Theoretical section – essential knowledge for every student:

1. List the defence mechanisms of the urinary tract.
2. Name the key microbial species colonizing the urethra.
3. Identify risk factors predisposing to urinary tract infection (UTI).
4. Describe the routes by which microorganisms can enter the urinary tract.
5. Which microorganisms cause UTIs? Classify them by microbial group (bacteria—Gram-positive and Gram-negative, viruses, fungi) and by frequency (common vs. rare causes).
6. UTI pathogens may exhibit what antimicrobial resistance mechanisms? In which UTI scenarios and patient populations should they be anticipated, and what are the therapeutic implications?
7. List antibiotics that can be used empirically to treat UTIs, and provide examples of UTI presentations appropriate for empirical therapy.
8. List antibiotics that should be used only based on susceptibility testing, explain why, and give examples of UTI presentations that should be treated only with culture-directed therapy.
9. Can UTIs be prevented? Provide examples of non-specific and specific prophylaxis.
10. Define significant bacteriuria. State the colony counts (CFU/mL) in 1 mL of urine that indicate UTI, according to the clinical syndrome.
11. Define asymptomatic bacteriuria. Does it require treatment? If yes, in whom and with which antibiotics? If no, in whom and why?
12. What are complicated UTIs? Which factors classify a case as complicated, and why? Please provide examples of complicated and uncomplicated UTIs and explain the differences between them.
13. Explain the terms: recurrent UTI, pyuria, sterile pyuria, hematuria, dysuria, urosepsis—link each term to an example UTI scenario (e.g., sterile pyuria accompanies UTIs caused by atypical bacteria, mycobacteria, etc.).
14. Identify microorganisms commonly associated with renal abscesses and pyonephrosis. How should such cases be diagnosed and treated? Do they require antimicrobial therapy?
15. Which microorganisms most often cause acute pyelonephritis? How should these infections be diagnosed and managed?
16. What is emphysematous pyelonephritis? Which patient groups are most commonly affected? What is the usual infectious etiology, and how should it be treated?
17. Which microorganisms are frequently associated with nephrolithiasis? Why these in particular? Which virulence factors predispose to stone formation? Outline the diagnosis and management of infection-associated stones.
18. Which UTIs in pregnant women may affect the fetus/newborn? Which pathogens most commonly cause UTIs in pregnancy, and which clinical forms do they present with? Which antibiotic classes are acceptable in pregnancy, which are contraindicated, and why?
19. Based on which clinical features should UTI be suspected in infants and young children (<5 years)? What is the most common etiology in this age group?
20. Which patient populations are most often affected by fungal UTIs? Which fungi are most commonly implicated? How are fungal UTIs diagnosed, and which drug classes are used for treatment?
21. Can viruses cause UTIs? If so, which viruses, which patient groups are typically involved, and are antiviral treatments available?
22. Why does urinary catheterization predispose to UTI? Explain the mechanisms. Which microorganisms are most frequently associated with catheter-related UTIs? What are the sources of catheter-colonizing microbes? Does catheter placement always lead to UTI—if not, when does it? How should catheter-associated UTI be treated in outpatients versus hospitalized patients?

Microbiological Diagnosis of Urinary Tract Infections (UTIs)

In patients whose clinical symptoms suggest a urinary tract infection (UTI), the primary biological specimen is a urine sample. In cases of UTIs with systemic manifestations, blood samples should also be collected for diagnostic purposes.

Indications for microbiological testing of urine

Urinalysis and urine culture should be performed in the following situations:
a) Suspected acute cystitis in individuals with risk factors
b) Suspected recurrent cystitis
c) Suspected acute or chronic pyelonephritis
d) Complicated forms of upper urinary tract infection and in men with prostatitis
e) In pregnant women, at each prenatal visit until delivery, to detect asymptomatic bacteriuria
f) In kidney transplant recipients
g) In patients with persistent clinical symptoms of infection following antibiotic therapy for UTI

Collection of Urine Specimens

1. Midstream urine

Midstream urine is the most commonly collected specimen for laboratory testing. The collection technique involves discarding the first portion of urine, which flushes out bacteria naturally present in the urethra, and collecting the subsequent portion into a sterile container. Ideally, the sample should be obtained from the first morning void after at least 8 hours of rest, or if not feasible, at least 4 hours after the previous urination. Before collection, the periurethral area should be carefully cleansed with warm water (without detergents or disinfectants) and dried with a disposable towel.

