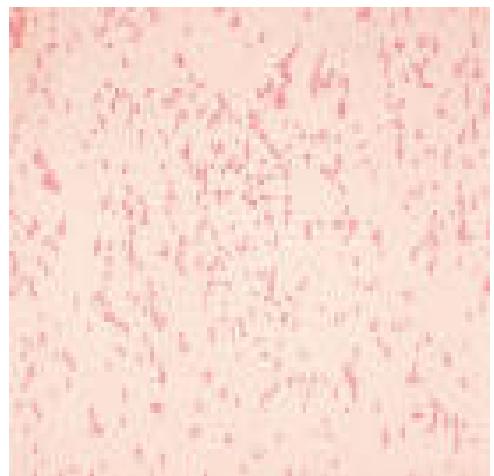
炭疽芽孢杆菌 $3\text{--}10 \mu\text{m}$

中



大肠埃希菌 $2\text{--}3 \mu\text{m}$

小



布鲁菌 $0.6\text{--}1.5 \mu\text{m}$

II Shape of bacteria

Coccus

*diplococcus ; streptococcus;
staphylococcus; tetrads;sarcina*

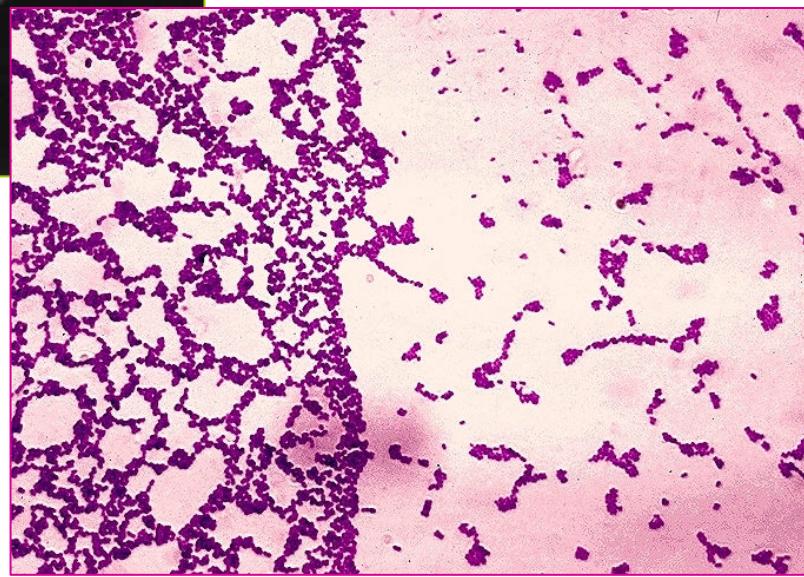
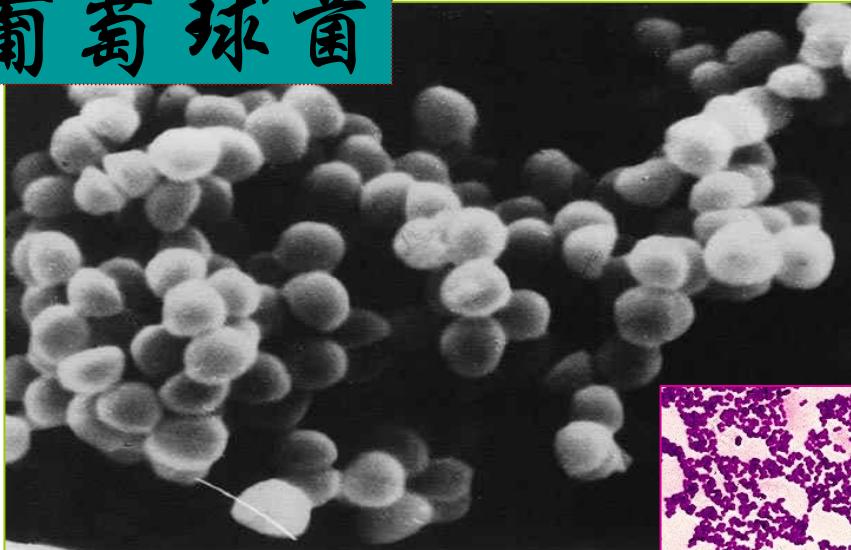
Bacillus

