اللهم وفقني في دراستي، ونوّر بالكتاب بصري، واشرح به صدري، واستعمل به بدني، واطلق به لساني، وقوِّ به عزمي بحولك وقوتك، فإنّه لا حول ولا قوة إلّا بك يا أرحم الراحمين

كل ما في السلايديات مطلوب حفظه و الملخصات المذكورة في الملف هي وسيلة لتسهيل ربط المعلومات و تضمن ملاحظات حكتها الدكتورة

وفقكم الله...

Biofilms

Pharmaceutical Microbiology

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Thin, Slimy Colonies or Communikes of bacteria ← Biofilms
in which adheres to a surface are capable to Produce their own extracellular matrix

Definition

ECM Provided certin benefits to the bacteria

- Biofilms are communities of surface-associated microorganisms encased in a self-produced extracellular matrix. ECM

embedded in ECM — يتكون Substratum — على certin surface — جزيئات بسيطة — هي تجمع بكتيري يتكون

- Biofilm formation is a nearly universal bacterial trait, and biofilms are found on almost all natural and artificial surfaces.

التجمع البكتيري مع بعضه يشكل Colonies لكن طبيعيا كمجتمع من خلية جنب خلية!

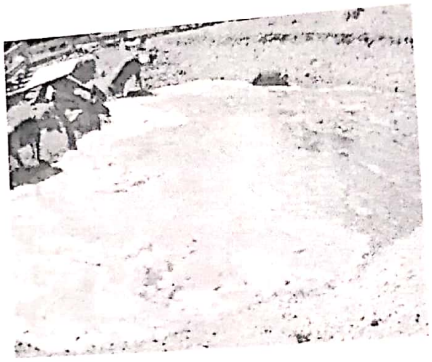
certain ECM — لكن يكونوا في

- Some examples of biofilms are the plaque ① that forms on teeth and ② the slime that forms on surfaces in watery areas.

Biofilms → Beneficial to the bacteria
Biofilms → Harmfull to Humans (cause disease)

مثال: الـ Plaque هو تراكم لـ Secretion على الأسنان
وسببها هو Bacterial colony ولازم يتم تنظيفها دوماً

Examples of biofilms



Old Science

- Biofilms science and technology has been an active field of study since the late seventies when the first definition of biofilms was brought to public attention by Bill Costerton and coworkers in 1978

- **Significance: Protect and allow bacteria to survive and thrive in hostile environments.** Withstand host immune responses, much less susceptible to antibiotics and disinfectants.

→ They can for example exchange their genomes, resist antibiotic, survive in high threatning condition

low nutrition, change in temperature & PH

Yellow is the Staphylococcus aureus

High-resolution scanning electron microscopy image of a community associated methicillin-resistant Staphylococcus aureus biofilm embedded in extracellular matrix, formed on implanted catheter tubing during experimental biofilm infection

هاي الصورة بتبيّن ال methicillin-resistant Staphylococcus aureus وهي Biofilm embedded inside matrix وبتكون موجودة بـ Catheter tube

Human Infections linked to biofilms

هاد مش لازم نحفظ

Table 1 Partial list of human infections involving biofilms

Infection or disease	Common biofilm bacterial species
Dental caries	Acidogenic Gram-positive cocci (e.g., Streptococcus)
Periodontitis	Gram-negative anaerobic oral bacteria
Otitis media	Nontypable strains of *Haemophilus influenzae*
Musculoskeletal infections	Gram-positive cocci (e.g., staphylococci)
Necrotizing fasciitis	Group A streptococci
Biliary tract infection	Enteric bacteria (e.g., *Escherichia coli*)
Osteomyelitis	Various bacterial and fungal species—often mixed
Bacterial prostatitis	*E. coli* and other Gram-negative bacteria
Native valve endocarditis	Viridans group streptococci
Cystic fibrosis pneumonia	*P. aeruginosa* and *Burkholderia cepacia*
Melioidosis	*Pseudomonas pseudomallei*
Nosocomial infections	
UTI prosthesis	Gram-negative rods
Sutures	*Staphylococcus epidermidis* and *S. aureus*
Exit sites	*S. epidermidis* and *S. aureus*
Arteriovenous shunts	*S. epidermidis* and *S. aureus*
Scleral buckles	Gram-positive cocci
Contact lens	*P. aeruginosa* and Gram-positive cocci
Urinary catheter cystitis	*E. coli* and other Gram-negative rods
Peritoneal dialysis (CAPD) peritonitis	A variety of bacteria and fungi
IUDs	*Actinomyces israelii* and many others
Endotracheal tubes	A variety of bacteria and fungi
Hickman catheters	*S. epidermidis* and *C. albicans*
Central venous catheters	*S. epidermidis* and others
Mechanical heart valves	*S. aureus* and *S. epidermidis*
Vascular grafts	Gram-positive cocci
Biliary stent blockage	A variety of enteric bacteria and fungi
Orthopedic devices	*S. aureus* and *S. epidermidis*
Penile prostheses	*S. aureus* and *S. epidermidis*