2. Catheterized urine

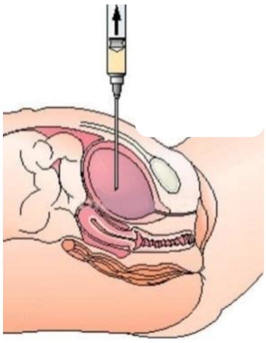
Urine for laboratory testing should always be collected through a newly inserted catheter, as indwelling catheters are rapidly colonized by bacteria that form biofilms. Catheterized specimens are indicated in selected situations, for example, in patients unable to provide a midstream urine sample due to urological or neurological conditions, including altered consciousness. Urine should never be collected from the drainage bag.

3. Suprapubic aspiration

Urine can also be obtained via suprapubic bladder aspiration, which provides a sterile specimen. This method is rarely performed in routine practice and is generally reserved for specific indications, such as in infants or when contamination-free specimens are essential.

3. Suprapubic bladder aspiration

The technique of suprapubic bladder aspiration enables the collection of urine specimens free from contamination with bacteria that colonize the urethra or urinary catheter. It is therefore particularly valuable when cultures obtained from catheterized or midstream urine specimens are unreliable. However, this method is invasive.



Suprapubic aspiration is most commonly performed in neonates, from whom obtaining clean and reliable urine samples is difficult, in cases of suspected urinary tract infection caused by anaerobic bacteria, or when urine collection by other means is not feasible.
The procedure involves disinfecting the skin over the bladder, followed by insertion of a sterile needle attached to a syringe directly into the bladder. The aspirated urine is then transferred into a sterile transport container after sealing the syringe outlet with a special cap.

Transport of Urine Samples to the Laboratory

Since urine is an excellent growth medium for bacteria, specimens should be delivered to the laboratory within 2 hours of collection. If immediate transport is not possible, the sample should be stored at 4 °C and transported under refrigeration within 4 hours. Alternatively, if refrigeration is not feasible, the sample may be secured on a transport-culture medium (e.g., Uricult) and transported at room temperature within 24 hours.

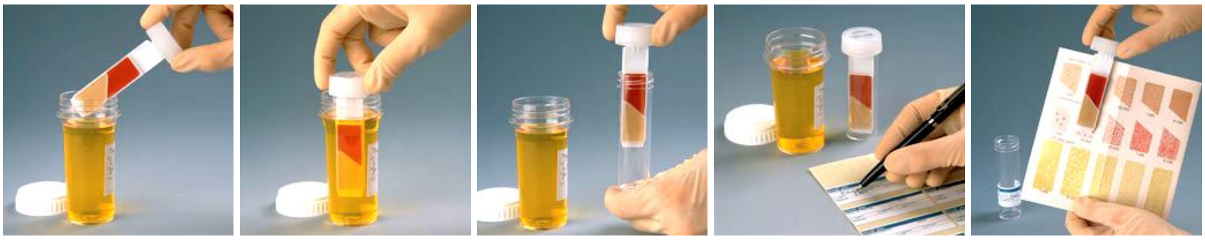
In young children, microbiological urine samples should be obtained after thorough cleansing of the periurethral area. The child should be held with the legs gently abducted, and a midstream urine sample should be collected directly into a sterile container. Special adhesive urine collection bags applied to the perineal skin are suitable for routine urinalysis but not for microbiological studies, as the urine is typically contaminated with bacteria from the perineal skin, urethra, and/or rectum.