*streptobacillus; coccobacillus;
mycobacterium; bifidobacterium*

Spiral
bacterium

*vibrio ; spirillum ;
helicobacterium ;*

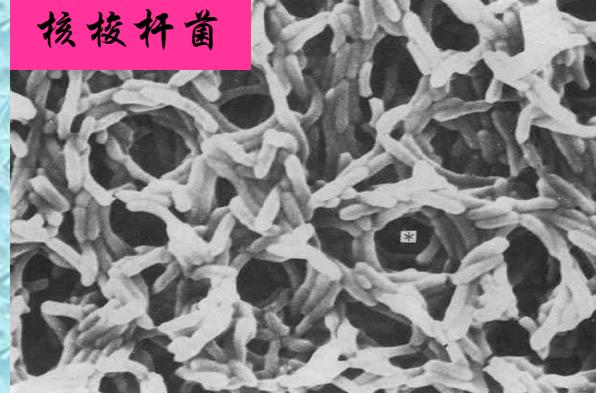
葡萄球菌



大肠杆菌



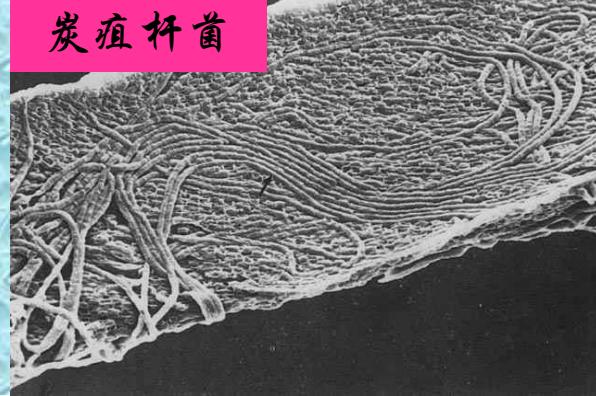
核梭杆菌



双歧杆菌

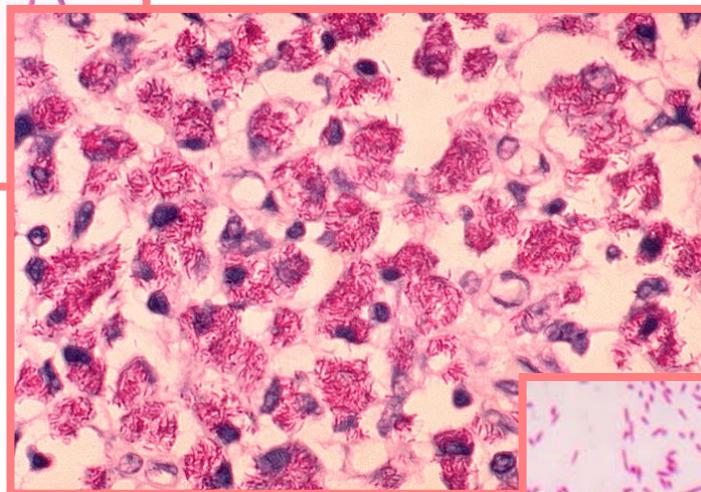


炭疽杆菌



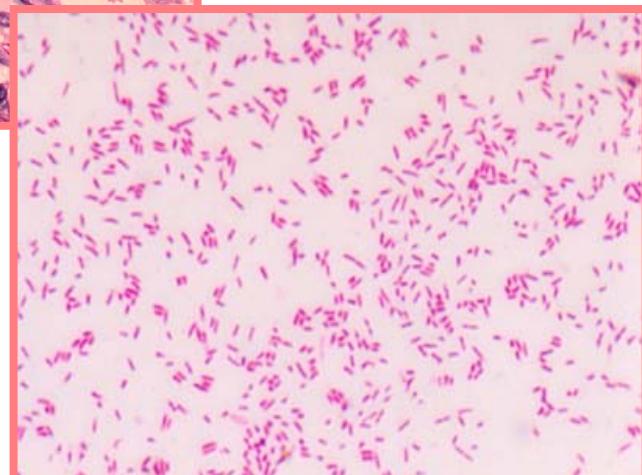


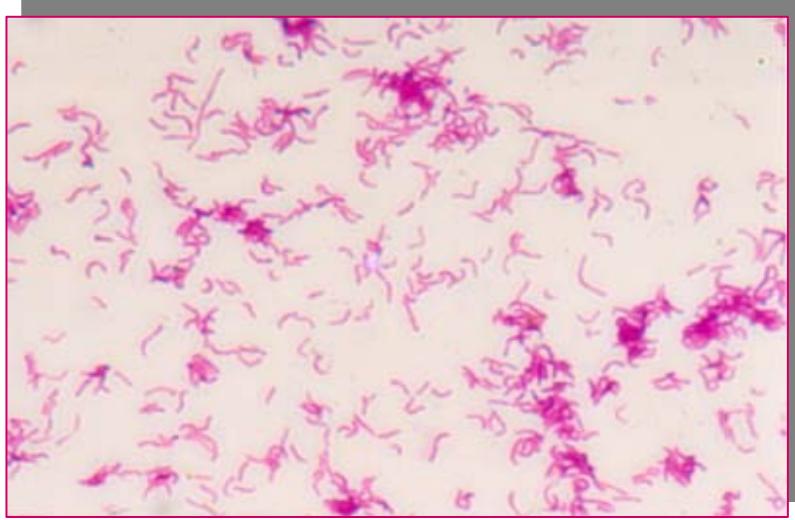
炭疽杆菌



结核杆菌

大肠杆菌





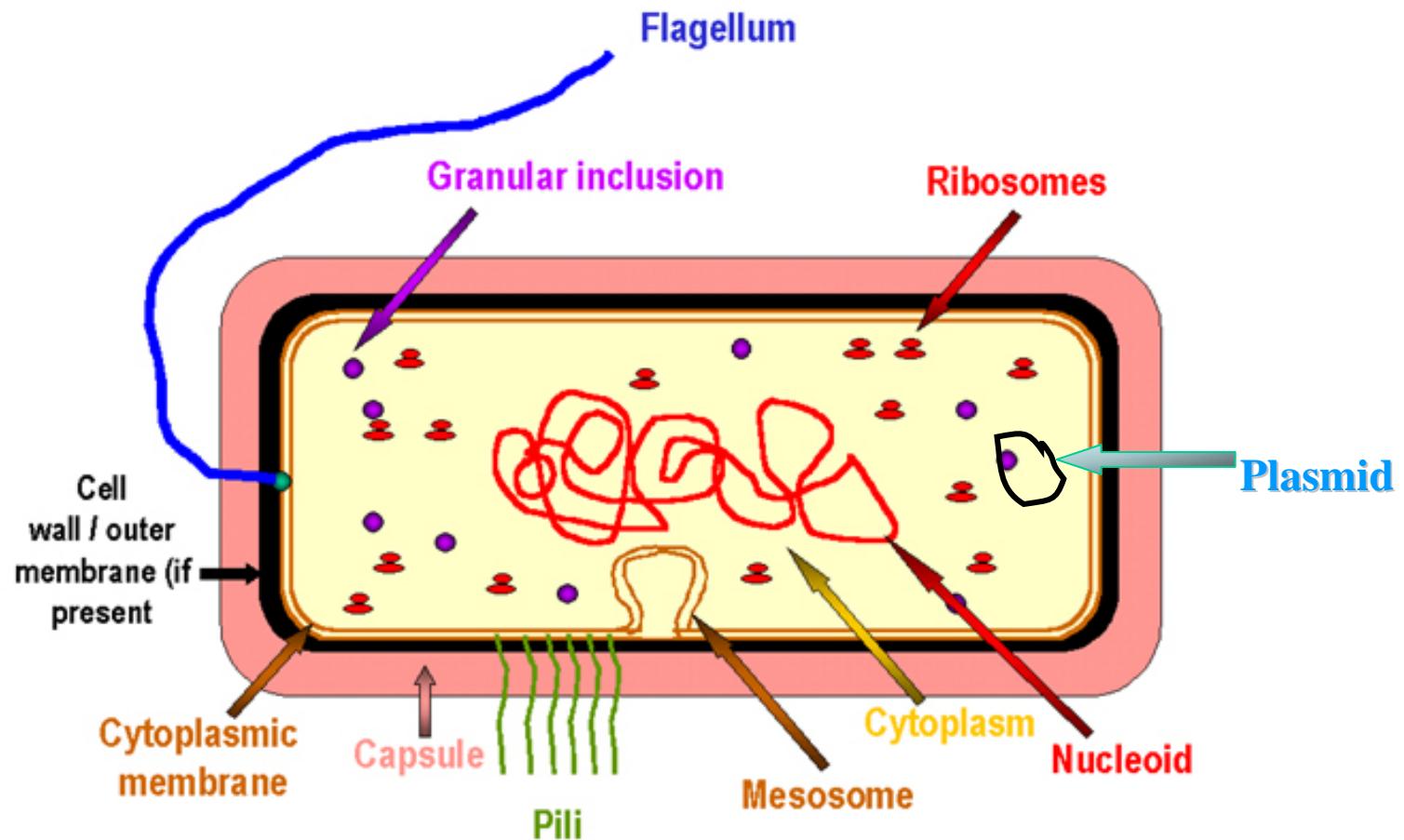
幽门螺杆菌



霍乱弧菌

Section 2

Bacterial structure



Structure of bacteria

Elementary structure

{ cell wall
cell membrane
cytoplasm
nucleoid

Special structure

{ capsule
flagellum
(flagella)
pilus (pili)
spore

Elementary structure

Cell Wall

1. structure & chemical composition

peptidoglycan (mucopeptide)

1) polysaccharide backbone

N-acetylglucosamine (G) and N-acetylmuramic acid (M) linked alternately in a chain .

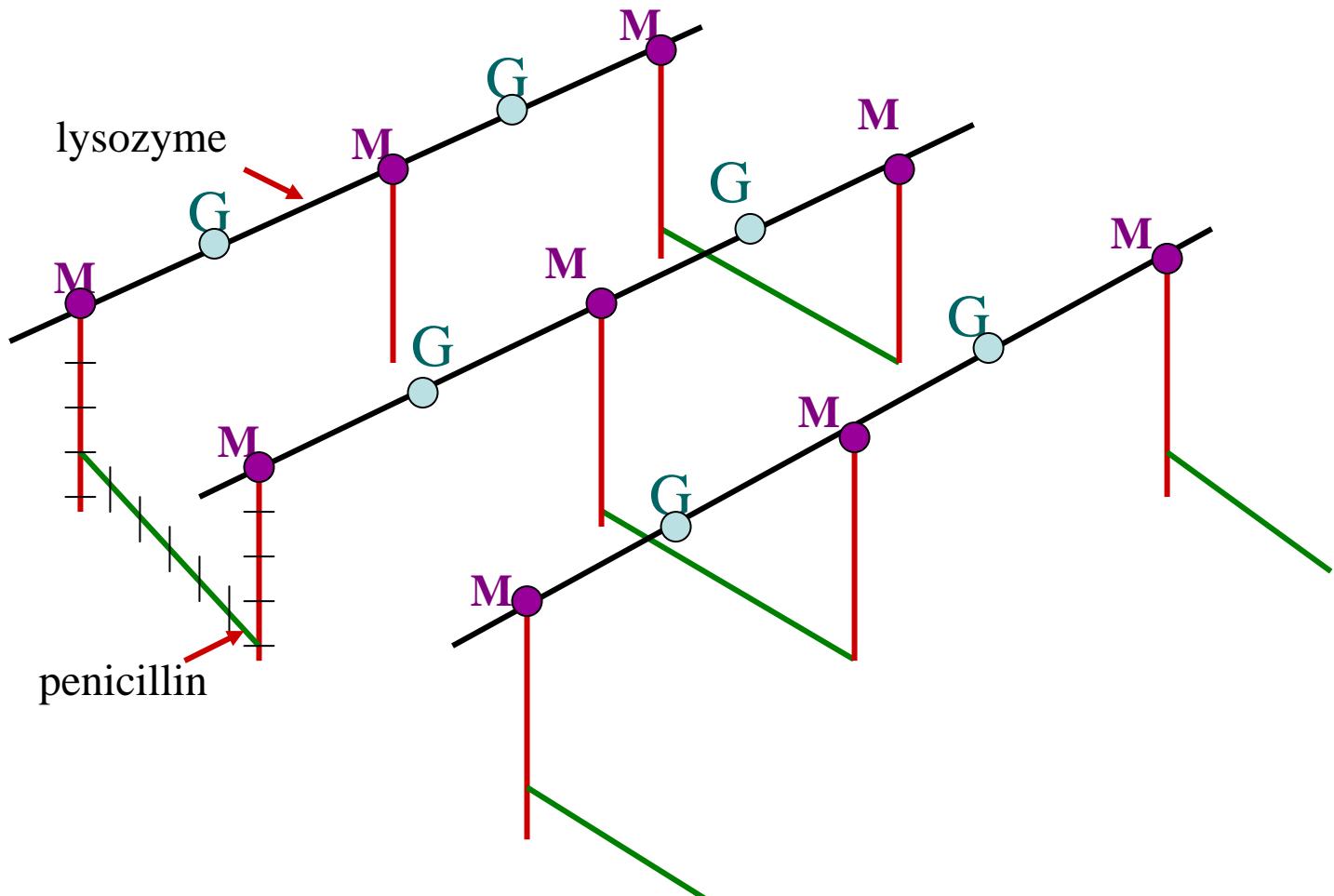
2) tetrapeptide side chain

G^+ : ala-glu-lys-ala link muramic acid ,

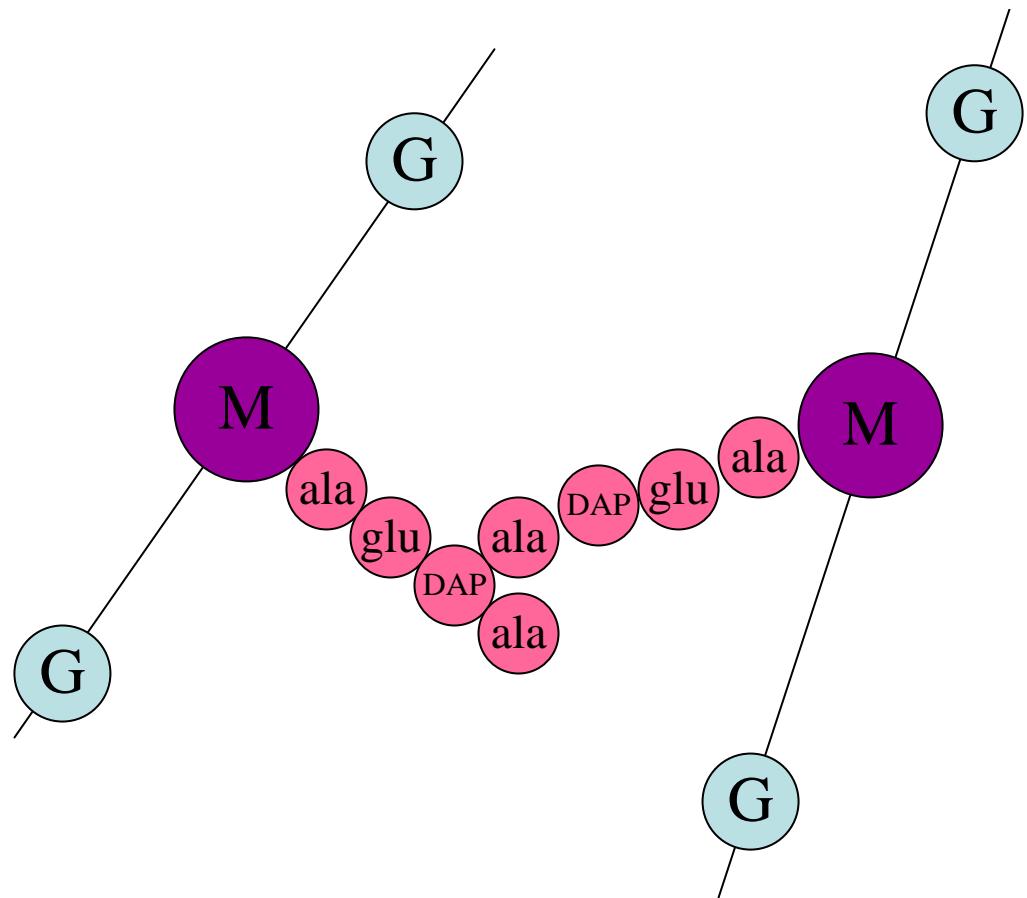
G^- : diaminopimelic acid (DAP)

3) pentapeptide bridge $G^+ [L\text{-glycine}]_5$

Structure of peptidoglycan of G⁺ B.



