

Surname	Centre Number	Candidate Number
First name(s)		4



LEVEL 3 DIPLOMA

4463U60-1



S23-4463U60-1

MONDAY, 5 JUNE 2023 – MORNING

MEDICAL SCIENCE

UNIT 6: Medical Case Study

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1–5	25	
6–11	25	
12–16	25	
Total	75	

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01

ADDITIONAL MATERIALS

You will need the Resource Folder.

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The total number of marks for this paper is 75.



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Case study 1: Age-Related Macular Degeneration (AMD)

Mark is an experienced designer who recently retired after celebrating his 62nd birthday.

Mark recalls, 'Towards the end of my career I struggled to focus and see the detail in many of the fabrics that I purchased. Sometimes I thought many of the colours in carpets or fabrics were too dull especially when I expected them to be brighter. As I had not had my eyes tested for a number of years I arranged an eye test with my local optician.'

The optician conducted the usual vision tests, performed some tonometry and used tropicamide in one of the tests. The optometrist was concerned with the results of the visual field test and referred him to an ophthalmologist.

Mark underwent an angiographic test of the eye, confirming that he was suffering the early stages of wet AMD. This explained his loss of colour perception and loss of vision.

The ophthalmologist gave Mark four intraocular injections of ranibizumab over 6 months. Recent follow up tests have shown that his AMD has not deteriorated.

Mark has also attended an outpatient support group which has given him some help in dealing with this condition and helped him plan for the future as he expects his AMD to worsen as he gets older.



Figure 1: The total number of common sight-threatening conditions in the UK in 2008 and 2018.

Sight-threatening condition	Total number of cases in 2008	Total number of cases in 2018
Wet AMD	415 000	516 000
Dry AMD	194 000	240 000
Glaucoma	266 000	561 000
Diabetic retinopathy	748 000	928 000
Diabetic maculopathy	188 000	236 000

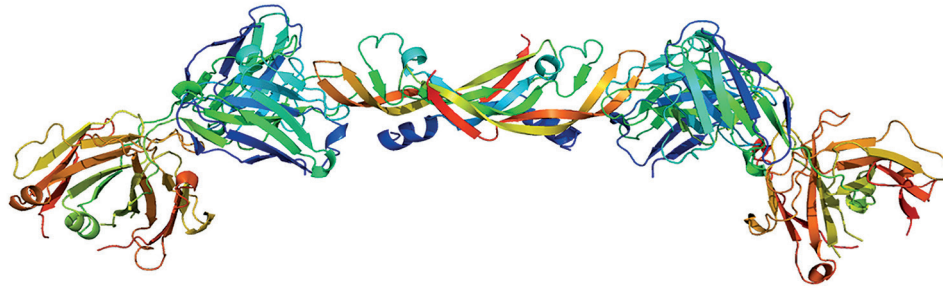
Figure 2: Cost of AMD drug therapy to the NHS.

Type of therapy	Drug used	Cost per treatment (£)	Number of treatments per year
Photodynamic therapy	verteporfin	890	Varies up to 6
Drug therapy	ranibizumab	551	8



Answer **all** questions.

1. In patients with AMD, there is over-production of a quaternary protein called vascular endothelial growth factor (VEGF). A quaternary structure is shown below.



- (a) (i) State what is meant by the term quaternary structure. [1]

.....

.....

- (ii) State **two** types of bond that would be found in a quaternary structure. [1]

1.

2.

- (b) Describe the effect of excess VEGF in the eye. [2]

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2. (a) Explain why the optometrist used eye drops containing tropicamide when examining Mark's eye. [2]

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- (b) The optometrist also carried out tonometry.

State what this test measures. [1]

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- (c) The ophthalmologist performed an angiographic test on Mark's eyes to determine the extent of the macular degeneration.

Describe the principles of this test.

[4]

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3. There is no cure for AMD, however drugs such as ranibizumab can treat the symptoms of AMD.

