



# MSS

## Microbiology

LEC no. 7



**Writer: Alaa Khader**

**Corrector: Shahd Alahmad**

**Doctor: Malik Sallam**



# Infections of the bones and joints

Malik Sallam, MD, PhD

1. 📢 Anything between brackets and in this color ( **LIKE THIS** ) is what Dr said during the lec .
2. 📢 There are tables that summarize what the doctor said and are based on the questions of the activities. Good Luck ! 🙌🙌
3. 📢 U'll see at the end of slides, the solutions of this lec's activity, CHECK IT ! The exam questions will be similar ( يفضل تلقي نظرة عليهم الآن )
4. 😎 KEEP GOING , this too shall pass .. Isn't it ?

# Infections of the bones and joints

- Infections of the bones and joints include **osteomyelitis** and **septic arthritis**.
- **Osteomyelitis** is an infection of the bone and includes the periosteum, medullary cavity, and cortical bone.
- **Septic arthritis** is an infection of the surface of the cartilage that lines the joint and the synovial fluid that lubricates the joint.
- *Staphylococcus aureus* is the **most common cause** of infection in both diseases.
- Children and elderly adults (and Injection drug users and Diabetics) are more likely to contract osteomyelitis and septic arthritis. **Children** usually develop osteomyelitis of the **long bones**, and **elderly** persons usually develop osteomyelitis of the **vertebral body** in the **lumbar** region of the spine.

# Infections of the bones and joints

- Two different types of arthritis are associated with microbial infections: 1. reactive arthritis and 2. septic (infectious) arthritis.
- Reactive arthritis is a sterile inflammatory process in the joint and can occur following a bacterial infection at a distant site in the body. (Indirect effect)
- Reactive arthritis (Reiter syndrome) results in **asymmetrical polyarthritis** (e.g., ankles, knees, feet, and sacroiliitis). The most **common cause** of this type of arthritis is ***Chlamydia trachomatis***. However, *Campylobacter jejuni*, *Yersinia enterocolitica*, *Shigella*, or *Salmonella*, can all cause reactive arthritis. It occurs more commonly in patients with **HLA-B27**. (genetic risk factor)

# Infections of the bones and joints

- Septic arthritis are mostly caused by bacteria.
- *S. aureus* is the **most common** cause of septic arthritis, which is more commonly seen in children and in elderly adults. Patients usually present with a triad of fever, joint pain, and impaired range of motion.
- Unlike osteomyelitis, septic arthritis can rapidly cause permanent damage to the joint and disability for the patient if not treated quickly and aggressively.

# 1. Osteomyelitis

- A progressive infection that can include one or multiple parts of the bone (e.g., periosteum, medullary cavity, and cortical bone).
- It is usually a subacute to chronic infection( in opposite septic arthritis which is usually Acute ) that can cause severe disability if not properly treated.
- If untreated, the disease progresses from inflammatory destruction of bone to necrosis, followed by new bone formation.

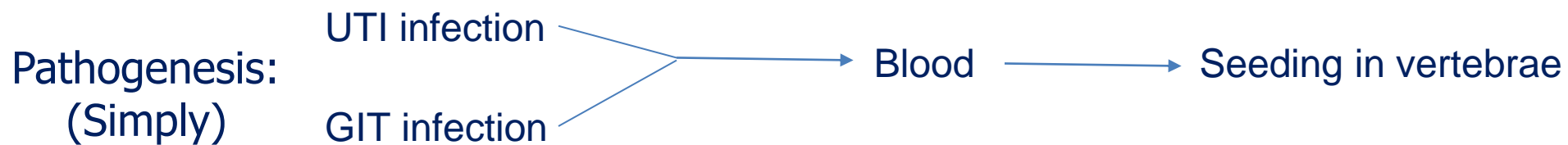
# Etiology of osteomyelitis

Common cause of all age groups: Staph. Aureus!