Structure of peptidoglycan of G- B.



Special components of G⁺ cell wall

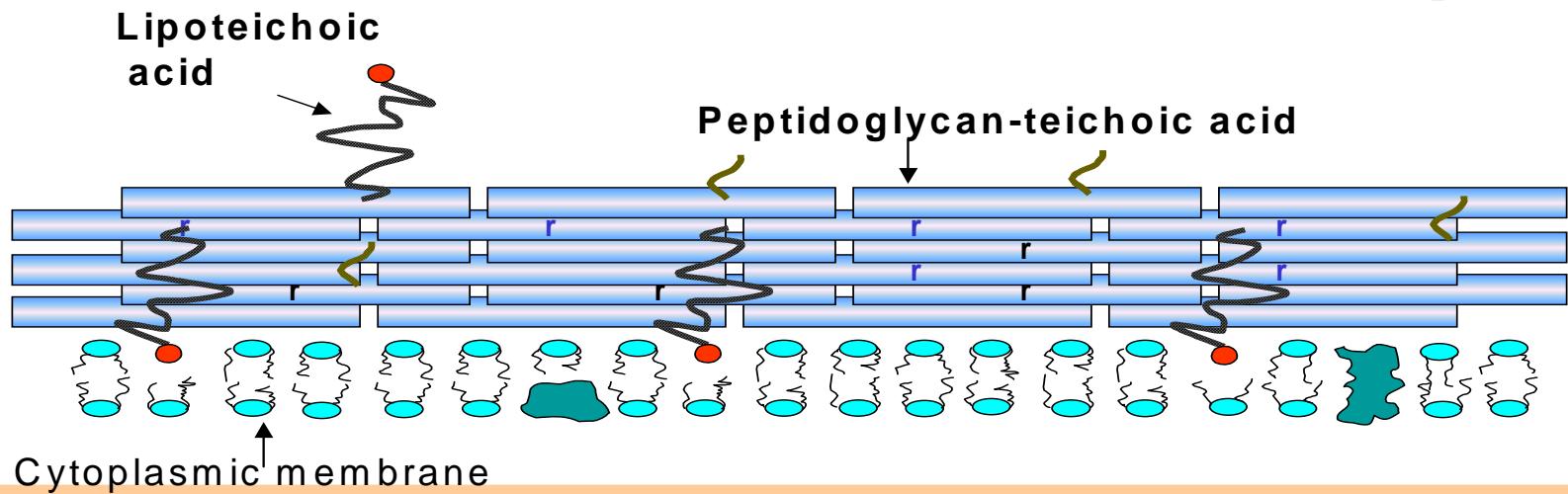
- 1. teichoic acids:** wall teichoic acid
membrane teichoic acid
(*lipoteichoic acid, LTA*)

function :

- 1)provide the cell with its consistency**
- 2)adhere-----pathogenicity**
- 3)antigenicity**

- 2. protein: SPA, M-protein**

Gram Positive Cell Envelope



Special components of G⁻ cell wall

1.lipopolysaccharide(LPS)

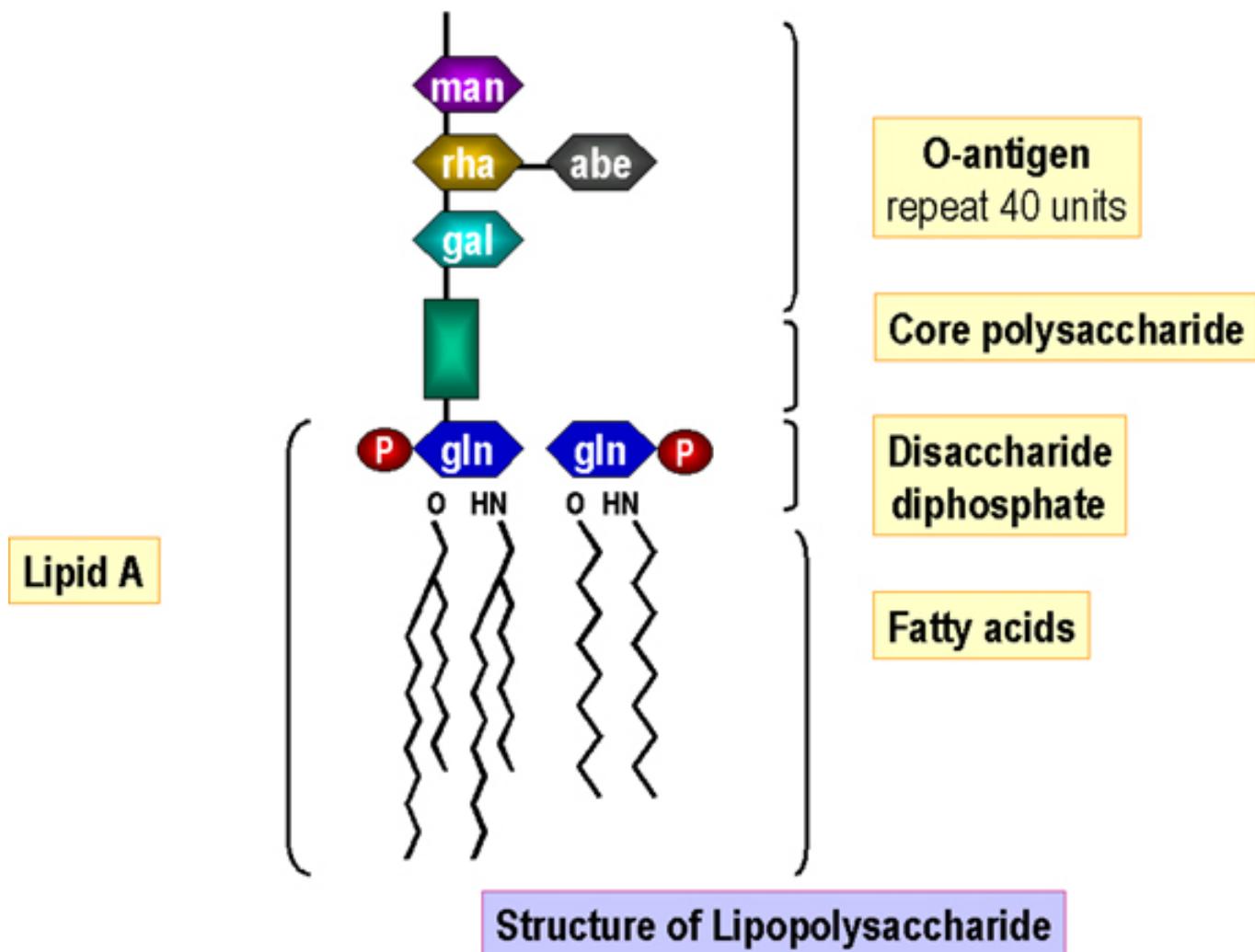
- 1) lipid A ---endotoxin , non-genus specific**
- 2) core polysaccharide**
- 3) specific polysaccharide “O”Ag**

2. Outer membrane protein :

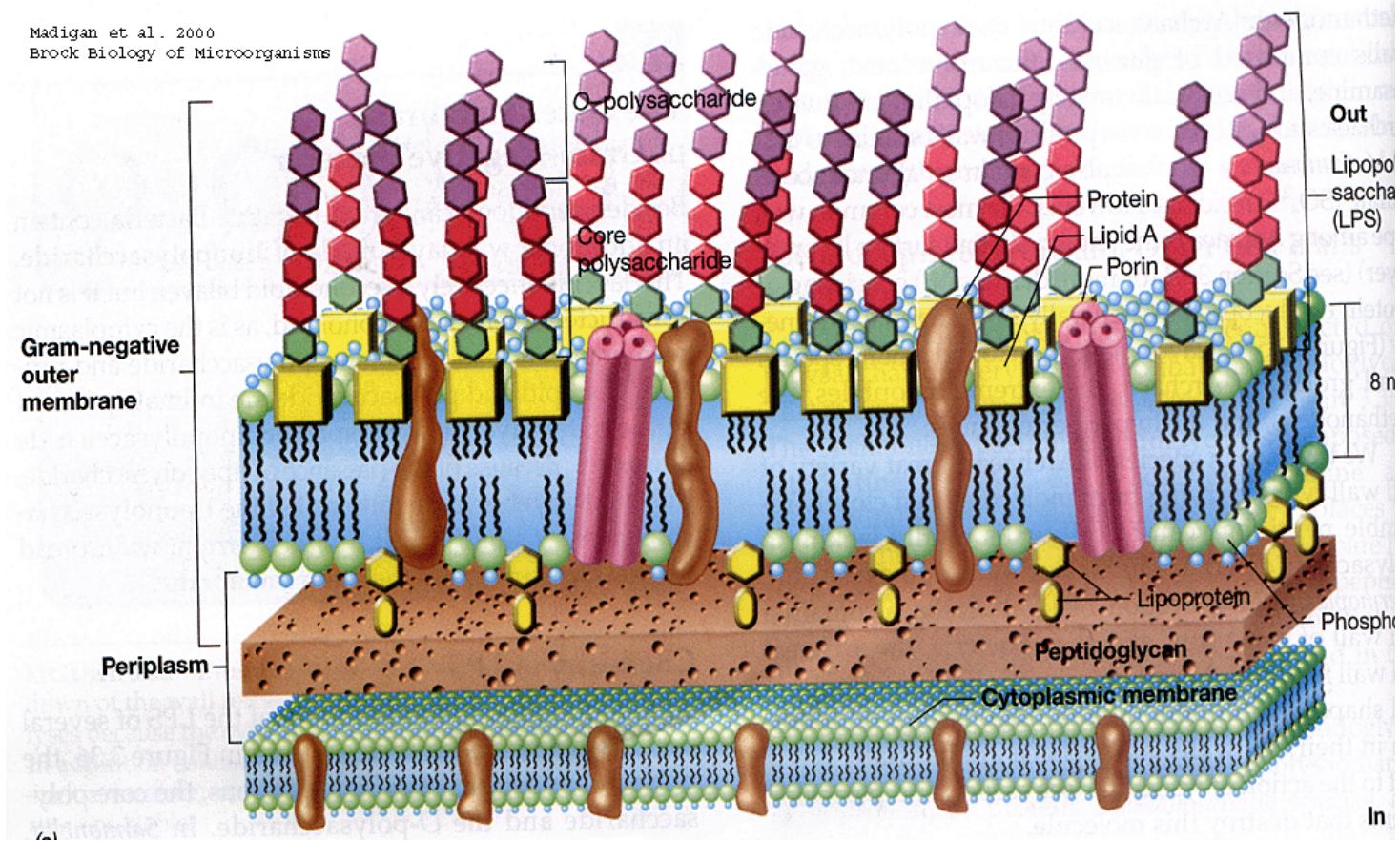
exchange ; receptor (sex pili ,phage); porin

