



**LEVEL 3 DIPLOMA**

**4463U60-1**

**MONDAY, 5 JUNE 2023 – MORNING**

**MEDICAL SCIENCE**

**Unit 6: Medical Case Study**

**1 hour 30 minutes plus your additional time allowance**

**Surname** \_\_\_\_\_

**First name(s)** \_\_\_\_\_

**Centre Number** \_\_\_\_\_

**Candidate Number** 4 \_\_\_\_\_

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

## **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 or your usual method.**

**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.**

**(Turn over)**

## **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.**

**(Turn over)**

**FIGURE 1: THE TOTAL NUMBER OF COMMON SIGHT-THREATENING CONDITIONS IN THE UK IN 2008 AND 2018.**

| <b>SIGHT-THREATENING CONDITION</b> | <b>TOTAL NUMBER OF CASES IN 2008</b> | <b>TOTAL NUMBER OF CASES IN 2018</b> |
|------------------------------------|--------------------------------------|--------------------------------------|
| <b>Wet AMD</b>                     | <b>415 000</b>                       | <b>516 000</b>                       |
| <b>Dry AMD</b>                     | <b>194 000</b>                       | <b>240 000</b>                       |
| <b>Glaucoma</b>                    | <b>266 000</b>                       | <b>561 000</b>                       |
| <b>Diabetic retinopathy</b>        | <b>748 000</b>                       | <b>928 000</b>                       |
| <b>Diabetic maculopathy</b>        | <b>188 000</b>                       | <b>236 000</b>                       |

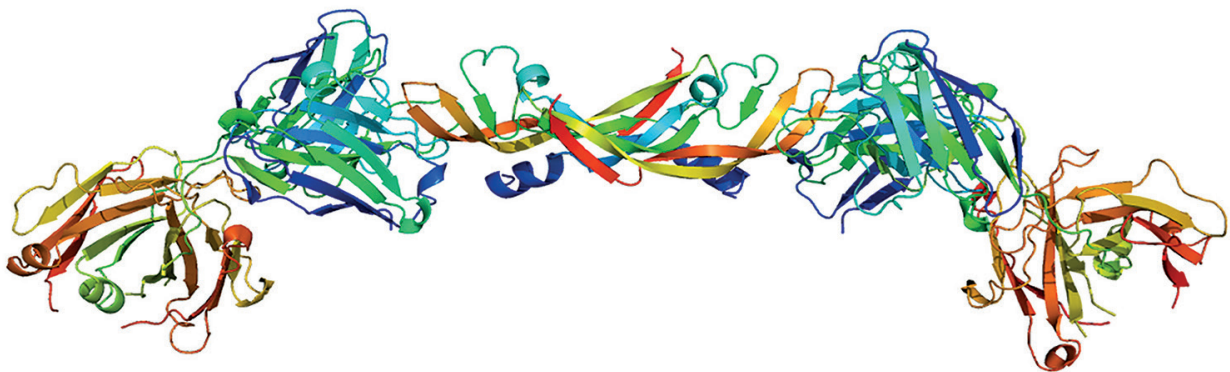
**FIGURE 2: COST OF AMD DRUG THERAPY TO THE NHS.**

| <b>TYPE OF THERAPY</b>      | <b>DRUG USED</b>   | <b>COST PER TREATMENT (£)</b> | <b>NUMBER OF TREATMENTS PER YEAR</b> |
|-----------------------------|--------------------|-------------------------------|--------------------------------------|
| <b>Photodynamic therapy</b> | <b>verteporfin</b> | <b>890</b>                    | <b>Varies up to 6</b>                |
| <b>Drug therapy</b>         | <b>ranibizumab</b> | <b>551</b>                    | <b>8</b>                             |

(Turn over)

**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 mark]**

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1 (a) (ii)

State TWO types of bond that would be found in a quaternary structure. [1 mark]

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

(b) Describe the effect of excess VEGF in the eye.