هاد اللي حركة الركوة بالريكوار عن هي السليم

Dental Caries & Otitis media & Some respiratory tract infection Like Cystic fibrosis Pneumonia & Endocarditis

→ Harmful, Slowly, Persistant infection

Biofilm formation and growth

- Basic structural unit of a biofilm is the microcolonies or cell cluster formed by the surface adherent bacterial cells.

- **IMPORTANT FACTORS IN BIOFILM FORMATION** Basic factors are:-

① • **Cell attachment**

② • **Extracellular polysaccharides (EPS)**

③ • **Cell-cell communication (Quorum sensing)**

Cell clusters أو Microcolonies هي الـ Basic structure unite الي بتكون Biofilm لحد ما تتكون وبتعمل Adhesion on surface ثم Biofilm formation

increasing of bacterial number because of further aggregation of bacteria

ثم Protection of bacterial aggregation by ECM

Basic units of biofilm

① • Microcolonies of homogenous or heterogenous bacterial species.

② • Matrix : A glycocalyx matrix made up of extracellular polymeric substance(EPS) surrounds the microcolonies and anchors the bacterial cell to the substrate.

matrix can:
1. Provide full Protection
2. Maintaining the integrity of biofilm
3. Prevent dehydration or desiccation
4. Resist antimicrobial agent
5. Creat a nutritionally rich environment

- Functions:
  - Maintains the integrity of biofilms
  - Prevents desiccation.
  - Resists antimicrobial agents
  - Create a nutritionally rich environment

Transporting of bacteria to reach surface, مثل flagella اللي بتساعد في Bacterial adhesion اللي بتساعد في Pili و

Quorum sensing

(3)

- is a **communication mechanism between bacteria** that allows specific processes to be controlled.
- Involves the regulation of expression of specific genes through the accumulation of signaling compounds that mediate intercellular communication. Communication between bacteria so there is bacterial expression of certin gene through accumulation of signaling compound
- Dependent on cell density and mediated through signaling compounds.

- The signals are thought to allow cross-talk between species, causing them to increase their production of exo-polysaccharide (1) and the factors that increase their virulence. (2)

signals اللي بتبعت

Quorum Sensing → expressing of certin gene are responsible for synthesis or formation of signaling compound which importe for communication between cells

Mechanisms of Biofilm formation

- **Formation of a biofilm begins with the attachment of free-floating microorganisms to a surface. These first colonists adhere to the surface initially through weak, reversible van der Waals forces. If the colonists are not immediately separated from the surface, they can anchor themselves more permanently using cell adhesion structures such as pili**

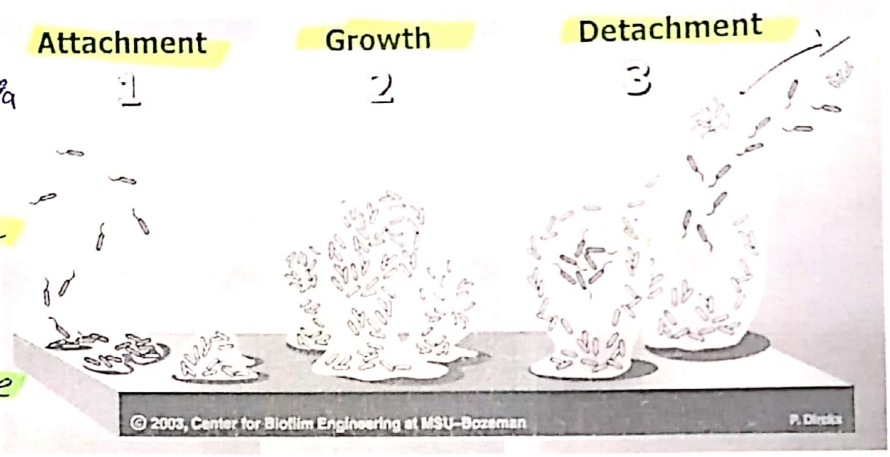
* Bacteria can form biofilm on any surface that is bathed in a nutrition containing fluid.

* 3 major component involve in biofilm formation:-
① Bacterial cell ② A solid surface ③ A Fluid medium

Stages of Biofilm Formation

Bacteria switch from a free-floating (**planktonic) state where** they function as individuals to a sessile state where they function as communities.