3.Lipoprotein

4.periplasmic space



Madigan et al. 2000
Brock Biology of Microorganisms



2.function

- 1) protection**
- 2) keep the constant shape**
- 3) antigenicity**
- 4) exchange material**

Bacteria L-Forms

cell wall deficient form

1) Morphology: cell wall deficient form

fried egg colony

2) Media : high osmotic ; reversion

3) Pathogenicity

G⁺-----protoplasts

G⁻ -----spheroplasts

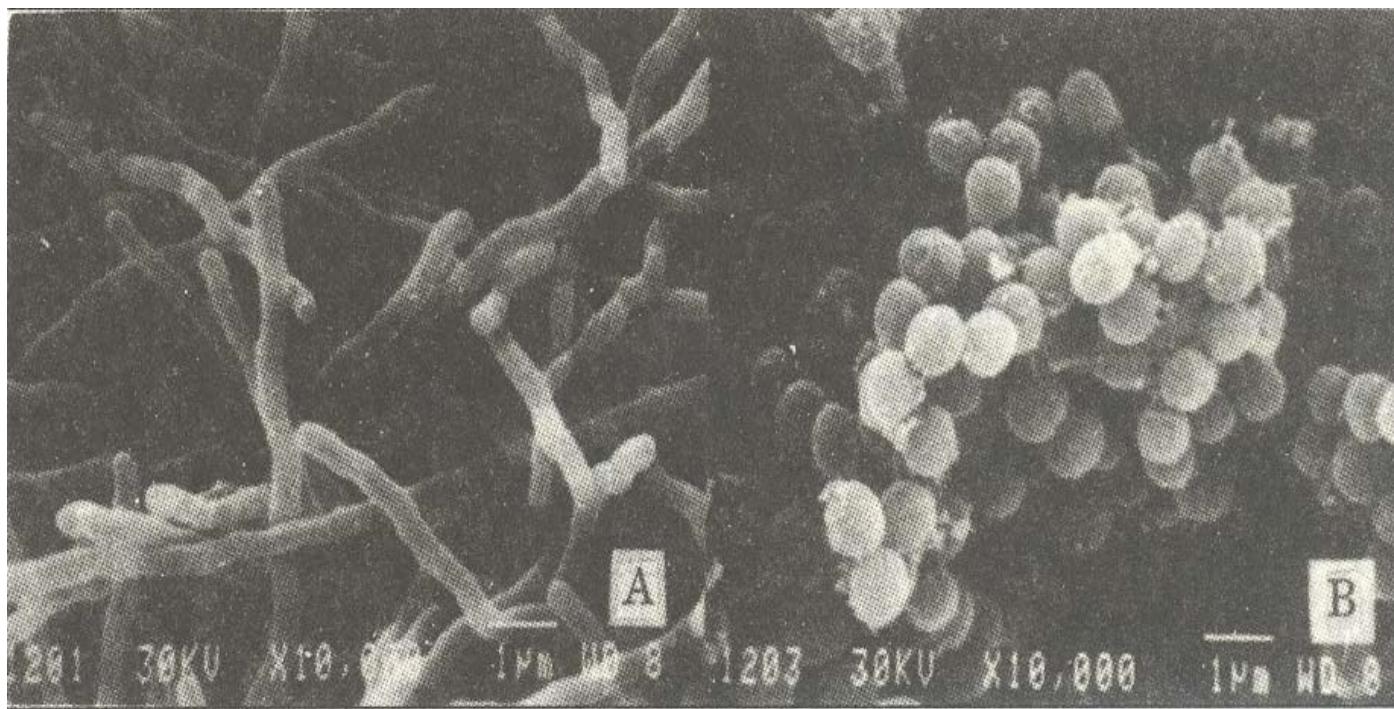
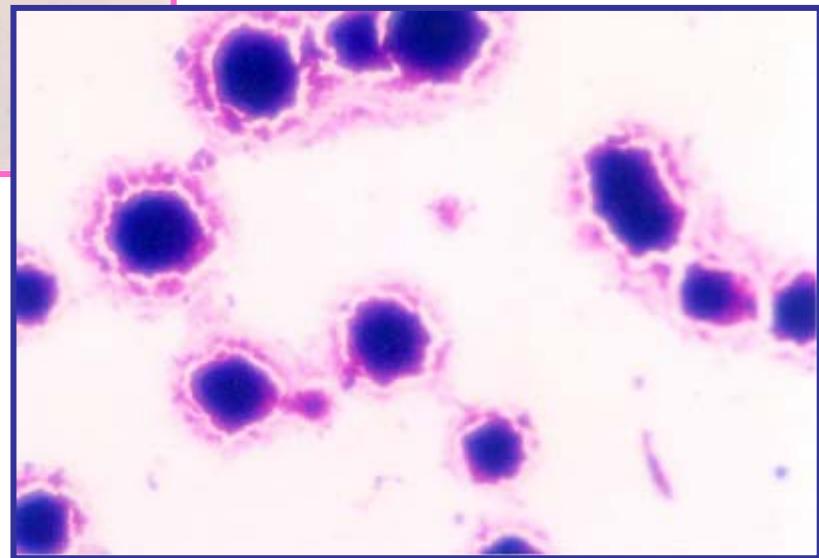
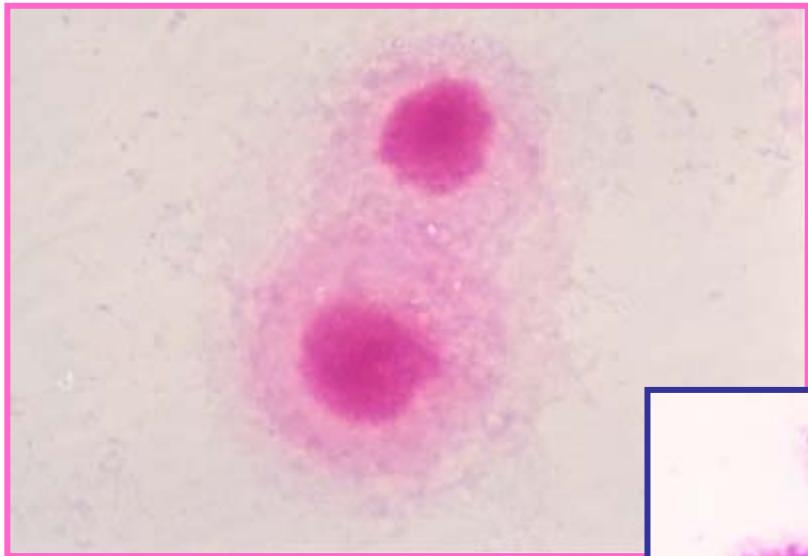


图 1-7 葡萄球菌 L型

A. 临床标本分出的丝状 L型菌落 (扫描电镜 $\times 10\,000$)

B. 丝状 L型菌落回复后 (扫描电镜 $\times 10\,000$)

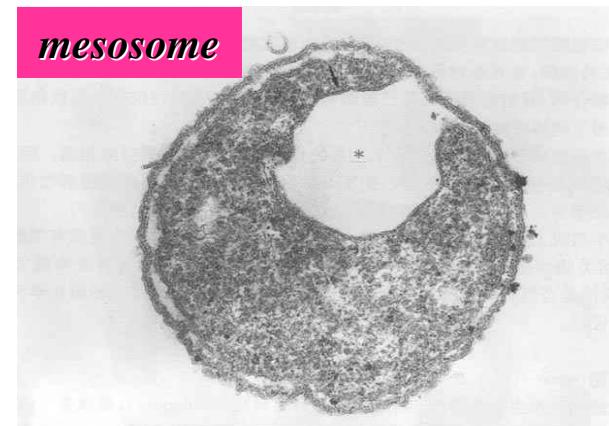
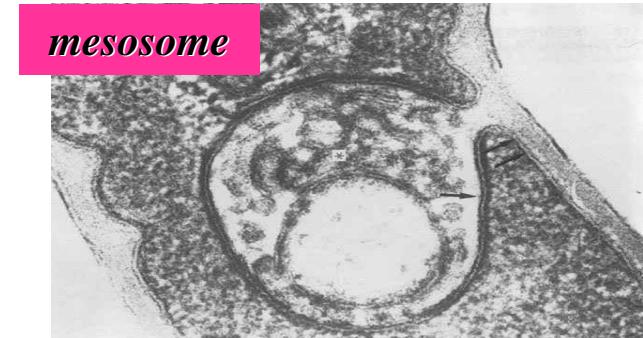
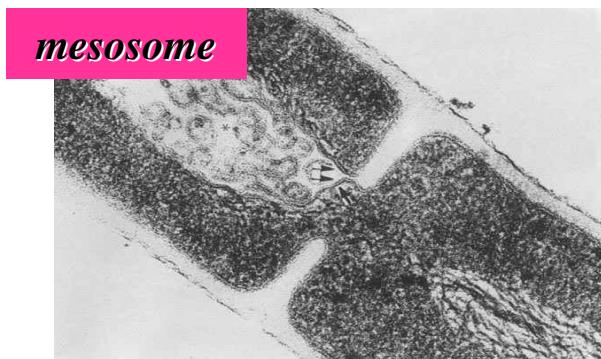