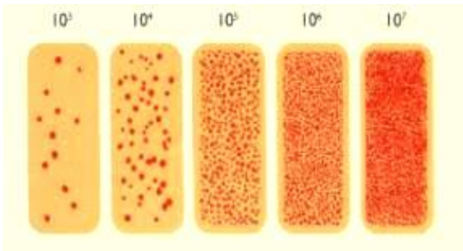
URICULT

URICULT is a system for urine collection, transport, and semi-quantitative culture, intended for use when transport of urine within 4 hours of collection is not feasible. A plastic paddle coated with bacteriological media is contained within a sterile, screw-capped plastic container. The paddle is double-sided: one side includes a medium selective for Gram-negative bacilli, and the other side a medium for Gram-positive cocci.

The procedure involves collecting urine into a sterile container, immersing the paddle in the urine sample, and then replacing it in its original container before dispatching it to the laboratory. Transport of URICULT does not require refrigeration.

In the laboratory, the URICULT device is incubated overnight at 37 °C, and the approximate bacterial count is determined by comparing the density of bacterial growth on the paddle's media. For the strains that grow, antimicrobial susceptibility testing and antibiogram determination can be performed subsequently.





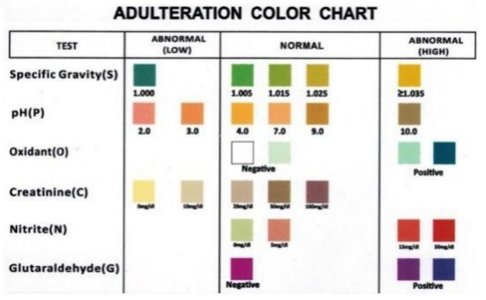
Directions of Routine Laboratory Testing of Urine:

a) Rapid screening tests – dipstick analysis of uncentrifuged urine (detection of leukocytes, nitrites, glucose, erythrocytes, urine pH, creatinine, etc.).
b) Urinalysis – urinary tract infection (UTI) is associated with increased numbers of bacteria, leukocytes, and/or nitrites.
c) Microbiological examination of urine – aerobic culture, pathogen identification, and antimicrobial susceptibility testing.

Rapid Tests in the Diagnosis of UTIs – General Urinalysis

These are dipstick tests that enable the detection of key parameters indicative of urinary tract infection (UTI). The test is intended for risk groups, such as children, in whom UTI is suspected based on medical history and/or physical examination. Urine dipstick testing should be regarded as a preliminary and screening method. The result of a dipstick test alone does not allow for a definitive diagnosis of UTI, nor does it exclude it.

A dipstick test can detect, among others:



a) Leukocyte esterase – a marker of pyuria.
b) Nitrites – a marker of bacteriuria (a negative result does not exclude bacteriuria, since not all bacteria produce nitrites, e.g., Staphylococcus saprophyticus, Enterococcus spp., and Pseudomonas aeruginosa).

Dipstick testing may also detect additional analytical parameters relevant to UTIs, such as glucose level, urine pH, erythrocytes, creatinine, etc.

Microbiological Examination of Urine
(Urine culture – the gold standard in the microbiological diagnosis of UTIs) is both a quantitative and qualitative test. It determines the presence and quantity of microorganisms in the examined urine sample, which is crucial for diagnosing UTIs. Additionally, it enables the assessment of the antibiotic susceptibility of isolated bacteria based on the antibiogram.