- (a) (i) Describe how ranibizumab treats the symptoms of AMD.

[2]

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- (ii) Give an advantage of administering this drug by intraocular injection.

[1]

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- (b) Photodynamic therapy can also be used to treat AMD.

Describe the principles of photodynamic therapy.

[3]

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4. **Figure 1** shows the total number of common sight-threatening conditions in the UK during 2008 and 2018.

- (a) Calculate the percentage of patients that suffer from both **dry** and **wet** AMD in **2018** from the total number of common sight-threatening conditions shown. [3]

percentage = ...

- (b) Calculate the percentage increase in patients suffering from **wet AMD** between 2008 and 2018. [2]

percentage increase = ...

- (c) Suggest a reason why there has been an increase in the numbers of patients suffering from wet AMD over the 10-year period. [1]

.....

5. **Figure 2** shows the cost of treating a patient with wet AMD to the NHS. Recently several doctors have used the anti-cancer drug Avastin to successfully treat patients with wet AMD.

Avastin treatment costs £168 per patient per year.

Calculate the **saving** per patient, per year to the NHS of using Avastin compared to ranibizumab. [2]

saving per patient per year = £



Case study 2: Kidney stones

Recently Steve had a high temperature and severe abdominal pain that came and went at different times of the day. He noticed that when he went to the toilet there was a small amount of blood in his urine.

Steve visited his GP who asked for a urine sample. The sample showed increased levels of uric acid and calcium. The GP suspected kidney stones and a bladder abnormality, so Steve was referred to the local hospital for further investigations.

After an examination and further blood and urine tests, he was sent to the day surgery unit where they performed some urodynamic studies. The urodynamic test results were normal, however the consultant still suspected that Steve had some kidney stones and he was prescribed tamsulosin.

Steve recalls, 'Within a day of taking the tamsulosin, and with plenty of fluids inside me, I needed to go to the toilet much more often. The stones passed out of me, but with some pain. Luckily, I haven't had any more episodes of abdominal pain and have felt well since they passed. I have taken the GP's advice of drinking more fluid during the day and now always carry a bottle of water with me.'



Compliance is a complex urodynamic test. It measures the changes in bladder volume and pressure. Compliance is expressed in millilitres per centimetre H₂O. Steve's bladder compliance results are shown in **Figure 3**.

Figure 3: Steve's bladder compliance.