[2 marks]

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(Turn over)

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

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- (b) The optometrist also carried out tonometry.**

**State what this test measures. [1 mark]**

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- 2 (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 marks]**

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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 marks]**

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**(ii) Give an advantage of administering this drug by intraocular injection. [1 mark]**

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

**Describe the principles of photodynamic therapy.  
[3 marks]**

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**4. FIGURE 1 on page 4 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 marks]**

**percentage = \_\_\_\_\_**

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

**percentage increase = \_\_\_\_\_**

**(Turn over)**

- 4 (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 mark]

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5. FIGURE 2 on page 4 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 marks]

saving per patient per year = £ \_\_\_\_\_

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|    |
| 25 |

(Turn over)

## **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.**

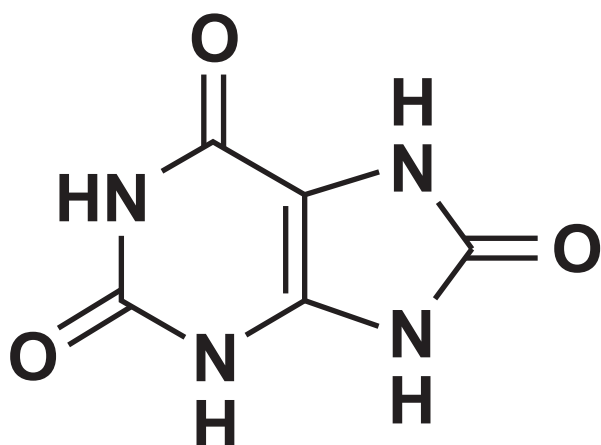
**Steve recalls, 'Within a day of taking the tamsulosin, and with plenty of fluids inside me, I needed to go to the toilet much more often. The stones passed out of me, but with some pain. Luckily, I haven't had any more episodes of abdominal pain and have felt well since they passed. I have taken the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

**(Turn over)**

**Compliance is a complex urodynamic test. It measures the changes in bladder volume and pressure.**

**Compliance is expressed in millilitres per centimetre H<sub>2</sub>O. Steve's bladder compliance results are shown in FIGURE 3 opposite.**

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 mark]

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- (b) Uric acid is a waste by-product. State ONE food that could increase the uric acid concentration in the blood. [1 mark]
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7.

| SUBSTANCE TESTED | REAGENT/PROCEDURE               | OBSERVATION   |
|------------------|---------------------------------|---------------|
| glucose          | heated with Benedict's solution | _____ → _____ |
| protein          | _____                           | blue → violet |
| sodium ions      | flame test                      | _____ flame   |

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 opposite to show some of these tests and their positive results. [3 marks]

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

(a) (i) Use FIGURE 3 opposite page 14 to find the volume of urine in Steve's bladder at a pressure of 70 cmH<sub>2</sub>O.  
[1 mark]

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 cmH<sub>2</sub>O. Show your working. [2 marks]

bladder compliance = \_\_\_\_\_ ml/cmH<sub>2</sub>O

(Turn over)

**8 (b) Much simpler urodynamic observations can be made.**

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

**1.** \_\_\_\_\_

\_\_\_\_\_

**2.** \_\_\_\_\_

\_\_\_\_\_

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

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10. FIGURE 4 opposite page 14 shows the percentage of the UK population with kidney stones.

Describe the trends shown by this graph.

[3 marks]

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(Turn over)

- 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 marks]**

[illegible]

**(Turn over)**





[illegible]

### **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.**

**(Turn over)**

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

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

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12 (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 marks]  
TWO have been done for you.

|          |       |       |       |          |
|----------|-------|-------|-------|----------|
| <b>A</b> | _____ | _____ | _____ | <b>B</b> |
|----------|-------|-------|-------|----------|

(Turn over)

**12 (c) *Leptospira* stain red with the counter stain, safranin.**

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

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

**1.** 

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**2.** 

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**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 marks]**

**1.** \_\_\_\_\_  
\_\_\_\_\_

**2.** \_\_\_\_\_  
\_\_\_\_\_

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

\_\_\_\_\_  
\_\_\_\_\_

**14. FIGURE 5 opposite page 25 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 marks]**

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14 (b)

**Suggest TWO reasons why the GP did not prescribe antibiotics until diagnosis of leptospirosis was confirmed. [2 marks]**

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

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

[illegible]

**(Turn over)**

15. Doxycycline and penicillin are antibiotics that treat leptospirosis.

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

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 mark]

\_\_\_\_\_

\_\_\_\_\_

(Turn over)

16. **FIGURE 6** opposite page 25 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 marks]**

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**END OF PAPER**

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| <b>25</b> |

**(Turn over)**

| <b>Question<br/>number</b> | <b>Additional page, if required.<br/>Write the question numbers in the<br/>left-hand margin.</b> |
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**(Turn over)**

| <b>Question<br/>number</b> | <b>Additional page, if required.<br/>Write the question numbers in the<br/>left-hand margin.</b> |
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FIGURE 3: STEVE’S BLADDER COMPLIANCE.