Technique of Quantitative Urine Culture
Quantitative urine culture is performed using calibrated inoculating loops: a large loop that delivers 0.01 ml of urine and a small loop that delivers 0.001 ml of urine.
Routinely, urine samples are inoculated onto one half of a MacConkey agar plate (MC, for Gram-negative rods) and one half of a blood agar plate (BA, for Gram-positive cocci). On one half of the medium, urine is inoculated using the large loop (0.01 mL), and on the other half, using the small loop (0.001 mL). The drop of urine applied to the agar surface is streaked in multiple directions with the loop to achieve optimal distribution of the material.
After overnight incubation, the number of bacterial colonies is counted on each half of the MC or BA plate. The number of colonies corresponds to the concentration of bacteria in the urine, expressed as colony-forming units (CFU) per millilitre (mL).
Example calculation:
Number of colonies × reciprocal of loop volume = CFU/ml
Large loop (0.01 ml; 10^2): 59 colonies → 59 × 100 = 5900 (≈ 6 × 10^3)
Small loop (0.001 ml; 10^3): 6 colonies → 6 × 1000 = 6000 (≈ 6 × 10^3)

Interpretation of Urine Culture Results
To determine whether bacteria isolated from urine cultures represent clinically significant etiologic agents of urinary tract infection (UTI) or contaminants originating from the urethra, the following criteria must be considered:

a) the method of urine sample collection,
b) the number of bacterial colonies grown in culture, expressed as CFU/ml of urine,
c) the number of bacterial species isolated (see below),
d) the species of bacteria recovered (commensal microbiota vs. potential pathogens) (see below).

Number of Bacterial Species
Approximately 95% of all urinary tract infections (UTIs) are caused by a single bacterial species, and it is doubtful that two different species are simultaneously responsible for infection. UTIS can't involve three distinct bacterial species. Therefore, the isolation of ≥2 species from a midstream urine specimen is generally regarded as contamination with urethral or skin microbiota and warrants repeat sampling.

Bacterial species such as Lactobacillus, viridans streptococci, and diphtheroids/coryneforms (except Corynebacterium urealyticum) are not causative agents of UTIs. Thus, they should not be considered in the diagnostic process (i.e., they should not be identified or tested for antibiotic susceptibility). They are regarded as contaminants originating from the urethra or skin, regardless of colony count.

Interpretation of Urine Cultures
The interpretation of urine culture results requires consideration of both the presence of microorganisms in the sample and the patient's clinical symptoms. A positive culture result alone is not sufficient to establish a diagnosis or to initiate treatment.

Bacterial and fungal UTIs are generally accompanied by leukocyturia (pyuria); therefore, a positive urine culture in the absence of pyuria most likely represents contamination. Exceptions to this rule, along with detailed guidelines for interpreting urine cultures, are presented in the table below.

Pyuria	Urine culture	Interpretation
Positive pyuria	Positive, with a bacterial count ≥10^5 CFU/ml One bacterial species	UTI
Positive pyuria	Positive culture, but with a bacterial count below the threshold for significant bacteriuria	UTI should be considered in the following situations: ➢ Urine sample obtained by suprapubic aspiration or catheterization ➢ Patient with glomerulonephritis ➢ Patient with prostatitis or orchitis ➢ Urethritis ➢ Fungal urinary tract infection ➢ Patient receiving antibiotic therapy (positive Gold test) ➢ Immunocompromised individuals ➢ Patients presenting with symptoms of acute or recurrent cystitis: women, pregnant women, children, and men with pyuria, as well as patients with complicated UTIs
Positive pyuria	negative	UTI should be considered in the following situations: ➢ Interstitial nephritis/cystitis ➢ Infection caused by atypical or demanding microorganisms (tubular syndrome), such as Mycobacterium tuberculosis and atypical mycobacteria, Chlamydia trachomatis, Mycoplasma spp., Ureaplasma spp., Corynebacterium urealyticum, fungi (Candida spp.), and viruses (BK virus, adenovirus, CMV) ➢ Pregnant women ➢ Patients with neutropenia, diabetes, kidney transplantation, or anatomical abnormalities of the urinary tract
Negative pyuria	Positive ≥2 bacterial species	contamination
Negative pyuria	Negative	Non-infectious etiology of urinary tract disease

*** Atypical bacteria from the genera Chlamydia, Mycoplasma, and Ureaplasma do not cause urinary tract infections** (UTIs). However, they may be responsible for urethritis (also known as urethral syndrome, classified as a sexually transmitted disease), whose symptoms can resemble those of UTIs, such as urinary urgency, dysuria, and burning sensations in the urethra.