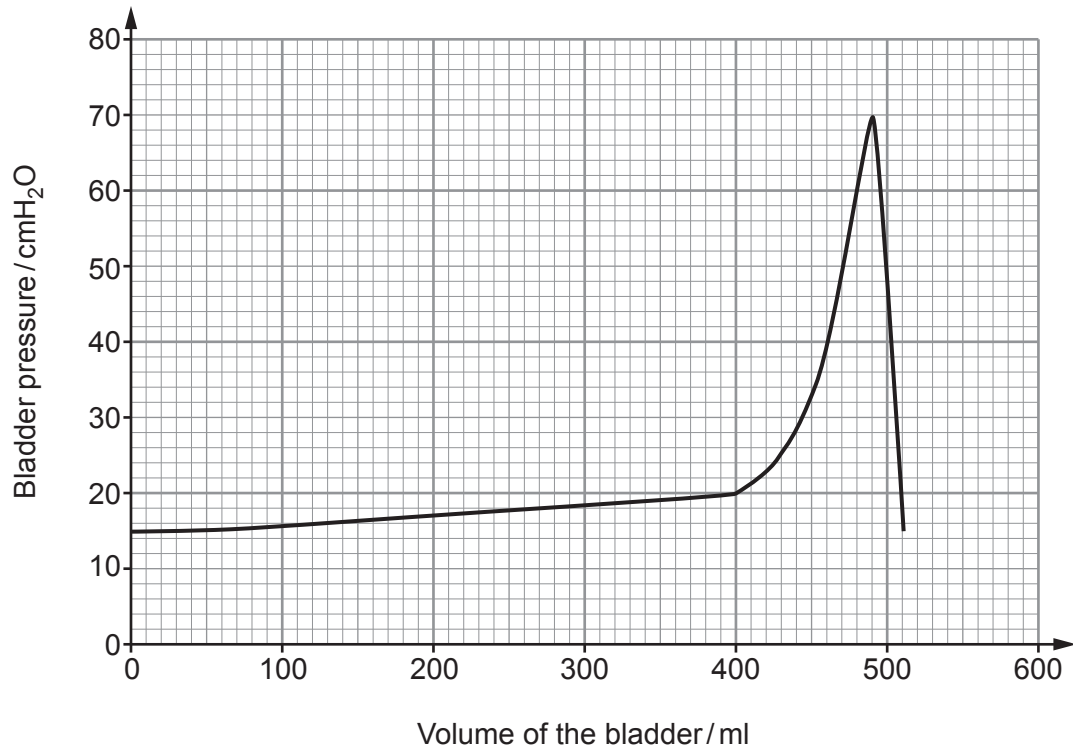
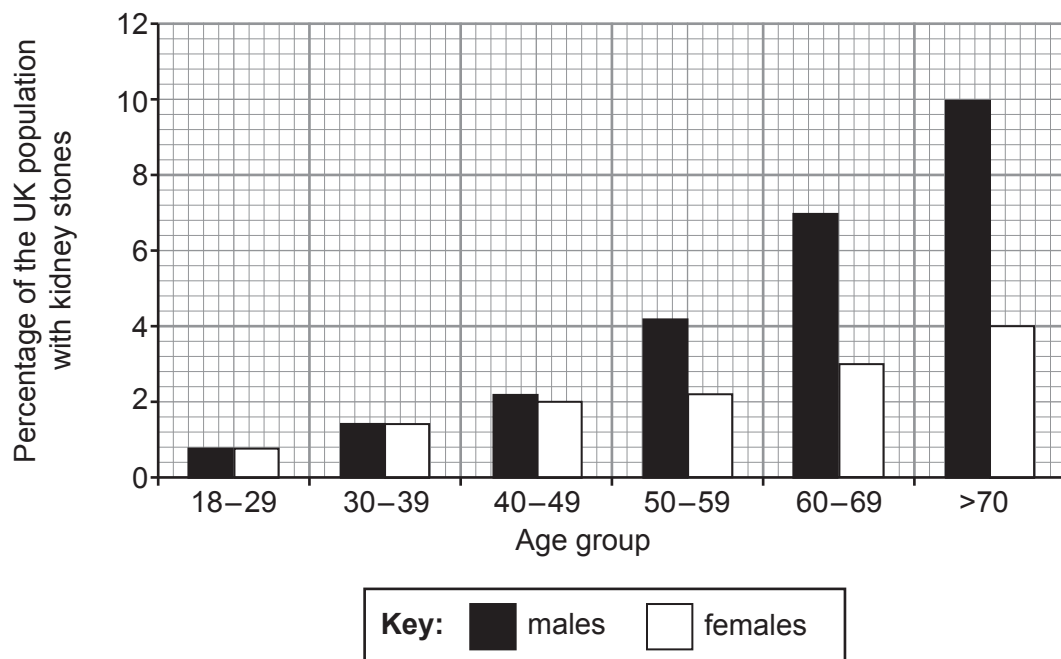
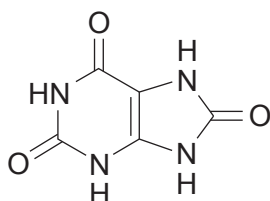


Figure 4: Percentage of the UK population with kidney stones.



6. Steve was suffering from kidney stones formed from uric acid. The structure of uric acid is shown below.



- (a) Uric acid has a similar structure to the adenine and guanine bases found in DNA.