Profile	Common causes
Infants	<i>Staphylococcus aureus</i> , <i>Streptococcus agalactiae</i> (group B Streptococcus), <i>Escherichia coli</i>
Children (1-16 years)	<i>S. aureus</i> , <i>Streptococcus pyogenes</i> (group A Streptococcus), <i>Haemophilus influenzae</i>
>16 years	<i>S. aureus</i> , coagulase-negative staphylococci (e.g., <i>Staphylococcus epidermidis</i> ), gram-negative bacilli (e.g., <i>E. coli</i> , <i>Pseudomonas</i> , <i>Serratia</i> )
Diabetic foot	<i>S. aureus</i> , <i>Streptococci</i> , <i>Enterococcus</i> , gram-negative bacilli (e.g., <i>Proteus mirabilis</i> , <i>Pseudomonas</i> ), anaerobes (e.g., <i>Prevotella</i> , <i>Bacteroides</i> , <i>Fusobacterium</i> , <i>Peptostreptococcus</i> )

# Osteomyelitis

- Elderly persons are more frequently infected with *S. aureus* and gram-negative, rod-shaped bacteria (e.g., *E. coli*, *Pseudomonas aeruginosa*, *Serratia marcescens*), and are more likely to develop gram-negative infections of the bloodstream following diverticulitis (infection in GI), acute prostatitis, and urinary tract infections.
- These organisms are also more likely to seed vertebrae in the lumbar region of the spine causing vertebral osteomyelitis.





# Osteomyelitis

- **Intravenous drug users** are more likely to acquire *P. aeruginosa* infections of the **cervical** vertebrae.
- Osteomyelitis in patients with **Sickle cell disease** is most likely due to *S. aureus* and **Salmonella**.
- Infections of prosthetic joints are most commonly due to **coagulase-negative Staphylococcus** (e.g., *S. epidermidis*) and the second most common cause of these infections is *S. aureus*.

# Osteomyelitis - Clinical manifestations

- The onset of symptoms of acute osteomyelitis can occur within 1-2 days, or symptoms of chronic osteomyelitis can take weeks to months to develop.
- **Children** are more likely to develop acute **long bone** osteomyelitis, which manifests with symptoms of chills, fever, and malaise. There is usually pain and localized swelling and redness over the site of infection in the bone and guarding of the body part.
- **Elderly** persons are more likely to develop subacute or **chronic vertebral osteomyelitis**, and usually present with localized lower back pain and tenderness with fever.

# Osteomyelitis - Epidemiology

- Acute hematogenous osteomyelitis occurs most commonly in children and usually results in a single site of infection that involves the metaphysis of the long bones (e.g., tibia, femur, and humerus).
- Osteomyelitis in adults usually involves the vertebral bodies. The lumbar vertebrae are most affected, followed by the thoracic vertebrae, and rarely the cervical vertebrae.
- Intravenous drug users are more likely to develop vertebral infections in the cervical vertebrae.

# Osteomyelitis - Pathogenesis

- The most common site of osteomyelitis by hematogenous spread in adults is the vertebrae, which contain small arteriolar vessels that trap bacteria in the vertebral body.
- A plexus of veins lacking valves, called Batson plexus, surrounds the vertebrae and drains the bladder and pelvic regions.
- As adults age, they are more likely to develop infections of the urinary tract (e.g., cystitis, prostatitis) that are most caused by *E. coli*, a gram-negative coliform, among other gram-negative coliforms causing UTI. These bacteria travel from the urinary tract to the vertebral bodies via Batson plexus and infect the vertebrae.

Read Only

# Osteomyelitis - Diagnosis

- In both acute and chronic osteomyelitis, the erythrocyte sedimentation rate is usually elevated.
- C-reactive protein levels are also elevated in acute and chronic conditions.
- Osteomyelitis is usually diagnosed using **imaging studies** (most important) that include plane film radiographs, CT scans, and **MRI**.
- Because MRI is more sensitive than plane films or CT scans, it can be used much earlier in the disease process to detect abnormalities.
- Two or three blood cultures may be useful in determining the cause of the infection.

الدكتور ذكر من هاي السلايد فقط إنه الاعتماد الأكبر على

MRI More than CT Scan

وإنه بنقدر نعمل Blood culture

# Osteomyelitis - Treatment and Prevention


There are three important steps to treating osteomyelitis in adults.

1. An **adequate sample collected** deep in the infected tissue should be obtained for culture and histopathology.
2. A specific **antimicrobial regimen should be designed** for the patient.
3. Surgery usually is **not** needed in the treatment of **acute** hematogenous osteomyelitis; however, **antibiotic treatment** for 4-6 weeks is required. Patients with **chronic** osteomyelitis usually **require** surgery.