CRITERIA FOR DIAGNOSING URINARY TRACT INFECTION (UTI) IN PATIENTS WITH CLINICAL SYMPTOMS OF UTI:

≥10^3 CFU/ml in midstream urine from premenopausal, nonpregnant women with acute cystitis
≥10^3 CFU/ml in midstream urine from men with acute UTI
≥10^4 CFU/ml in midstream urine from women with acute, uncomplicated pyelonephritis
≥10^5 CFU/ml in midstream urine from women with recurrent uncomplicated UTI
≥10^3 CFU/ml in urine obtained through a freshly inserted catheter from patients undergoing continuous or intermittent catheterization who present with symptoms of UTI

Asymptomatic bacteriuria requires treatment in pregnant women (as well as in patients before urological procedures or transurethral resection of the prostate) and subsequent close monitoring due to the risk of developing pyelonephritis, preterm delivery, and hypertension. Given the increasing antibiotic resistance of bacteria, the diagnostic criteria for asymptomatic bacteriuria must be strictly observed. In patient groups other than those mentioned above, this condition does not require treatment.

CRITERIA FOR THE DIAGNOSIS OF ASYMPTOMATIC BACTERIURIA
a) ≥10^5 CFU/ml in two consecutive midstream urine samples obtained from a woman.
b) ≥10^5 CFU/ml in a single midstream urine sample obtained from a man.
c) ≥10^2 CFU/ml in a urine sample obtained via a freshly inserted catheter from either a woman or a man.
d) ≥10^5 CFU/ml in a urine sample obtained via a freshly inserted catheter from patients with continuous or intermittent catheterization.

Routine follow-up urine cultures after treatment of UTI are not recommended.
However, follow-up urine culture is advised in the following cases:
a) Patients with persistent symptoms of UTI.
b) 1–2 weeks after completion of therapy in pregnant women and in patients at high risk of renal damage, even in the absence of clinical symptoms of infection (e.g., after urological procedures, kidney transplantation).

Gold Test – detection of growth-inhibiting factors in urine culture
The Gold test is not a separate diagnostic procedure, but rather an integral component of every urine culture. It enables the detection of antibacterial substances derived, for example, from the diet, administered medications, or other sources, that may interfere with bacterial growth.
A positive Gold test supports the diagnosis of UTI, even when the bacterial count in urine is below the conventional threshold of significant bacteriuria.
The test employs two reference bacterial strains that are highly susceptible to all antibiotics and antibacterial substances:
Staphylococcus aureus ATCC 25923 (representing Gram-positive cocci),
Escherichia coli ATCC 25922 (representing Gram-negative bacilli).
Method: A sterile paper disk is soaked in the patient's urine and placed on an agar plate inoculated with the reference strains. The presence of an inhibition zone around the urine-soaked disk indicates the presence of a substance in the tested urine sample that suppresses the growth of either Gram-negative or Gram-positive bacteria, respectively.

II. PRACTICAL PART

I. Urine cultures

1. Perform a urine culture in a 25-year-old pregnant woman with symptoms of acute uncomplicated cystitis.
Inoculate the urine sample using calibrated loops onto:
a) ½ of a blood agar (BA) plate using the small loop (0.001 ml), and ½ of a BA plate using the large loop (0.01 ml)
b) ½ of a MacConkey agar (MC) plate using the small loop (0.001 ml), and ½ of an MC plate using the large loop (0.01 ml).

Label the agar plates with your initials, package them appropriately, and place them in the incubator. The plates will be incubated overnight. The following morning, they will be removed from the incubator and stored in a refrigerator (at refrigerator temperature, bacterial growth is inhibited, so the number of colonies will not change until the next class).