Name this type of structure.

[1]

.....

- (b) Uric acid is a waste by-product. State **one** food that could increase the uric acid concentration in the blood.

[1]

.....



7. When Steve went to the GP he was asked to provide a urine sample so that a dipstick test could be performed.



The dipstick test analyses the concentration of several substances, pH and signs of infection in the urine. Some of these tests can be performed in the laboratory.

Complete the table below to show some of these tests and their positive results.

[3]

Substance tested	Reagent/procedure	Observation
glucose	heated with Benedict's solution	 →
protein		blue → violet
sodium ions	flame test	 flame



8. Steve had some complex urodynamic tests performed in hospital.

- (a) (i) Use **Figure 3** to find the volume of urine in Steve's bladder at a pressure of 70 cmH₂O. [1]

volume = ... ml

- (ii) Use this volume and the formula

$$\text{bladder compliance (ml/cmH}_2\text{O)} = \frac{\text{volume (ml)}}{\text{pressure (cmH}_2\text{O)}}$$

to calculate the compliance of Steve's bladder at 70 cmH₂O. Show your working. [2]

bladder compliance = ... ml/cmH₂O

- (b) Much simpler urodynamic observations can be made.

State **two** other urodynamic observations that could be made. [2]

1.
2.



9. Describe how the alpha-blocker drug, tamsulosin, helps a patient with kidney stones. [2]

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10. **Figure 4** shows the percentage of the UK population with kidney stones.

Describe the trends shown by this graph. [3]

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11. The concentration of water in the blood is controlled by a hormone and the kidneys.

Explain the role of this hormone in the process. [10]

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Case study 3: Leptospirosis (Weil's disease)

Alison is an experienced outdoor pursuits teacher, specialising in canoeing and paddle boarding.

Alison recalls, 'During my last training session of the week, I had a number of beginners learning to paddle board and I spent most of my time in the river helping them get on and off the board. I had a weekend off and felt tired. Instead of enjoying myself I ended up in bed, with a temperature and headache. I couldn't eat, and if I did, I felt sick.'

Alison made an appointment to see her GP. The symptoms Alison suffered did not point to anything specific and the GP asked her to return to the surgery in a few days for a blood test. She was advised to take some pain killers to help her fever.

The blood test results confirmed that Alison was suffering from leptospirosis. The GP prescribed doxycycline and within a few days Alison felt much better.

Alison is still an active instructor but now practises much better infection control. She washes her hands more regularly and makes sure any cuts are covered when she is in the water. She also makes sure there is plenty of clean, fresh water to hand.



Figure 5: Graph showing antibody concentration after exposure to *Leptospira* bacteria.