# Osteomyelitis - Treatment and Prevention

- A patient with osteomyelitis due to methicillin-sensitive *S. aureus* can be treated with nafcillin or oxacillin. However, if the infection is due to methicillin-resistant *S. aureus* (MRSA), vancomycin should be given.
- Streptococcus infections can be treated with penicillin G.
- If the osteomyelitis is due to *Serratia* or *Pseudomonas*, piperacillin-tazobactam and gentamicin can be used. If anaerobic bacteria are the cause of osteomyelitis, clindamycin or metronidazole should be given.

# Osteomyelitis

Features	Etiology	Clinical manifestation	
<p>1. A progressive infection that can include one or multiple parts of the bone</p> <p>2. a subacute to chronic infection =severe disability if not treated</p>	<ul style="list-style-type: none"> <li>• Staphylococcus aureus is the most common cause of infection</li> <li>• prosthetic joints= <b>Staphylococcus epidermidis</b></li> <li>• sickle cell disease = S. aureus and  <b>Salmonella.</b></li> <li>• Intravenous drug users= P. aeruginosa</li> </ul>	<p>Acute:</p> <ul style="list-style-type: none"> <li>• 1-2 days</li> <li>• Children</li> <li>• Long bones</li> <li>• Symptoms: chills, fever, and malaise.</li> </ul>	<p>Chronic:</p> <ul style="list-style-type: none"> <li>• weeks to months</li> <li>• Elderly</li> <li>• develop subacute or chronic <b>vertebral</b> osteomyelitis</li> <li>• Symptoms: localized lower back pain +tenderness+ fever</li> </ul>
Treatment		Epidemiology & Pathogenesis	Diagnosis
<p>3 important steps to treating osteomyelitis in adults:</p> <ol style="list-style-type: none"> <li>1. Sample collection</li> <li>2. Antimicrobial regimen</li> <li>3. Surgery: <ul style="list-style-type: none"> <li><input type="checkbox"/> acute: no need ✕, antibiotic is needed: 4-6 weeks</li> <li><input type="checkbox"/> chronic: required ✓</li> </ul> </li> </ol>	<p>• Antibiotics:</p> <p>A patient with osteomyelitis:</p> <ol style="list-style-type: none"> <li>1. methicillin-sensitive S. aureus= nafcillin or oxacillin.</li> <li>2. Resistant(MRSA)= vancomycin</li> <li>3. Streptococcus infections= penicillin G.</li> <li>4. Serratia or Pseudomonas= gentamicin</li> <li>5. anaerobic bacteria =clindamycin</li> </ol>	<ul style="list-style-type: none"> <li>• Acute hematogenous osteomyelitis occurs most commonly in children</li> <li>• Osteomyelitis in adults usually involves the vertebral bodies. The lumbar vertebrae are most affected</li> <li>• The most common site of osteomyelitis by hematogenous spread in adults is the vertebrae</li> </ul>	<ul style="list-style-type: none"> <li>✓ In both acute and chronic osteomyelitis: erythrocyte sedimentation ↑, C-reactive protein levels ↑</li> <li>✓ diagnosed using imaging studies that include plane film radiographs, CT scans, and <b>MRI.</b></li> </ul>



# Septic Arthritis

---

- Viruses, fungi, and bacteria can all cause infectious arthritis.
- Bacterial infectious arthritis causes the most injury.
- **Bacterial** (septic) arthritis is a serious infection, and if not treated quickly, can result in significant **permanent damage** to the joint and disability.



# Septic Arthritis - Etiology

- *S. aureus* is the most common cause of septic arthritis in patients of all ages.
- There are two major classes of septic arthritis: gonococcal and non- gonococcal arthritis. *S. aureus* is the most common cause of non- gonococcal arthritis, and *Neisseria gonorrhoeae* is the most common cause of gonococcal arthritis in sexually active young adults.
- Gram-negative bacilli are more likely to cause septic arthritis (e.g., *E. coli*, *Proteus*, and *Serratia*) in the elderly.
- *Streptococci* (e.g., viridans Streptococci, *S. pneumoniae*, and *S. agalactiae*) accounts for 20% of cases of septic arthritis.
- Infections with anaerobic organisms usually are a consequence of trauma or of abdominal infection.