تبدأ العملية بـ Floating bacteria وبعدين Planktonic bacteria that become to be a sessile State وبعدين community



STAGE 1 Attachment

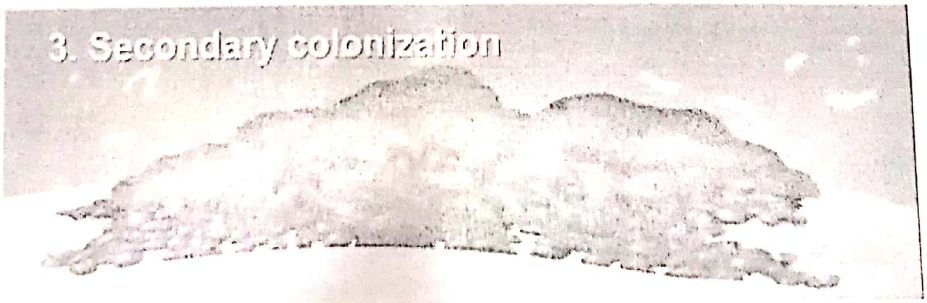
- Adsorption of inorganic and organic molecules to the solid surface, forming a thin layer termed as conditioning layer.

STAGE 2

- Adhesion of microbial cells to this layer.
  - Phase 1 - Transport of microbes to surface.
  - Phase 2 - Initial non specific microbial-substrate adherence phase.
  - Phase 3 - Specific microbial-substrate adherence phase.

STAGE 3

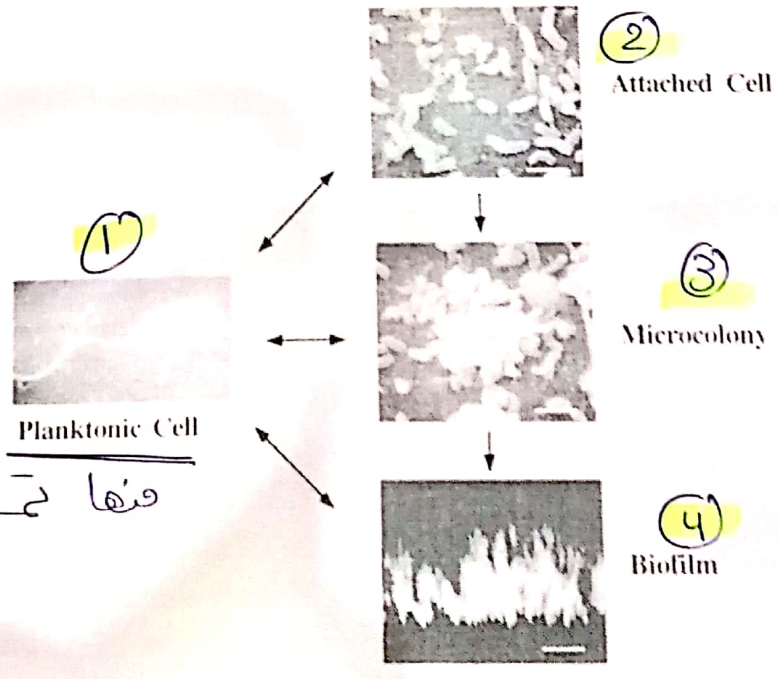
- Bacterial growth and expansion.
- Monolayer of microbes attracts secondary colonizers forming microcolony, and the collection of microcolonies gives rise to the final structure of biofilm.



STAGE 3

- A mature biofilm will be a metabolically active community of microorganisms where individuals share duties and benefits.
- Some microorganisms help in adhering to the solid support, while some others create bridges between different species.