During the next session, examine the cultures in both media:

1. Assess how many different colony types have grown. On MacConkey agar, determine whether the colonies are lactose-fermenting (lactose-positive) or non–lactose–fermenting (lactose-negative).
2. Count the colonies on one plate (if growth is present on MacConkey agar, count colonies on this medium). Multiply the number of colonies by the inverse of the loop volume used:

small loop (0.001 ml) = multiplier 1000
large loop (0.01 ml) = multiplier 100
Record your results:

a) Type(s) of colonies observed: ……………………..…………………………………………………………….
b) Number of bacterial colonies: …………………………….. and …………………………………CFU/ml

Based on the Gram-stained preparation of the bacterial colonies grown in culture and their appearance on the agar plates, assess which bacterial species may be responsible for the presented case of urinary tract infection (UTI).
a) Gram staining: ………………………………………………..
b) Colony morphology (lactose-fermenting or non-lactose-fermenting on MacConkey agar, hemolysis pattern on blood agar): ……………………………………………………………….
c) Presumptive species/group of bacteria: ………………………………………………………………..
Does the number and type of bacteria isolated from the urine sample meet the diagnostic criteria for UTI in this case? ………………………………………………………………………………

If the number and type of bacteria per 1 mL of urine meet the criteria for the diagnosis of a urinary tract infection (UTI), which groups of antibiotics may be used in this specific case? What factors should be taken into account when selecting the antibiotic? In this clinical scenario, should resistance of the isolated bacteria to antibiotics be anticipated? If so, which resistance mechanisms might be involved? Provide examples
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Insert the species or genera of microorganisms that cause urinary tract infections (UTIs) in outpatients into the table. Underline those species whose micro- and macroscopic features correspond to the bacteria isolated in the urine culture from the pregnant patient.

Common (typical) pathogens of community-acquired urinary tract infections	Less common pathogens of community-acquired urinary tract infections	

2. Perform a urine culture (according to the description above) from a 73-year-old hospitalized male patient who, following hip replacement surgery (immobilized in bed), had a urinary catheter inserted. After one additional week of hospitalization, the patient developed clinical symptoms suggestive of a urinary tract infection (UTI).
Inoculate the urine sample using calibrated loops onto:

a) ½ of a blood agar (BA) plate using the small loop (0.001 ml), and ½ of a BA plate using the large loop (0.01 ml)
b) ½ of a MacConkey agar (MC) plate using the small loop (0.001 ml), and ½ of an MC plate using the large loop (0.01 ml).
Label the agar plates with your initials, package them appropriately, and place them in the incubator.
The plates will be incubated overnight. The following morning, they will be removed from the incubator and stored in a refrigerator (at refrigerator temperature, bacterial growth is inhibited, so the number of colonies will not change until the next class).

During the next class session, examine the cultures in both media:

1. Assess how many different types of colonies have grown (determine whether they are lactose-positive or lactose-negative on MC).

2. Count the colonies on one of the plates (if there is growth on MC, count the colonies from this medium). Multiply the number of colonies by the inverse of the loop volume used:
small loop (0.001 ml) = multiplier 1000
large loop (0.01 ml) = multiplier 100
Record your results:

a) Type(s) of colonies observed: …………………………………………………………….
b) Number of bacterial colonies: ……………………………… and ……………………………….CFU/ml

Based on the Gram-stained preparation of the bacterial colonies grown in culture and their appearance on the agar plates, assess which bacterial species may be responsible for the presented case of urinary tract infection (UTI).
a) Gram staining: ………………………………………………..
b) Colony morphology (lactose-fermenting or non-lactose-fermenting on MacConkey agar, hemolysis pattern on blood agar): ……………………………………………………………..
c) Presumptive species/group of bacteria: ……………………………………………………………..
Does the number and type of bacteria isolated from the urine sample meet the diagnostic criteria for UTI in this case? Should additional diagnostic tests be performed in this case? If so, which ones?
……….
……….
……….