# Septic Arthritis - Clinical Manifestations

- Patients with non-gonococcal septic arthritis usually present with the triad of **fever, joint pain, and impaired range of motion**.
- Most patients with **non**gonococcal septic arthritis present with pain and swelling in a **single joint**.
- **Polyarticular** arthritis is commonly seen in **gonococcal** septic arthritis, which is primarily an infection of sexually active young adults and teenagers.
- In **gonococcal** septic arthritis, skin lesions evolve over a few days from papular to pustular or vesicular to necrotic.

# Septic Arthritis - Epidemiology

- Most cases occur in young, old, and among IDUs (Injection drug users).
- In gonococcal joint infection, the mortality rate is low. In septic arthritis due to *S. aureus*, the mortality rate can reach 50%.
- In adults, the knee is the most infected joint, followed by the hip, shoulder, ankle, and wrists; in children, the hip joint is most affected, followed by the knee.
- Almost all cases of non-gonococcal arthritis are monoarticular. Polyarticular arthritis usually is observed in patients with gonococcal septic arthritis.
- Nearly 50% of patients who develop septic arthritis have an underlying chronic joint disease (e.g., rheumatoid arthritis, osteoarthritis).
- Gonococcal septic arthritis is more likely to occur in females.

# Septic Arthritis - Pathogenesis

- Organisms can enter the joint by direct inoculation, contiguous spread from infected periarticular tissue, or by bacteremia. However, the most common route of infection is following bacteremia.
- **Causes** of bacteremia leading to septic arthritis include **UTI, IDU, intravenous catheters, endocarditis, and soft tissue infections**. Some bacteria have surface factors that promote their adherence to the joint (**associated with intravenous catheters**).
- In patients with osteomyelitis, the arteriolar anastomosis between the epiphysis and the synovium allows the organisms to spread into the joint space.

# Septic Arthritis - Pathogenesis

المطلوب من هاي السلايد هو المخطط بالأصفر

- Damage of joint cartilage is the major debilitating result of septic arthritis.
- Bacterial growth in the joint causes an acute inflammatory reaction that results in infiltration of polymorphonuclear (PMN) leukocytes.
- Injury to joint cartilage is due to the synthesis of cytokines and inflammatory products produced by the polymorphonuclear leukocytes and bacterial production of factors such as chondrocyte proteases of *S. aureus*, which cause joint damage.

# Septic Arthritis - Pathogenesis

- Most joint injury may be caused by the cytokines and inflammatory products produced by the polymorphonuclear leukocytes. Infection with *N. gonorrhoeae* induces a relatively mild influx of polymorphonuclear leukocytes into the joint; thus, minimal joint destruction is usually observed in infections with this organism.
- In *S. aureus* infections, a significant number of polymorphonuclear leukocytes are recruited to the joint resulting in significant damage to the joint cartilage. Cartilage erosion eventually occurs at the lateral margins of the joint and causes significant cartilage damage followed by joint space narrowing. In untreated infections, significant damage to the joint can occur within 3 days.

Read Only

You only need to know that Most joint injury may be caused by the cytokines and inflammatory products produced by the polymorphonuclear leukocytes.

# Septic Arthritis - Diagnosis

- A critical laboratory test used to diagnose septic arthritis infections is analysis of the synovial fluid. A white blood cell count, gram stain smear, and culture of the synovial fluid are essential in determining the cause of septic arthritis.
- The most important use of synovial fluid analysis is to differentiate between non-inflammatory, inflammatory, and septic arthritis.
- Blood cultures should also be obtained and are useful in a significant number of cases. In cases of gonococcal septic arthritis, pharyngeal, rectal, cervical, or urethral specimens should be placed on Thayer-Martin plates. (To culture Neisseria gonorrhoea)



# Septic Arthritis - Diagnosis

لمطلوب من الجدول هو فكرة عامة عن اهمية استخدام Synovial fluid في الوصول لتشخيص مناسب"، عليه سؤال بالآكتفتي بسلايد 31