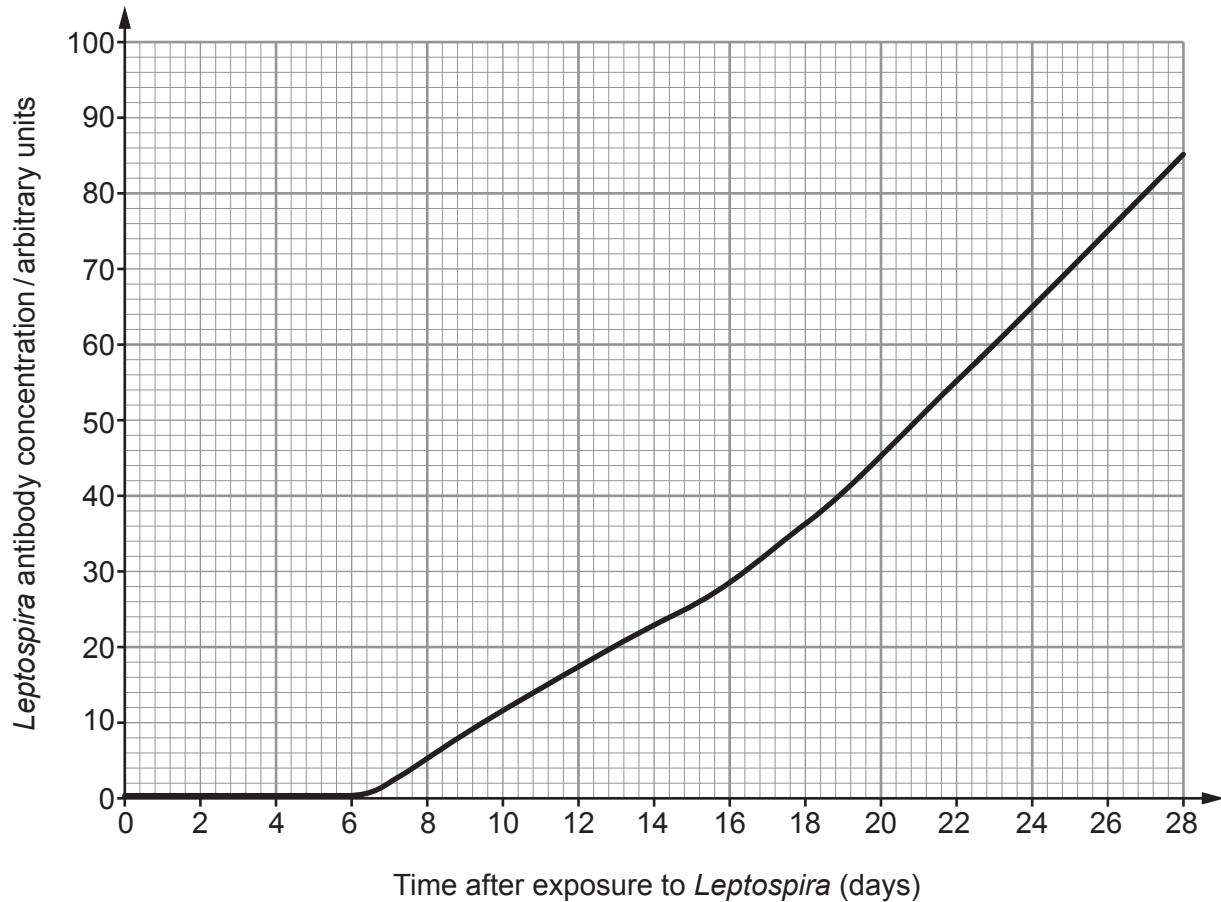


Figure 6: Data from the International Journal of Infectious Diseases, showing the incidence of leptospirosis in selected countries.

Selected countries with high incidence of leptospirosis	Annual incidence per million population	Selected countries with low incidence of leptospirosis	Annual incidence per million population
Trinidad & Tobago	120.4	Italy	0.7
Barbados	100.3	Germany	0.7
Jamaica	78.0	UK	0.6
Costa Rica	67.2	Spain	0.3
Nicaragua	23.3	USA	0.1



12. *Leptospira* is a genus of gram-negative bacteria.

- (a) State how *Leptospira* can infect a healthy person to cause leptospirosis. [1]

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.....

- (b) A gram stain can be performed to distinguish between gram-positive and gram-negative bacteria. The steps for this test are given below, but they are not in the correct order.

A – Bacteria are added and fixed to a microscope slide.

B – A counter stain, safranin, is added to the slide for 1 minute.

C – Iodine is added for 1 minute to fix the stain.

D – Alcohol is used to wash and decolourise the cells for 10–15 seconds.

E – Crystal violet is added for 1 minute then washed off with water.

Complete the boxes below placing the steps above in the correct order. [2]

Two have been done for you.

A				B
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- (c) *Leptospira* stain red with the counter stain, safranin.

Explain why the structure of gram-negative bacteria makes them stain red. [2]

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- (d) State **two** other ways to distinguish between different types of bacteria. [2]

1.
2.