Biofilm formation in *Vibrio cholerae*



وهنا تمت البداية

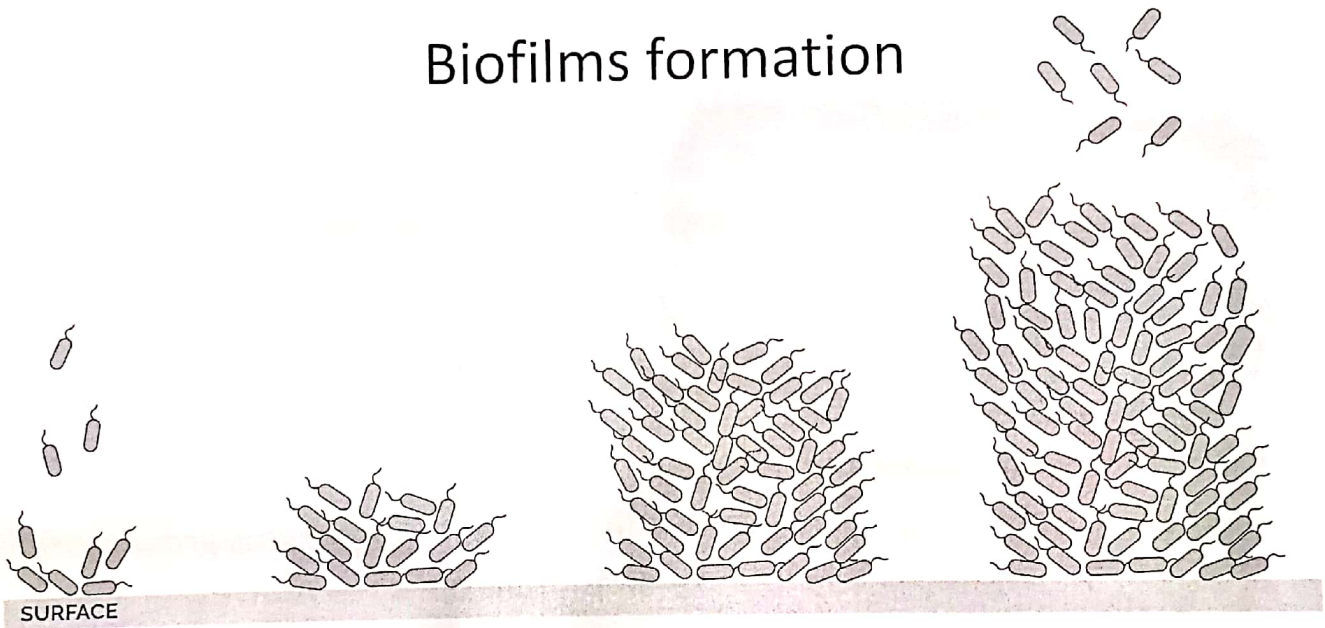
STAGE 4 : Detachment / Dispersion

خروج البكتيريا من Biofilm وده بساعد على Bacterial Survival & Disease Spreading

- During detachment, as a strategy of bacterial cells to leave biofilms and continue another biofilm life cycle

- Detachment plays an important role in shaping the morphological characteristics and structure of mature biofilm.

Biofilms formation



Benefits Of Biofilm To Microbes

- Helps the bacteria to survive in unfavorable environmental and nutritional conditions.
- Resistance to antimicrobial agents.
- Opportunity of genetic material exchange.
- Ability to communicate between bacterial population of same and or different species.
- Produce growth factors across species boundaries.

Role of biofilms in antibiotic resistance

How Biofilm resist antibiotics?

- Delayed penetration of the antimicrobial agent----EPS diffusional barrier ; delays rate of transport of drugs
- Bacteria intact in biofilms more resistant than single cells
- Altered growth rate of organisms in biofilms----organisms grow more slowly in biofilms---Slow uptake of antimicrobials----Actively growing and dividing cells are required for drug action

Slowly growing bacteria تكون Biofilm داخل البكتيريا

Alter growth of ذ ز

antimicrobial agent

Biofilms a Great threat to Implants

- A significant number of people are affected by biofilm infections which develop on medical devices implanted in the body such as catheters (tubes used to conduct fluids in or out of the body), artificial joints, and mechanical heart valves.

- When implanted material becomes colonized by microorganisms, a slow developing but persistent infection results

Infection <<<< Biofilm بالـ المشكلة

Endocarditis and Biofilms

↳ Infection of vascular endothelium of heart

- Microorganisms may attach and develop biofilms on components of mechanical heart valves and surrounding tissues of the heart, leading to a condition known as prosthetic valve endocarditis.
- The primary organisms responsible for this condition are S. epidermidis, S. aureus, Streptococcus spp., gram-negative bacilli, enterococci, and Candida spp.

- These organisms may originate from the skin, other indwelling devices such as central venous catheters, or dental work.

قبل ما الدكتور يعمل Dental Procedure آي سألوا المريض

إذا عنده ① Cardiac disease أو ② Valve replacement

Urinary catheters and Biofilms

- Urinary catheters are tubular latex or silicone devices, which when inserted may readily acquire biofilms on the inner or outer surfaces.
- The organisms commonly contaminating these devices and developing biofilms are **S. epidermidis, Enterococcus faecalis, E. coli, Proteus mirabilis, P. aeruginosa, K. pneumoniae, and other gram-negative** organisms.
- The longer the urinary catheter remains in place, the greater the tendency of these organisms to develop biofilms and result in urinary tract infections

* كل ما دخلنا جسم الجهاز Solid device فرصة البكتيريا لتبني Biofilms

Longer time of replacment of catheter So high chance of development of biofilm

* بعض البكتيريا اللي ممكن تسبب Urinary tract infection بتعمل induce Biofilm formation