<i>Feature</i>	<b>Normal</b>	<b>Septic arthritis (SA)</b>	<b>Non-inf arthritis</b>	<b>Inf arthritis</b>
<i>Clarity and color</i>	Clear	<b>Opaque</b> , yellow to green	Clear, yellow	Translucent, yellow, or opalescent
<i>Viscosity</i>	High	Variable	High	Low
<i>White blood cells/mm<sup>3</sup></i>	<200	<b>&gt;100,000</b>	200-2000	2000-10,000
<i>% PMN</i>	<25%	<b>&gt;75%</b>	<25%	>50%
<i>Total protein g/dL</i>	1-2	3-5	1-3	3-5
<i>Glucose concentration relative to blood</i>	Nearly equal	<25%	Nearly equal	50-80%
<i>Culture</i>	Negative	Positive in non-gonococcal arthritis; usually negative in gonococcal arthritis	<b>Negative</b>	<b>Negative</b>
<i>Disease</i>	NL	SA	Osteoarthritis, trauma to joint	Rheumatoid arthritis, Reiter disease, Gout, Acute rheumatic fever

# Septic Arthritis - Treatment and Prevention

- Treatment of **non-gonococcal** septic arthritis involves two essential components. First 1<sup>st</sup>, purulent exudate should be **completely drained** and washed by arthroscopy or **surgery**. Second 2<sup>nd</sup>, an appropriate **antibiotic** based on gram stain smear, culture results, and clinical presentation should be **administered intravenously**.
- Antimicrobial treatment for non-gonococcal septic arthritis is **3-4 weeks** as opposed to 4-6 weeks for osteomyelitis. Even with appropriate treatment, **one third** of patients with non-gonococcal septic arthritis **suffer significant joint damage**. Elderly patients, patients with pre-existing chronic joint disease, and patients with prosthetic joints are more likely to have adverse outcomes. (لان)  
المفاصل عندهم اساساً فيها مشاكل )


# Septic Arthritis - Treatment and Prevention

- Treatment of gonococcal septic arthritis requires **complete drainage** and washing of the purulent synovial fluid from the joint and antibiotic therapy with intravenous ceftriaxone for 24-48 hours after clinical improvement.
- Oral cefixime, ciprofloxacin, ofloxacin, or levofloxacin should be used to complete a total of 7-10 days of therapy.
- Residual joint damage is unusual.
- **Prevention** of **non**-gonococcal arthritis involves **avoiding joint trauma** and appropriate and timely treatment of infections.
- **Prevention** of **gonococcal** arthritis involves **avoiding sex partners who have gonorrhea** and identifying and treating those with gonorrhea and practicing safe sex.

# Septic arthritis

Features	Etiology	Clinical manifestation	
<p>1. infection of the surface of the cartilage that lines the joint and the synovial fluid that lubricates the joint</p> <p>2. Reactive arthritis (Reiter syndrome): is a sterile inflammatory process in the joint and can occur following a bacterial infection at a distant site in the body</p>	<ul style="list-style-type: none"> <li>• <b>S. aureus</b> is the most common cause of infection.</li> </ul>	<p>Septic arthritis:</p> <ul style="list-style-type: none"> <li>• Patients usually present with a triad of <b>⚠ fever, joint pain, and impaired range of motion.</b></li> <li>• can rapidly cause <b>permanent damage to the joint</b></li> </ul>	<p>Reactive arthritis:</p> <ul style="list-style-type: none"> <li>• <b>asymmetrical polyarthritis</b></li> <li>• common cause= <i>Chlamydia trachomatis</i></li> <li>• in patients with <b>HLA-B27</b></li> </ul>
Epidemiology & Pathogenesis		Diagnosis	
<ul style="list-style-type: none"> <li>• In adults, the <b>knee</b> is the <b>most infected joint</b></li> <li>• in children, the hip joint is most affected</li> <li>• The most common site of osteomyelitis by hematogenous spread in adults is the vertebrae</li> <li>• Damage of joint cartilage is the major debilitating result of septic arthritis = <b>due to the synthesis of cytokines and inflammatory products</b></li> </ul>		<ul style="list-style-type: none"> <li>✓ <b>A critical laboratory test=</b> <b>⚠ analysis of the synovial fluid</b></li> <li>✓ Its use = to differentiate between non-inflammatory, inflammatory, and septic arthritis</li> <li>✓ Septic arthritis= has high WBCs, opaque and yellow color of synovial fluid.</li> </ul>	