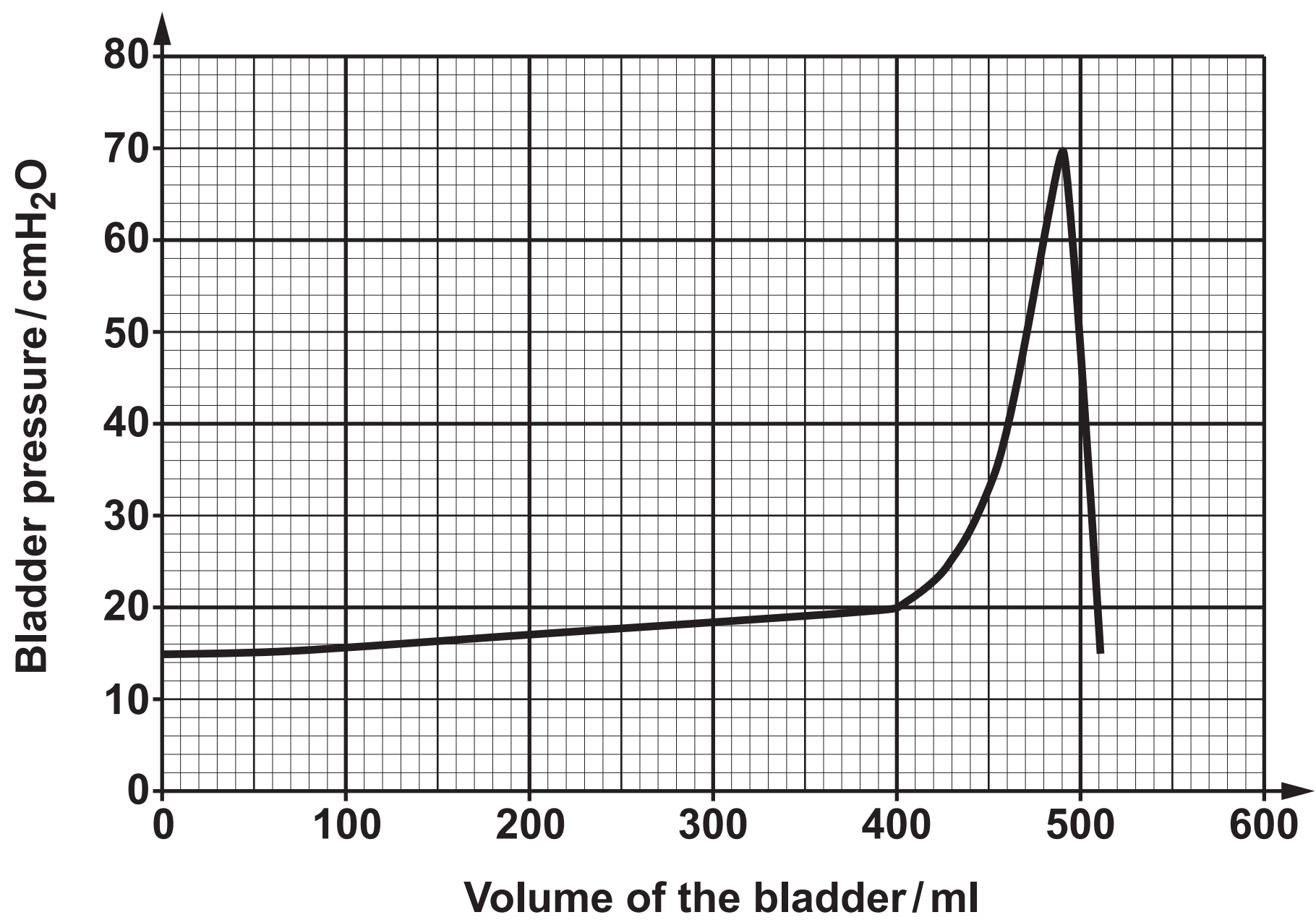


FIGURE 4: PERCENTAGE OF THE UK POPULATION WITH KIDNEY STONES.