cell membrane

mesosome

invagination vesicular membrane
increase membrane area

septal mesosome : cell division

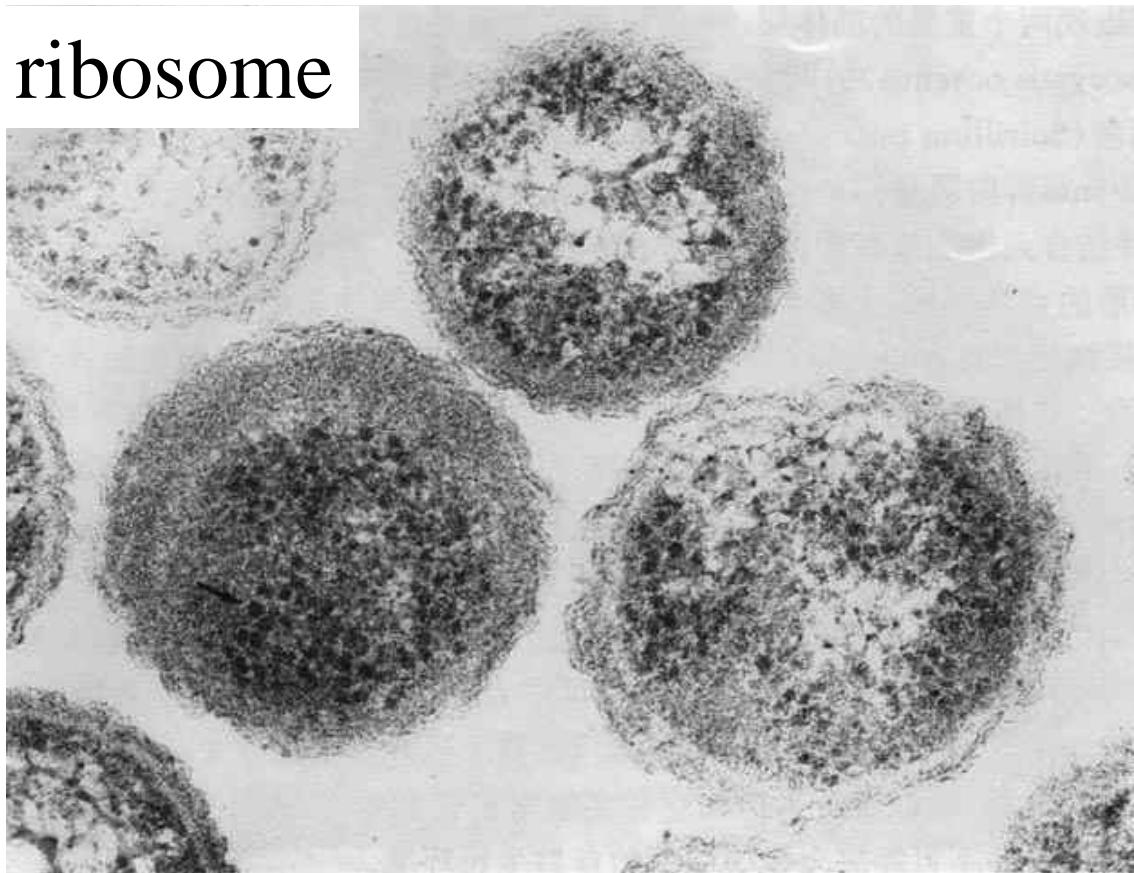


cytoplasm

ribosome

- ※ **70S (30S+50S)**
- ※ **RNA(66%), protein(34%)**
- ※ **rRNA---23S, 16S, 5S**
- ※ **antibiotic**
- ※ **protein synthesize**

ribosome



plasmid

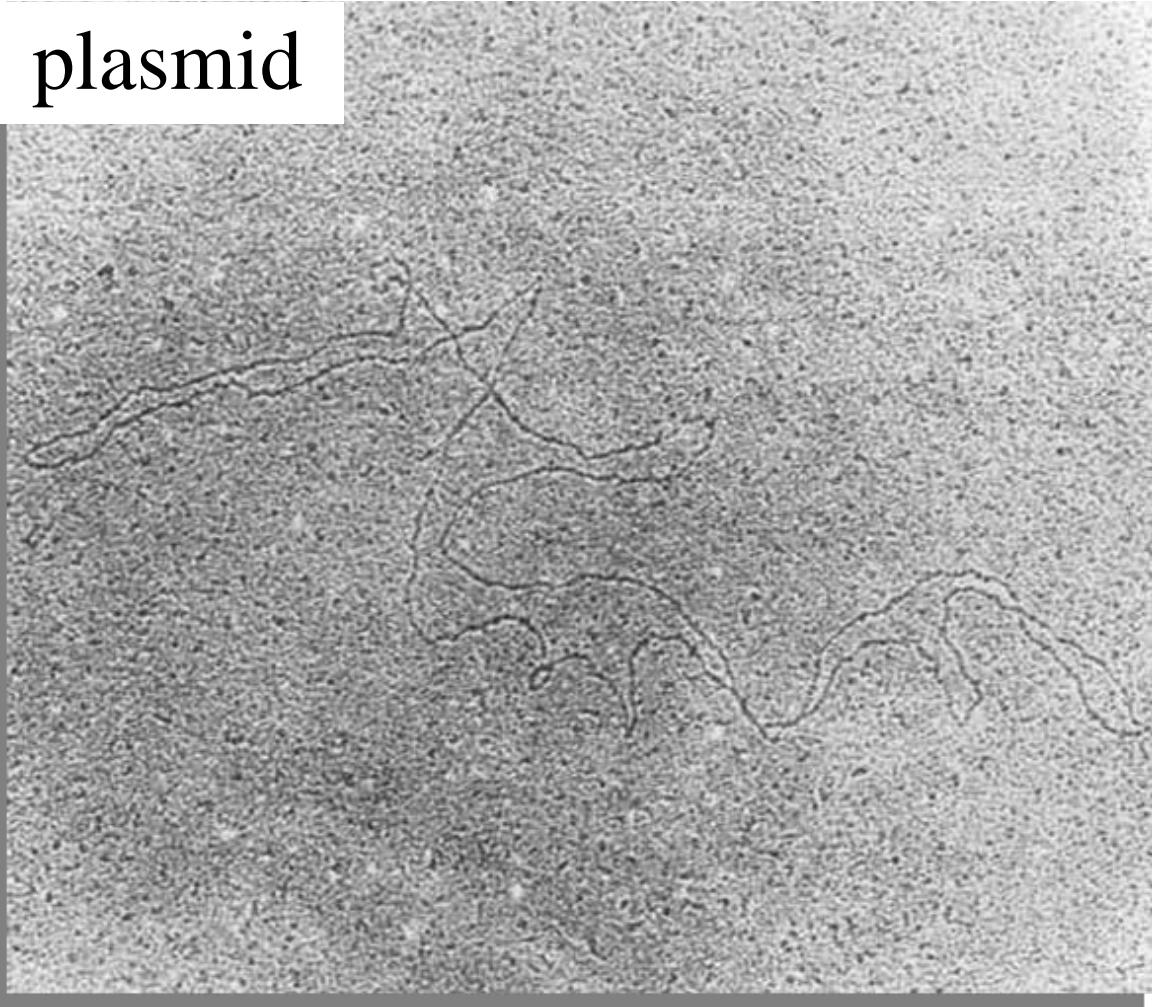
- * extra-chromosomal genetic material circle
- * double chains DNA
- * replicated independently
- * carry genetic information
- * control some functions of bacteria

factor F -----control sex pilus

factor R-----control drug resistance

col factor -----control E.col. to produce bacteriocin

plasmid



Special Structure

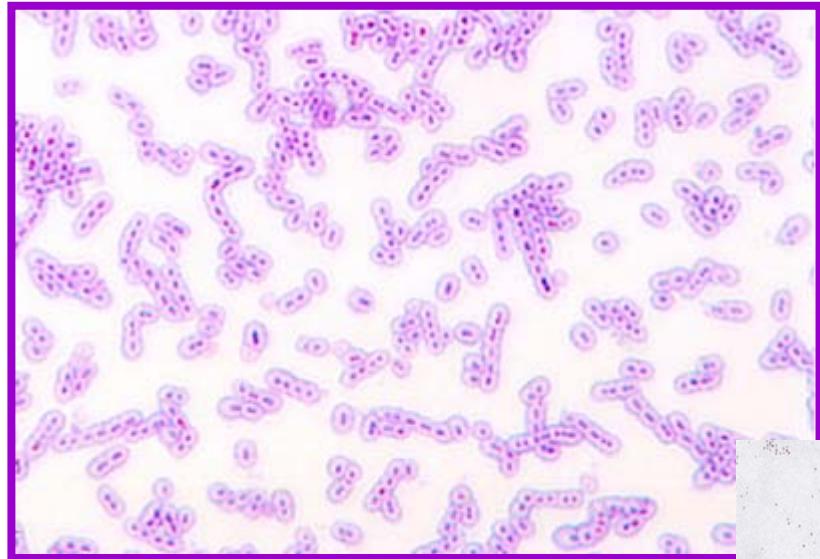
capsule

**slime layer outside the cell wall
composed of polysaccharide or
polypeptide**

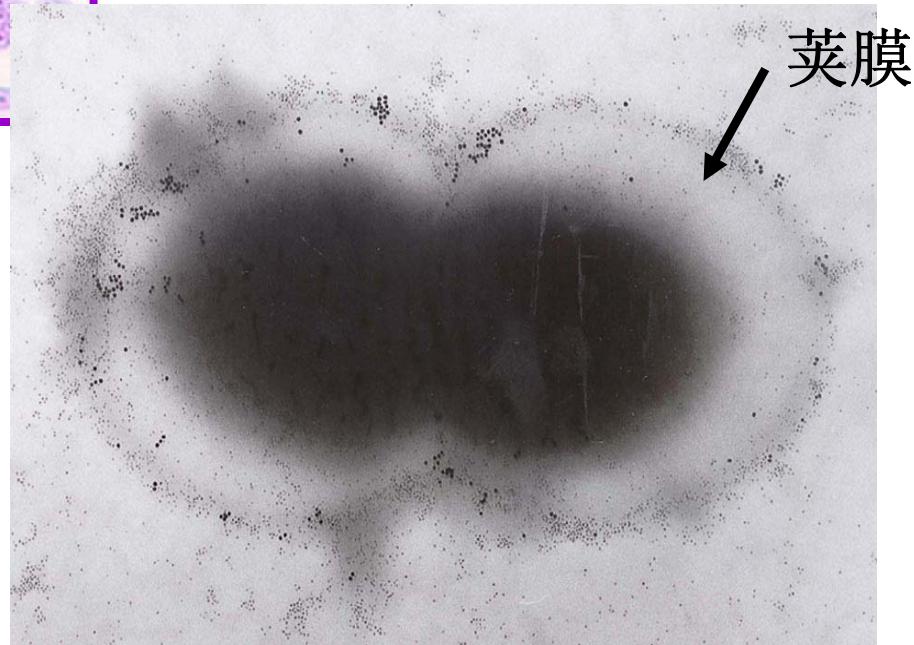
pneumococcus

>0.2 μ m capsule

<0.2 μ m microcapsule



肺炎双球菌荚膜



Function

- 1. anti—phagocytosis**
- 2. protect the cell wall**
- 2. anti-dry**
- 3. antigenicity**
- 4. type**