13. Alison was advised to take some over-the-counter painkillers to help her fever.

(a) State **two** advantages of using over-the-counter painkillers. [2]

1.

2.

(b) State **one** disadvantage of using over-the-counter painkillers. [1]

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14. Figure 5 shows the antibody concentration after exposure to *Leptospira* bacteria.

(a) Explain why Alison was asked to return after a week for a blood test, in order for an ELISA to be carried out. [2]

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(b) Suggest **two** reasons why the GP did not prescribe antibiotics until diagnosis of leptospirosis was confirmed. [2]

1.

2.

(c) Describe the humoral immune response to *Leptospira*. [4]

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15. Doxycycline and penicillin are antibiotics that treat leptospirosis.

- (a) Describe how these antibiotics kill the *Leptospira*. [4]

Doxycycline:

Penicillin:

- (b) Penicillin is effective against *Leptospira*, however it is not suitable for all patients.

Suggest why penicillin is not suitable for all patients. [1]

16. Figure 6 shows the incidence of leptospirosis in selected countries.

Suggest why visitors to Jamaica are more likely to suffer from leptospirosis than visitors to the UK. [2]

END OF PAPER



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LEVEL 3 DIPLOMA

4463U60-1A

JUNE 2023

MEDICAL SCIENCE **UNIT 6 (Medical Conditions)**

For use with **Unit 6: Medical Case Study** examination

**Pre-Release Article for use in the following
examination on Monday, 5 June 2023**

Level 3 Diploma in Medical Science

Age-Related Macular Degeneration

Age-related macular degeneration (AMD) is a common eye condition that usually affects people in their 50s and 60s. This can happen gradually or over several years (dry AMD), or quickly over a few weeks or months (wet AMD).



Symptoms of AMD

AMD affects the middle part of a patient's vision, not the edges (peripheral vision). It can be present in one eye or both. AMD can make things like reading, watching TV, driving or recognising faces difficult.

Other symptoms include:

- seeing straight lines as wavy or crooked
- objects looking smaller than normal
- colours seeming less bright than they used to
- seeing things that aren't there (hallucinations)

AMD isn't painful and doesn't affect the appearance of the eyes.

Causes of AMD

The causes of AMD are unknown. In a patient with AMD the blood vessels of the retina become more permeable or 'leaky'. There is over-production of a protein called vascular endothelial growth factor (VEGF), which increases the permeability of blood vessels and encourages the growth of new blood vessels. New blood vessels and leaky blood vessels can cause retinal damage.

Certain factors increase the risk of a patient developing AMD. These include:

- increasing age
- family history
- smoking
- cardiovascular diseases

Diagnosing AMD

If a GP suspects AMD, they will refer a patient to an optometrist. The optometrist will examine the eye and check a patient's vision using different lenses and a reading chart. During the examination, the optometrist may put drops in the eyes containing a drug called tropicamide. They may also perform tonometry. Sometimes patients are referred to an ophthalmologist. This is necessary if there is a possibility that treatment is needed quickly or other tests, such as an angiographic test of the eye, are required.

Treatments for AMD

Dry AMD – there is no treatment, but vision aids can help reduce the effect of AMD.

Wet AMD – the treatment does not cure the condition but aims to slow its progression. Regular intraocular injections with anti-VEGF drugs, for example ranibizumab can be given. An alternative treatment using light pulses, called photodynamic therapy, may also be used to stop the patient's vision getting worse.

Living with AMD

An eye specialist will also refer a patient with AMD to a low-vision clinic. The clinic gives useful advice and practical support for patients with AMD.

Kidney Stones

Kidney stones can develop in one or both kidneys, and most often affect people over the age of 30.