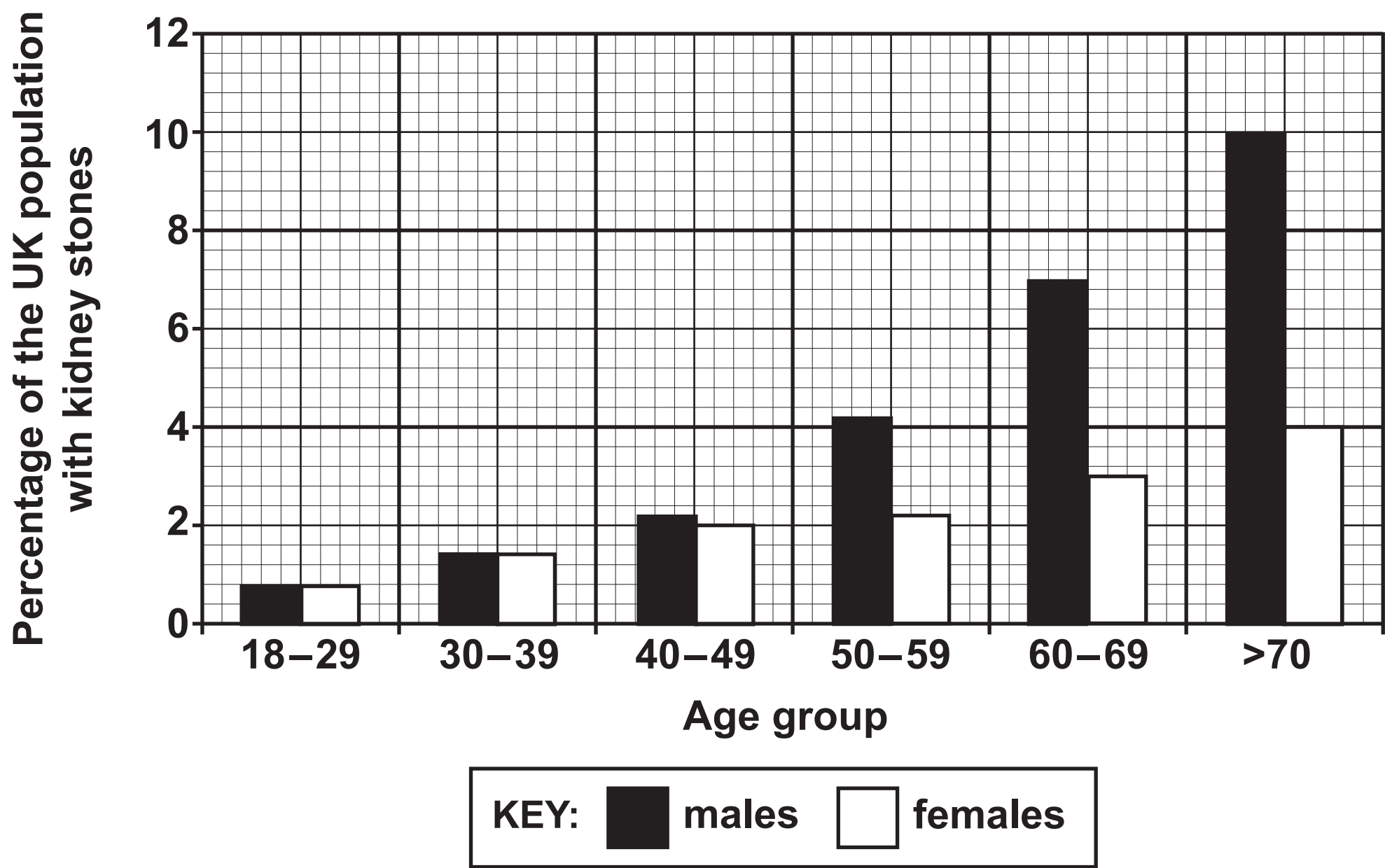


**FIGURE 5: GRAPH SHOWING ANTIBODY CONCENTRATION AFTER EXPOSURE TO LEPTOSPIRA BACTERIA.**

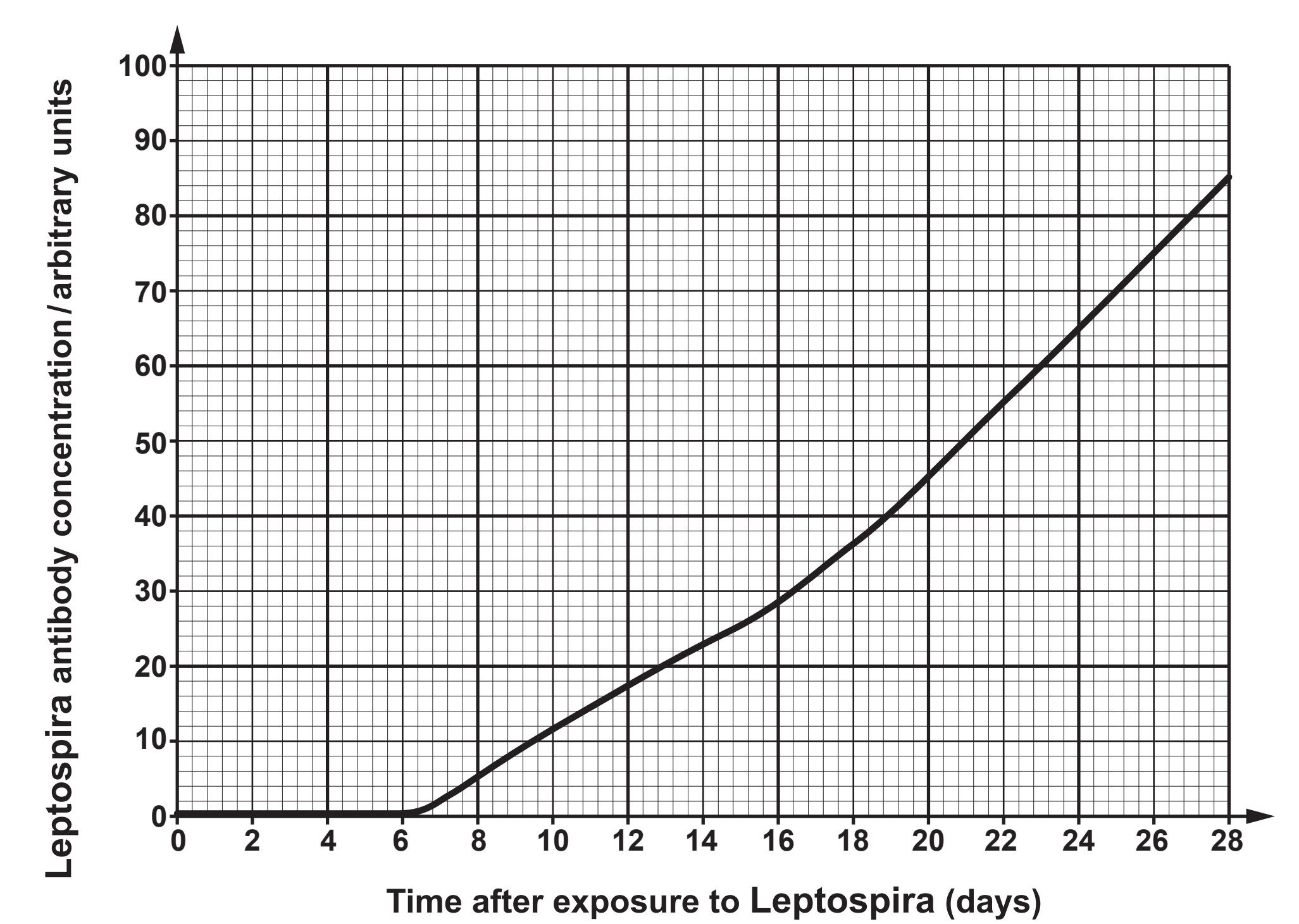


**FIGURE 6: DATA FROM THE INTERNATIONAL JOURNAL OF INFECTIOUS DISEASES, SHOWING THE INCIDENCE OF LEPTOSPIROSIS IN SELECTED COUNTRIES.**

| 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                                     |