Flagella

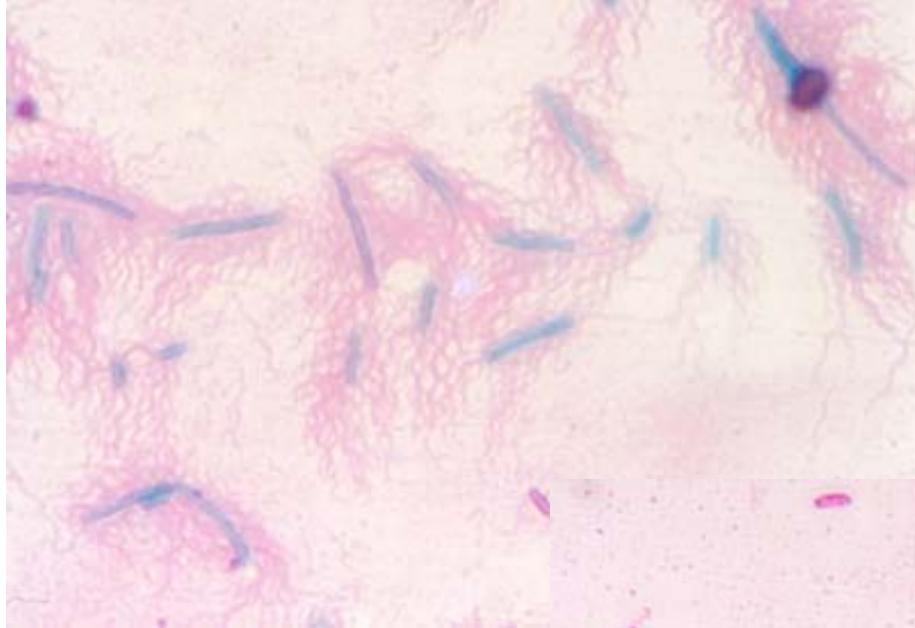
Long filamentous appendage

Originate in the protoplasmic membrane

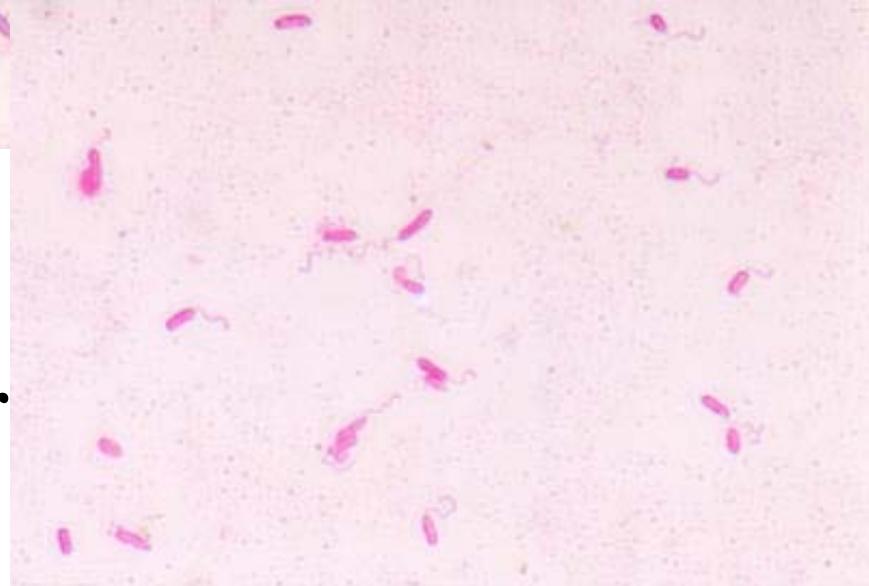
Function

- 1. motility**
- 2. antigenicity : “H”Ag**
- 3. pathogenicity some bacteria (vibrio)**

Peritrichous



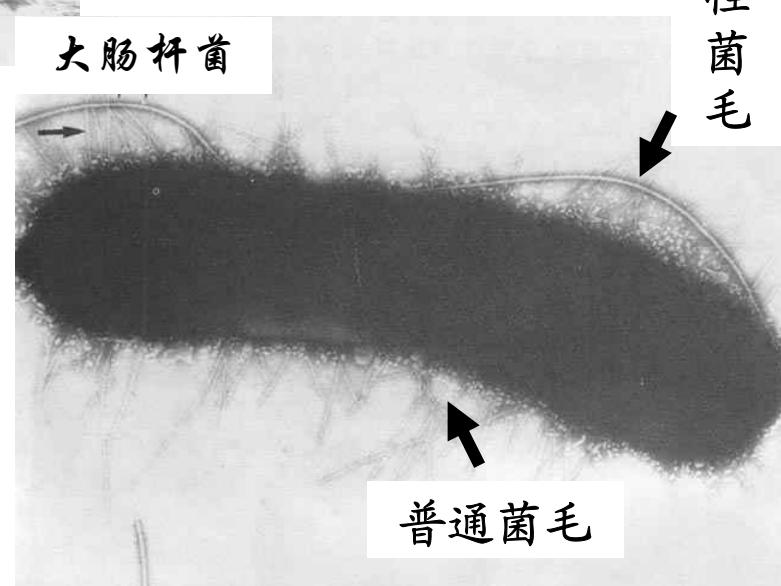
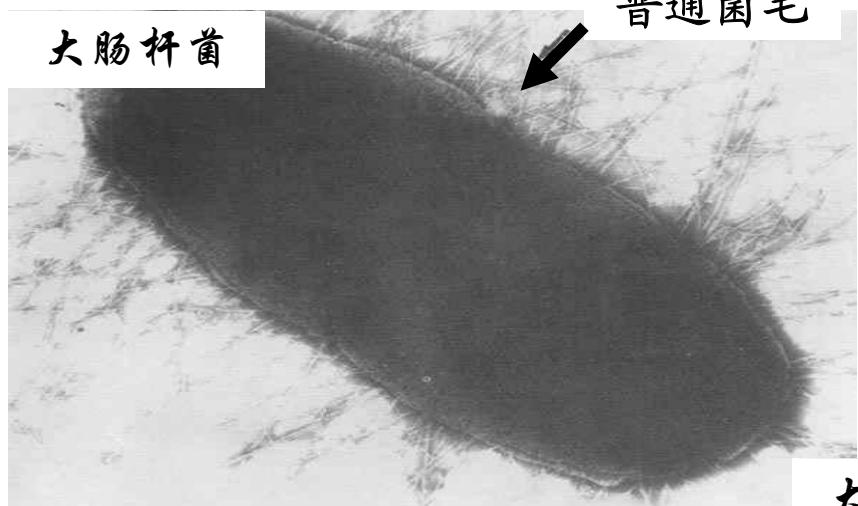
polar



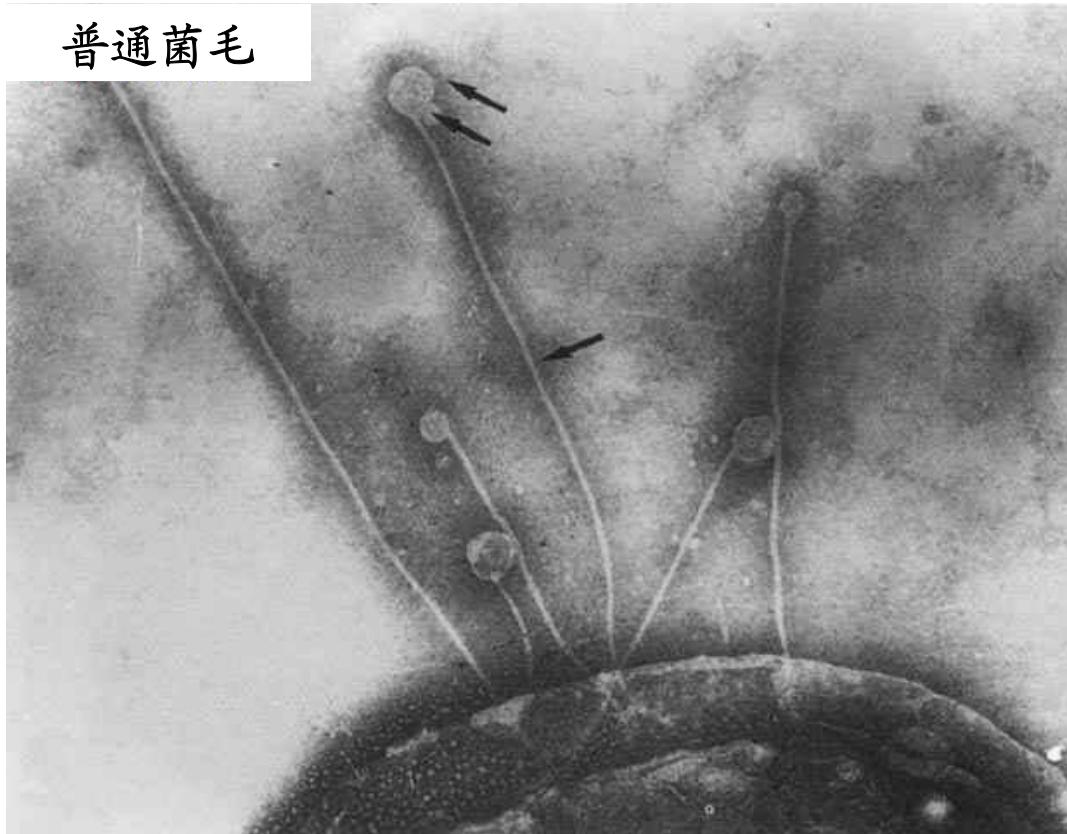
pilus

1. common pilus : 100—200/cell
 - adhere to surface of B.
 - associated with pathogenicity.
2. sex pilus : 1-4/cell
 - male bacteria with sex pilus
 - transfer of genetic material (DNA)
 - during bacteria conjugation

$F^+ \longrightarrow F^-$



普通菌毛



spore

dormant form (resting forms)