If the number and type of bacteria per 1 mL of urine meet the criteria for the diagnosis of a urinary tract infection (UTI), which groups of antibiotics may be used in this specific case? What factors should be taken into account when selecting the antibiotic? In this clinical scenario, should resistance of the isolated bacteria to antibiotics be anticipated? If so, which resistance mechanisms might be involved? Provide examples
……….
……….
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Insert the species or genus of microorganisms responsible for urinary tract infections (UTIs) in hospitalized patients with indwelling urinary catheters into the table. Underline those species whose micro- and macroscopic characteristics match those of the bacteria isolated in the urine culture of the catheterized patient.

Common (typical) pathogens of community-acquired urinary tract infections	**Less common pathogens of community-acquired urinary tract infections**	

3.

Perform a urine culture (according to the procedure described above) of a 34-year-old woman with uncontrolled diabetes who presented to her primary care physician with symptoms of cystitis (painful urinary urgency and urethral burning). The patient has a history of recurrent cystitis—this is her third episode within the past 6 months. Each episode was treated with a 5-day course of antibiotics.

The routine urine culture (plated on MacConkey agar [MC] and blood agar [BA]) showed no bacterial growth. Consequently, the patient was instructed to provide a repeat urine sample for investigation of fungal pathogens.

Inoculate the urine sample onto Sabourand medium using a large loop. Label the plate with your initials, package it appropriately, and place it in the incubator. The plates will be incubated overnight. The following morning, they will be removed from the incubator and stored in a refrigerator (at refrigerator temperature, bacterial growth is inhibited, so the number of colonies will not change until the next class).

At the next class session, examine the culture on Sabourand agar.

Record your results:

a) Type(s) of colonies observed: ……………………………………………………………………………

Based on the Gram-stained preparation of the bacterial colonies grown in culture and their appearance on the Sabourand agar, assess which microbial species may be responsible for the presented case of urinary tract infection (UTI).

a) Gram staining: ………..

b) Colony morphology: …………………………………………………………………………………………………….

c) Presumptive species/group of microorganisms: ……………………………………………………………………………..

Does the number and type of microorganisms isolated from the urine sample meet the diagnostic criteria for UTI in this case? Explain why and indicate further diagnostic procedures:

……

……

……

Which groups of antimicrobial agents can be used in this specific case? What factors should be taken into account when selecting treatment? Should drug resistance be anticipated in this clinical scenario?

……

……

What risk factors for urinary tract infection of this etiology are present in this patient's case?

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4. Perform a urine culture from a 63-year-old hospitalized patient with post-influenza pneumococcal pneumonia, who had been treated with cefotaxime and subsequently developed typical symptoms of acute pyelonephritis during antibiotic therapy.

Inoculate the urine sample using calibrated loops onto:

a) ½ of a blood agar (BA) plate using the small loop (0.001 ml), and ½ of a BA plate using the large loop (0.01 ml)

b) ½ of a MacConkey agar (MC) plate using the small loop (0.001 ml), and ½ of an MC plate using the large loop (0.01 ml).
Label the agar plates with your initials, package them appropriately, and place them in the incubator. The plates will be incubated overnight. The following morning, they will be removed from the incubator and stored in a refrigerator (at refrigerator temperature, bacterial growth is inhibited, so the number of colonies will not change until the next class).

During the next session, examine the cultures in both media:

3. Assess how many different colony types have grown. On MacConkey agar, determine whether the colonies are lactose-fermenting (lactose-positive) or non–lactose–fermenting (lactose-negative).
4. Count the colonies on one plate (if growth is present on MacConkey agar, count colonies on this medium). Multiply the number of colonies by the inverse of the loop volume used:

small loop (0.001 ml) = multiplier 1000
large loop (0.01 ml) = multiplier 100
Record your results:

c) Type(s) of colonies observed: …………………………………………………………………
d) Number of bacterial colonies: ……………………………… and ……………………………….CFU/ml

Based on the Gram-stained preparation of the bacterial colonies grown in culture and their appearance on the agar plates, assess which bacterial species may be responsible for the presented case of urinary tract infection (UTI).
a) Gram staining: ………..
b) Colony morphology (lactose-fermenting or non-lactose-fermenting on MacConkey agar, hemolysis pattern on blood agar): ……………………………………………………………………………………………………….
c) Presumptive species/group of bacteria: ……………………………………………………………………………..
Does the number and type of bacteria isolated from the urine sample meet the diagnostic criteria for UTI in this case? Explain why and indicate further diagnostic procedures:
……….
……….
……….