Symptoms of kidney stones

Very small kidney stones may go undetected and pass out painlessly when a patient urinates. Larger kidney stones can cause symptoms, including:

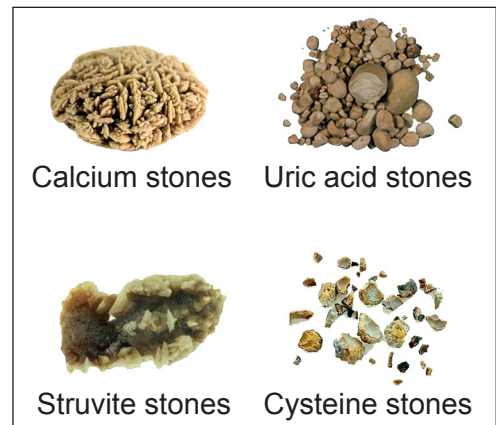
- pain in the side of the abdomen or groin
- high temperature
- severe abdominal pain that comes and goes
- feeling sick or vomiting
- urine infection, often with blood in the urine

A kidney stone can block the ureter and cause a kidney infection. This is because waste products are unable to pass the blockage, which may cause a build-up of bacteria.

Causes of kidney stones

The risk of developing kidney stones is increased when a patient does not drink enough fluid. Kidney stones come in a variety of sizes, shapes and colours. Some are like grains of sand, whilst in rare cases others can grow to the size of a golf ball. The main types of kidney stones are:

- calcium stones, the most common type of stone
- struvite stones, usually caused by an infection
- uric acid stones, often found in the bladder and can be caused by certain foods
- cysteine stones



Diagnosing kidney stones

A GP will usually be able to diagnose kidney stones from a patient's symptoms and medical history. Diagnostic tests include:

- simple urine samples using a dipstick to check for substances in the urine including glucose, protein and ions
- simple and complex urodynamic studies like measuring the compliance of the bladder.
- an examination of any stones that are passed
- blood tests to check that the kidneys are working properly, measuring ADH concentration in the blood and the levels of substances that could cause kidney stones

Treating kidney stones

Most kidney stones are small enough to be passed out in the urine and can be treated at home. To ease the symptoms, a GP might recommend:

- drinking plenty of fluids throughout the day
- over-the-counter painkillers, like ibuprofen
- an alpha-blocker such as tamsulosin which helps the stones to pass

Preventing kidney stones

The best way to prevent kidney stones is to drink plenty of water each day to avoid dehydration. To prevent stones returning, three litres of fluid should be drunk throughout the day.

Leptospirosis (Weil's disease)

Leptospirosis is an infection that is caught indirectly from animals, most commonly rats, mice, cows, pigs and dogs. It is one of the most common infections in the world, particularly in areas like the Caribbean, Latin America, and the Indian subcontinent where the water is warmer.

Symptoms of leptospirosis

The most common symptom is a fever. Other symptoms include:

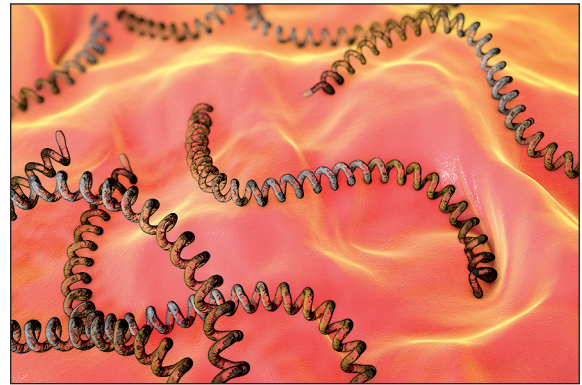
- headache
- nausea and vomiting
- aching muscles and joints
- red eyes
- loss of appetite

Severe leptospirosis can cause multiple organ failure and death.

Causes of leptospirosis

Leptospirosis is a bacterial infection caused by gram-negative bacteria of the genus *Leptospira*. The most common way to catch leptospirosis is from exposure to contaminated freshwater or soil. This usually means infected urine gets into the patient's mouth, eyes, or a cut. This can happen during activities like kayaking, outdoor swimming, or fishing.