- 1) forming: inadequate nutrition**
- 2) germination**

spore → vegetative form

activation → initiation → outgrowth

肉毒杆菌芽孢



炭疽杆菌芽孢

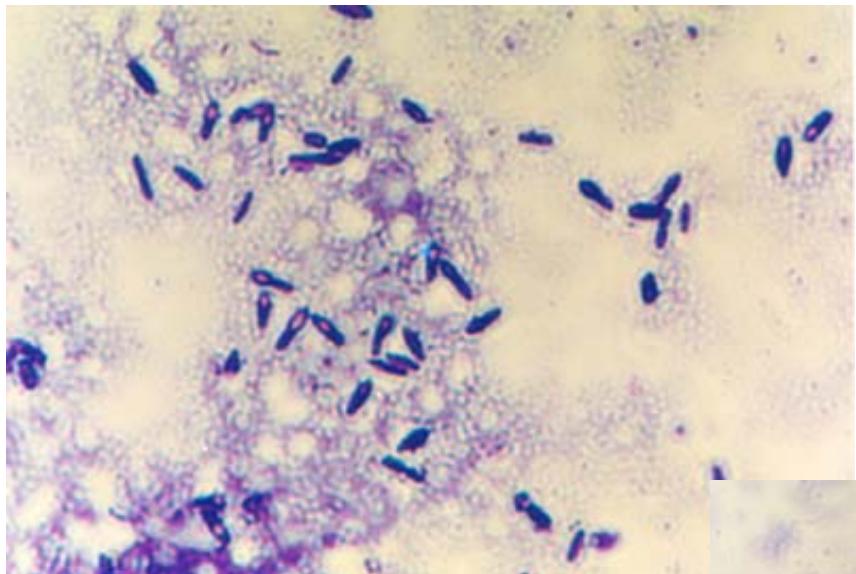


肉毒杆菌芽孢



破伤风杆菌芽孢

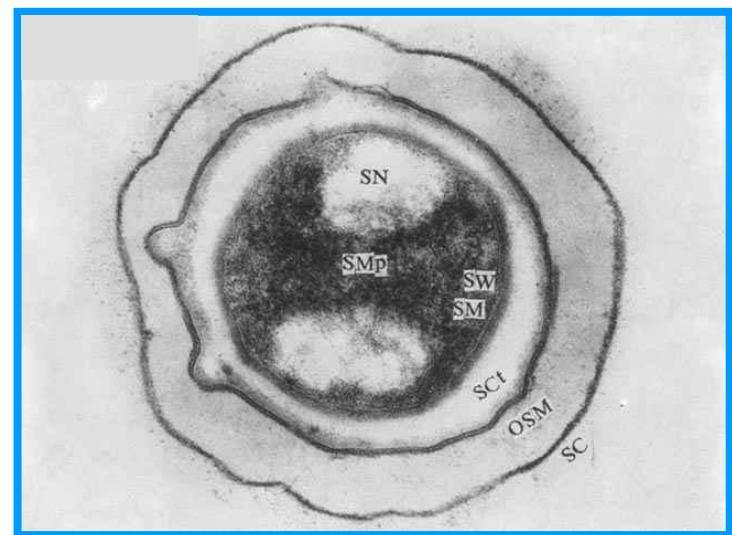
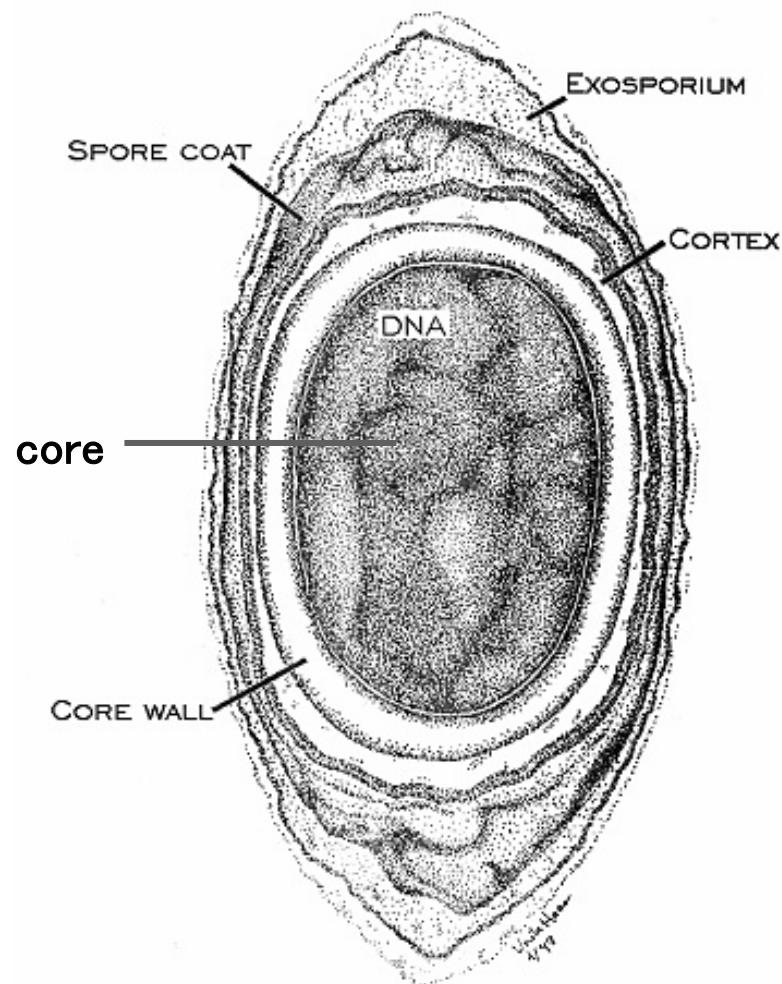




肉毒杆菌芽孢

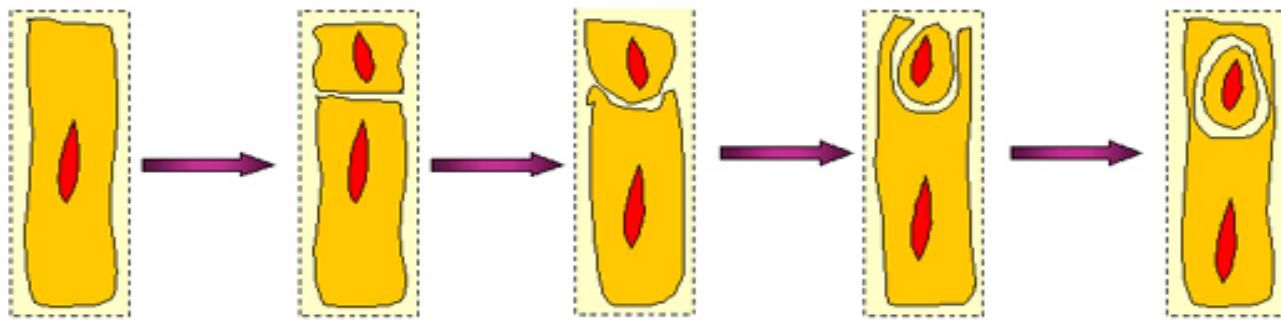
破伤风杆菌芽孢





Structure of spore

**End of
vegetative growth** **Asymmetric
septation** **Endocytosis or engulfment of daughter protoplast**



**Steps in endospore
formation**

**Lysis of mother cell
and release of
SPORE**

**Assembly of
proteinaceous
spore coat**

**Synthesis of
peptidoglycan-containing
cortex**

3) function

highly resistant to heat, chemical and dry

reason:

- (1) many layers ----thick coat**
- (2) little water 40% free water**
- (3) large amount of calcium dipicolinic acid**
(吡啶二羧酸钙)
- (4) heat-stable enzyme**

Section 4

Bacterial growth and reproduction

Bacterial requirements for growth

❑ nutrients

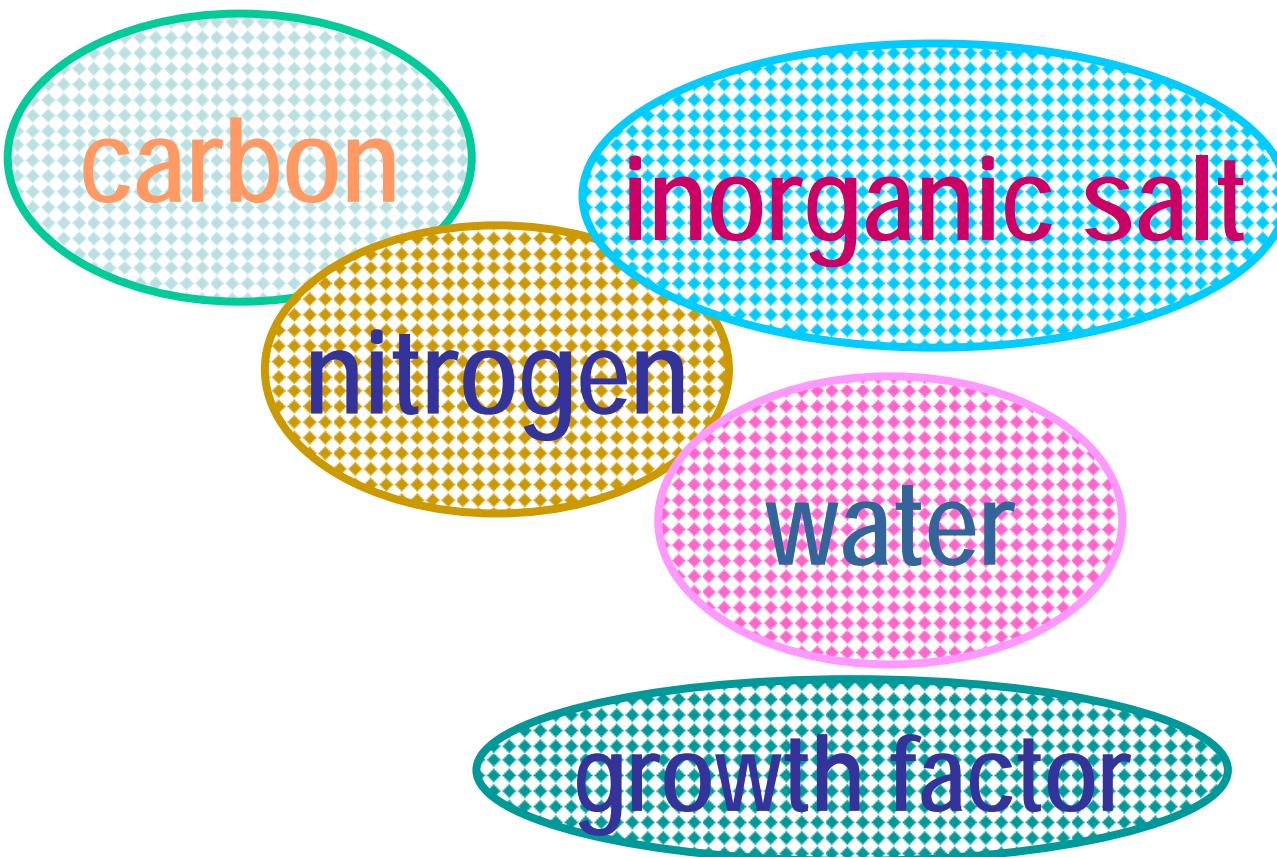
❑ optimal pH

❑ optimal temperature

❑ oxygen (or absence)