Which groups of antimicrobial agents can be used in this specific case? What factors should be considered in antibiotic therapy when a patient has a history of prior treatment with cefotaxime? Could this treatment have influenced the development of the UTI? If so, in what way? Justify your answer.
……….
……….
……….
In this clinical case, should resistance of the isolated bacteria to antibiotics be anticipated? If so, what type of resistance?
……….
……….
……….

III. ANALYSIS OF EXEMPLAR URINE TEST RESULTS

Case 1. From a 16-day-old newborn (outpatient) presenting with fever and hematuria, a midstream urine sample collected into a sterile container yielded the following culture results: a) Klebsiella pneumoniae 10^2 CFU/ml, b) Enterococcus 10^3 CFU/ml, c) Staphylococcus epidermidis 10^4 CFU/ml. Does the obtained urine culture result (type and number of bacteria) meet the criteria for the diagnosis of UTI? If YES – justify. If NO – indicate the reason and outline the following diagnostic steps
……….
……….
……….

Case 2. From a suprapubic urine sample obtained from a 20-day-old infant hospitalized for fever and hematuria, Klebsiella pneumoniae was isolated at a concentration of 10^2 CFU/ml. The strain demonstrated the following antibiotic susceptibility profile:

Amikacin – R
Amoxicillin/clavulanic acid – I
Cefotaxime – S
Ceftazidime – S
Gentamicin – R
Imipenem – S
Meropenem – S
Piperacillin/tazobactam – S

Answer the following questions and justify your responses:

Could the bacterial species isolated from the urine be responsible for a UTI in this patient?

………

Does the number of isolated bacteria meet the diagnostic criteria for UTI?

………

Which antibiotic from the susceptibility profile can be used for treatment, considering the patient's age and medical history?..

What resistance mechanism is most likely presented by the isolated strain? Justify your answer.

Rationale:

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Case 3. A 63-year-old man with an indwelling urinary catheter placed two weeks earlier, hospitalized in the ICU, developed fever and hematuria noted in the urine collection bag. A urine sample obtained via a newly inserted catheter was sent for laboratory testing. The culture yielded E. coli ESBL+ at 10^3 CFU/ml. The isolated strain demonstrated the following antibiotic susceptibility profile:

Amikacin – S
Amoxicillin/clavulanic acid – I
Ampicillin/sulbactam – I
Cefotaxime – R
Ceftazidime – S
Gentamicin – S
Imipenem – S
Meropenem – S
Piperacillin/tazobactam – S
TMP-SMX – R

Answer the following questions and justify your responses:

Is the isolation of an ESBL-positive strain from urine possible, and what does it indicate?

……

Can the bacterial species isolated from urine be responsible for UTI in this patient?

……

Does the number of isolated bacteria meet the criteria for diagnosing UTI?

……

Which antibiotic can be used for treatment, considering the patient's age and the resistance profile of the isolate? Which groups of antibiotics are excluded from therapy due to this resistance mechanism?

……

……

Case 4. A 34-year-old pregnant woman presented to her primary care physician with symptoms of urinary urgency and fever. She was prescribed oral TMP-SMX, but after two days her symptoms did not resolve, and she returned to the physician.

Was the prescribed antibiotic appropriate? Justify your answer.

………

What should be the recommended management for pregnant women with symptomatic UTI? Which microorganisms most commonly cause UTIs in this patient population?

………