Septic arthritis

Types	Etiology	Clinical Manifestations	Epidemiology	Pathogenesis	Diagnosis	Treatment & Prevention
non- gonococcal arthritis	<b><i>S. aureus</i></b> is the most common cause	<ul style="list-style-type: none"> <li>fever, joint pain, and impaired range of motion</li> <li>pain and swelling in a single joint.</li> <li>Monoarticular arthritis</li> </ul>	<ul style="list-style-type: none"> <li>the mortality rate can reach 50%.</li> <li>chronic joint disease</li> </ul>	<ul style="list-style-type: none"> <li>Damage of joint cartilage is the major debilitating result of septic arthritis.</li> <li>the most common route of infection is following bacteremia</li> <li>Causes: UTI, IDU, intravenous catheters, endocarditis, and soft tissue infections</li> </ul>	<ul style="list-style-type: none"> <li>analysis of the synovial fluid</li> </ul>	<ul style="list-style-type: none"> <li>First, purulent exudate should be completely drained by surgery.</li> <li>antibiotic be administered intravenously (3–4 weeks)</li> <li>Prevention: avoiding joint trauma</li> </ul>
gonococcal arthritis	<p>⚠ <b><i>Neisseria gonorrhoeae</i></b> is the most common cause in sexually active young adults</p>	<ul style="list-style-type: none"> <li>Polyarticular arthritis</li> <li>skin lesions from papular to pustular or vesicular to necrotic</li> </ul> 	<ul style="list-style-type: none"> <li>the mortality rate is low.</li> <li>more likely to occur in females</li> </ul>	<ul style="list-style-type: none"> <li>synthesis of cytokines and inflammatory products</li> </ul>	<ul style="list-style-type: none"> <li>Blood cultures: Thayer-Martin plates</li> </ul>	<ul style="list-style-type: none"> <li>complete drainage.</li> <li>intravenous ceftriaxone.</li> <li>Prevention: avoiding sex partners who have gonorrhea</li> </ul>

# Activity #7 Solutions ..

**Patients with septic arthritis usually present with the triad of:**

Fever, sore throat, and joint pain

Skin lesions, joint pain, and back pain

Skin lesions, joint pain, and lymphadenopathy

✓ Fever, joint pain, and impaired range of motion

**Osteomyelitis in patients with sickle cell disease is most likely due to:**

Neisseria gonorrhoea

Candida

Streptococcus pyogenes

✓ Salmonella

**The most common cause of osteomyelitis is:**

Pseudomonas aeruginosa

E. coli

Neisseria gonorrhoea

✓ Staphylococcus aureus

**A critical laboratory test used to diagnose septic arthritis infections is:**

Erythrocyte sedimentation rate

C reactive protein

Complete blood count

✓ Synovial fluid analysis

**In sexually active young adults, the most common cause of septic arthritis is:**

Pseudomonas aeruginosa

✓ Neisseria gonorrhoea

Streptococcus pyogenes

E. coli

## Additional Questions ( similar to activity )

Which microorganism is predominantly associated with the infection of bone and marrow, often referred to as osteomyelitis, especially in diverse patient populations ranging from children to the elderly and those with underlying conditions such as diabetes?“

- A) Pseudomonas aeruginosa
- B) E. coli
- C) Neisseria gonorrhoeae
- D) Staphylococcus aureus

Identifying the infectious agent in joint-related inflammatory conditions is crucial for appropriate management. Which diagnostic test is essential for determining the causative organism in septic arthritis?

- A) Erythrocyte sedimentation rate
- B) C-reactive protein
- C) Complete blood count
- D) Synovial fluid analysis



When considering osteomyelitis in individuals with hemoglobinopathies, particularly sickle cell disease, which organism is most frequently identified as the causative agent?

- A) Neisseria gonorrhoeae
- B) Candida
- C) Streptococcus pyogenes
- D) Salmonella

Which constellation of symptoms is commonly observed in individuals diagnosed with septic arthritis?

- A) Fever, sore throat, and joint pain
- B) Skin lesions, joint pain, and back pain
- C) Skin lesions, joint pain, and lymphadenopathy
- D) Fever, joint pain, and restricted joint movement

 **Answers : D D D D**

# Thanks for listening!

اللهم يسرنا ليسرى وجنّبنا العسرى واغفر لنا في الآخرة ✨

والأولى واجعلنا من أئمة المتقين :

وأخر وعوانا أن الحمد لله رب العالمين