❑ osmotic pressure

Nutrient Requirements



pH

grow best at neutral pH: 7.2~7.6

Some can survive/grow

- acid pH 3

- alkali pH 9

Growth temperature

psychrophile: -5~30°C

mesophile: 10~45°C

human body temperature: 37 °C

* **pathogens**

* **opportunists**

thermophile: 25~95°C

Growth atmosphere

- strict (obligate) aerobe
- strict (obligate) anaerobe
- facultative anaerobe
- microaerophilic bacterium

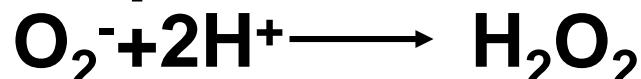
Reason that obligate anaerobes can't grow in oxygen condition:

(1) Lack of cytochrome and cytochromase

Eh 300mv/120mv

(2) Lack of superoxide dismutase (SOD) , catalase , peroxidase

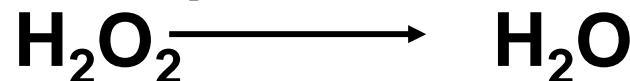
superoxide dismutase



catalase



peroxidase



osmotic pressure

0.5% NaCl

halophilic bacterium: 3% NaCl

bacterial L-form: 3% -5% NaCl

Mode and speed of Bacterial reproduction

- ◆ **binary fission**
- ◆ **generation time:**

time for bacterial mass to double

20~30min

Growth in a broth culture ---The Growth curve

(1) lag phase :

adaptation

(2) logarithmic phase:

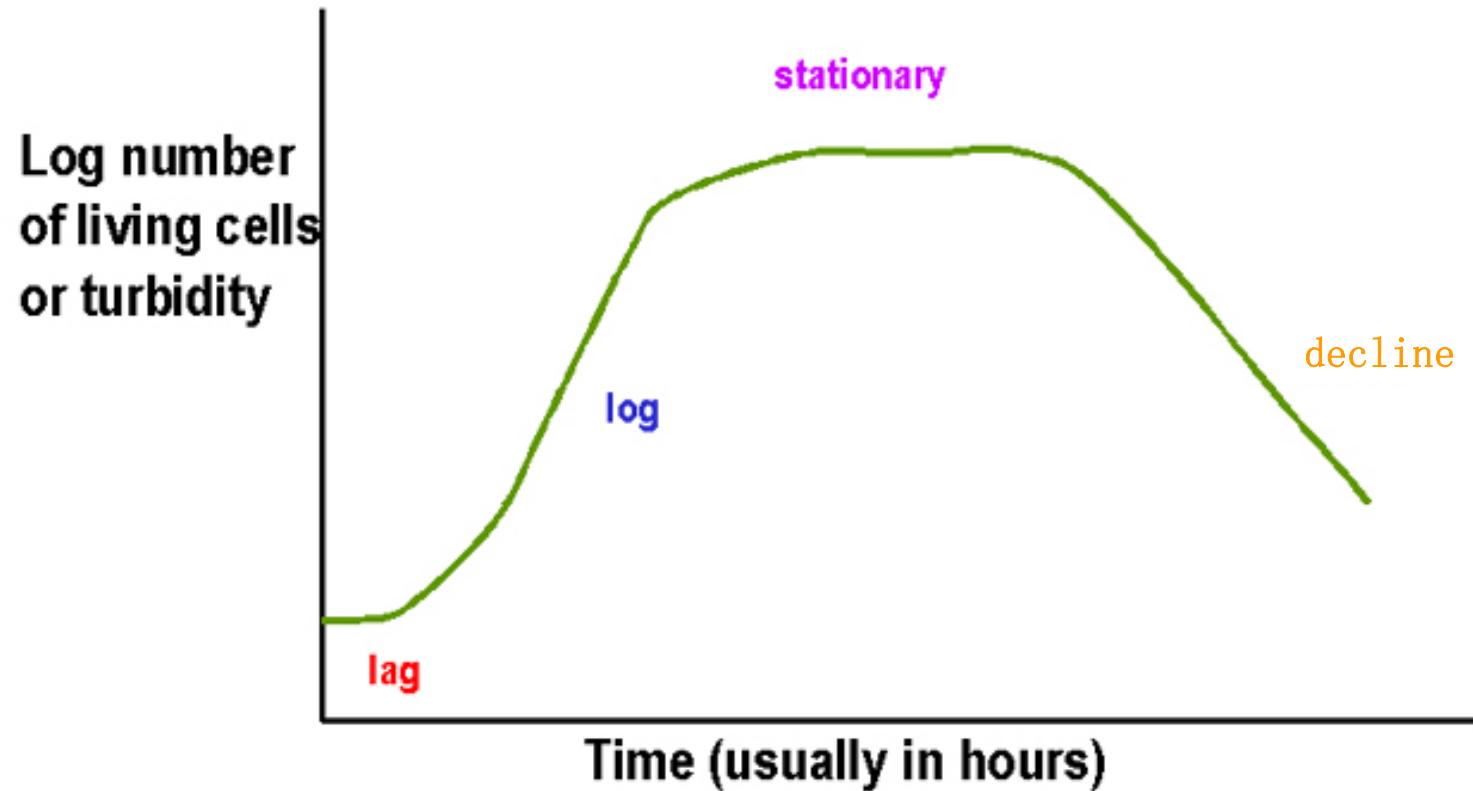
most rapid reproduction

(3) stationary phase:

rate of reproduction=rate of dead

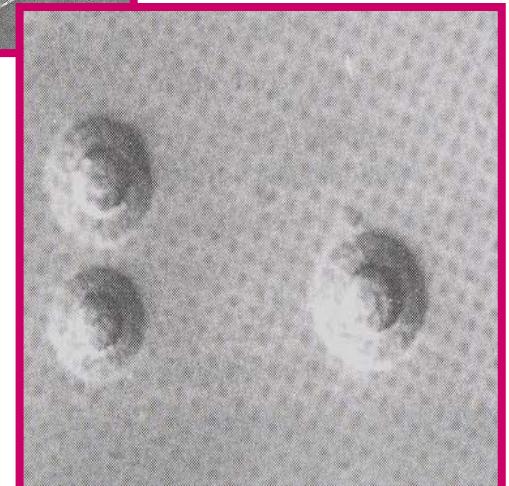
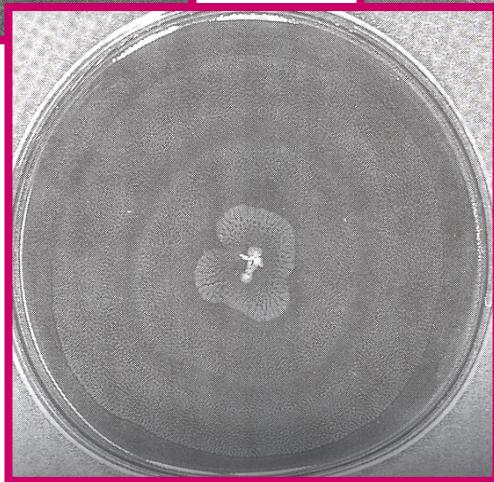
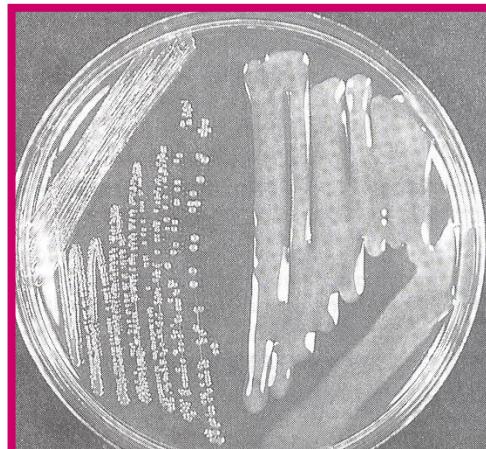
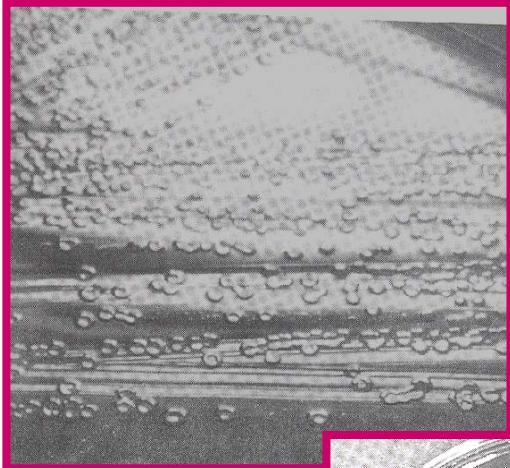
(4) decline phase:

rate of dead > rate of reproduction.



The Growth Curve

Growth in a solid medium---colony



Section 5

Bacterial Metabolism

Bacterial enzyme

**Exoenzyme hydrolase
coagulase.....**

**Endoenzyme metabolic enzyme
respiratory enzyme**

Metabolic products

1. Catabolic products and biochemical reaction

VP test

methyl red test

citrate utilization test

indole test

.....

2. Anabolic products and clinical significance

1) pyrogen

polysaccharide of G⁻ cell wall(LPS)

anti-high temperature 121°C , 30min

Fluid infusion reaction

2) toxin and invasive enzymes

exotoxin

endotoxin

enzyme

3) pigment

water-soluble P. aerogenosa ---green

fat -soluble S. aureus —golden

4) antibiotics

killing or inhibiting substances produced by some kinds of microorganisms

Actinomycete

5) bacteriocin

protein by certain bacteria , which can kill or inhibit the growth of related strains.

6) vitamin