Less commonly, infection can occur when working with animals or animal parts, or in occupations where people are in contact with contaminated water. It is relatively rare in the UK, but it has been increasing in holiday-makers.



Diagnosing leptospirosis

A GP will diagnose leptospirosis after considering the symptoms shown by the patient and the risk of exposure of the patient to contaminated water supplies. It is a notifiable disease and blood samples are sent to the National Leptospirosis Service (NLS) to confirm the diagnosis. The diagnosis is confirmed by one of the following:

- testing for *Leptospira* DNA
- ELISA
- microbiological culture of the *Leptospira* bacteria

Treating leptospirosis

A GP may prescribe antibiotics such as doxycycline or penicillin. Usually, a full recovery is seen in a few days or weeks. Over-the-counter painkillers may be taken to relieve the fever. If a more serious infection is present, intravenous antibiotics may be required, which are usually administered in hospital.

Preventing leptospirosis

To prevent infection it is advisable that the following procedures are followed:

- wash hands with soap and water after handling animals or animal products
- clean any wounds as soon as possible and cover cuts and grazes
- do not touch dead animals with bare hands
- do not drink untreated water from rivers, canals or lakes.



LEVEL 3 DIPLOMA

4463U60-1B



S23-4463U60-1B

JUNE 2023

MEDICAL SCIENCE UNIT 6 (Medical Conditions)

For use with **Unit 6: Medical Case Study** examination

**Resource Folder for use in the following
examination on Monday, 5 June 2023**

Level 3 Diploma in Medical Science

4463U601B
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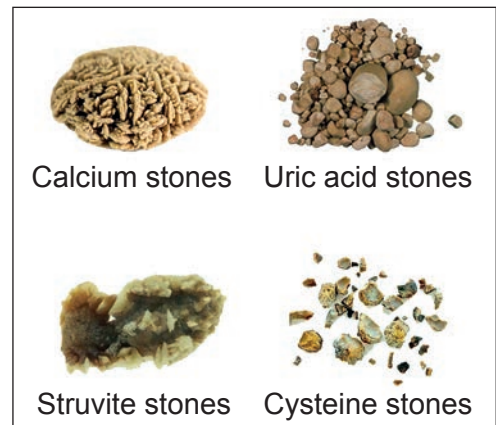
- pain in the side of the abdomen or groin
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A kidney stone can block the ureter and cause a kidney infection. This is because waste products are unable to pass the blockage, which may cause a build-up of bacteria.

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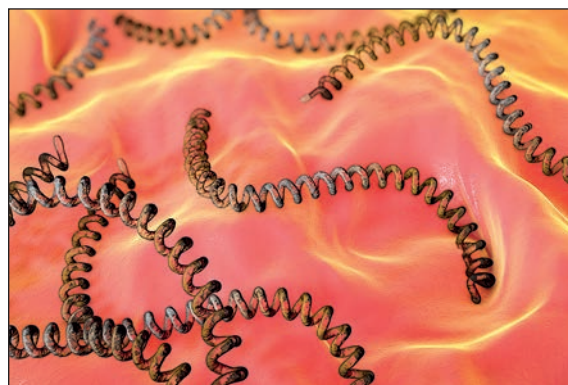
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Less commonly, infection can occur when working with animals or animal parts, or in occupations where people are in contact with contaminated water. It is relatively rare in the UK, but it has been increasing in holiday-makers.



Diagnosing leptospirosis

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- testing for *Leptospira* DNA
- ELISA
- microbiological culture of the *Leptospira* bacteria

Treating leptospirosis

A GP may prescribe antibiotics such as doxycycline or penicillin. Usually, a full recovery is seen in a few days or weeks. Over-the-counter pain killers may be taken to relieve the fever. If a more serious infection is present, intravenous antibiotics may be required, which are usually administered in hospital.

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