

a) Hong Xin Yue

b) Dunman High School

c) 10 Tanjong Rhu Road

d) A sword thrust forward

1471 words

Mid-Year Examination

Year 6

Name: _____

Index Number: _____

Class _____

H2 Biology

9744/01

(2 marks each)

Answer all questions

1 The antibiotic revolution started in 1928 with the discovery of penicillin by Alexander Fleming, with the first purified penicillin, penicillin G, becoming widely available to the public in 1945. More than 20 new classes of antibiotics were marketed during the antibiotic era between 1940 and 1962¹. However, since then only a few new classes have been discovered, including malacidins - reported only this year – which kills several types of drug resistant bacteria including methicillin-resistant *Staphylococcus aureus* (MRSA), without engendering resistance². The antibiotic era revolutionized the treatment of infectious diseases worldwide, especially in developed countries.

Which of the following could provide support for the benefits of antibiotics?

A In Sweden, mortality rates due to septicemia, syphilis, and non-meningococcal meningitis declined faster in after the introduction of antibiotics³

B The average life expectancy in the US rose from 62 years in 1920 to 74.5 years in 1980.⁴

C Adding antibiotics to the drinking water of chickens could reduce both *Salmonella* and *E. coli* infections in chickens⁵

D All of the above

¹ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3085877/>

² https://www.washingtonpost.com/news/speaking-of-science/wp/2018/02/13/a-potentially-powerful-new-antibiotic-is-discovered-in-dirt/?noredirect=on&utm_term=.ad09620f5c45

³ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1653532/>

⁴ <https://www.seniorliving.org/history/1900-2000-changes-life-expectancy-united-states/>

⁵ https://www.ahi.org/wp-content/uploads/2011/06/ForTheRecord-27_additional-sources.pdf

Answer: D

(So it's time. Again)
(Sometimes I wonder why we put in so much effort)
(They'd probably curse and swear at us)

(In their heads, of course)
(Heh, I would too)
(In my time we didn't have much of such luxuries)

2 What is not a reason for the use of low-dose antibiotics in livestock production?

- A** To promote growth of animals
- B** To prevent contamination of meat
- C** To introduce more medication into the human diet
- D** An attempt to increase profits

Answer: C

(I remember when we used to keep chickens)
(Fragile things)
(Bought a hundred chicks every year)
(And immediately you had to be very, very vigilant)

(We kids were tasked with taking care of them)
(Our parents worked hard)
(They'd be out before sunrise, and back after we've gone to bed)

3 Breastfed children are known to have lower BMI and stronger immune systems in later childhood, however, this effect is not found in those who received antibiotics before weaning. Suggest a potential reason.

Suggested answer: Breast milk contains bacteria that aids the development of microbiota in the infant's digestive system. The introduction of antibiotics would reduce microbiota growth, which is essential to the development of an infant's immune system and metabolism.⁶

⁶ <https://medshadow.org/news/antibiotics-may-negate-benefits-of-breastfeeding/>

(When you saw a chick all droopy and bedraggled, you rushed to remove it)
(And hope it wasn't too late)

(Most of the time it was though)
(The next day you'd see another one)
(Then another one...)

4 It has been found that one major way in which antibiotics and antibiotic resistant bacteria enter the environment is via animal manure, and could eventually spread to humans through contaminated water⁷. Many soil bacteria are found to be colistin-resistant, as this is widely used in agriculture. What are some reasons for farmers to continue this practice?

- A** Ignorance
- B** Greed
- C** To waste money
- D** Both A and B

Answer: D

(At least half would be wiped out)
(Sometimes all)
(Our parents would beat us)

(These chickens were an investment for a whole year)
(That didn't help matters though)
(They tried their best for us)
(Bore most of the burden)
(Even now I'll never truly understand what they went through)

5 What is a potential benefit of prophylactic antibiotic use?

- A** 40% reduction in mortality in Malawian children when amoxicillin or cefdinir is added to food regimens for the outpatient treatment of acute severe malnutrition, which reduces gut and respiratory infections⁸
- B** Increasing selection pressure for antibiotic resistance in bacteria
- C** Overall reduction of healthcare costs

⁷ <http://www.sustainabletable.org/257/antibiotics>

⁸ <https://academic.oup.com/jid/article/210/4/514/2908572>

D All of the above

Answer: A

*(But we knew the desperation)
(Sometimes we could find enough money)
(Or beg a few chicks from the neighbours)
(Well, sometimes)
(...)*

6 State two symptoms of tuberculosis.

Suggested answer: Chest pain, pain when breathing, persistent cough, fatigue, fever, chills, swollen lymph nodes, joint or bone pain, coughing of blood and sputum, weight loss

*(The cough)
(Anyone who had heard it before would know)
(It started with my eldest brother)
(‘Persistent cough’ is an understatement)
(Our sisters tended to him)
(He would be coughing the entire night)*

7 Name a drug that is used to treat tuberculosis.

Suggested answer: isoniazid/rifampicin/Pyrazinamide/Ethambutol/Streptomycin

*(We were all cramped in the one room house)
(It was partitioned into a dining area and bedroom)
(Our parents would sleep in the dining area when they came home)
(They would have left when we woke up)

(There was blood and phlegm)
(He coughed into a spittoon)
(The colours were faded and chipped on one side)*

8 What are the possible side effects of antibiotics?

- A Diarrhoea
- B Potential to block neuromuscular activity
- C Increased risk of tendinitis
- D All of the above

Answer: D

(I was the one who dropped it)

(Lucky it didn't break)

(But my father was annoyed all the same)

(My brother took the blame for me)

(My younger sister had to get up and empty the spittoon multiple times each night)

(To say the least, we had no money for a doctor)

9

THE SPREAD OF ANTIBIOTIC RESISTANCE

An increasing proportion of bacteria display resistance to common antibiotics.

— Fluoroquinolones — Cephalosporins (3rd gen) — Aminoglycosides
— Carbapenems — Polymyxins

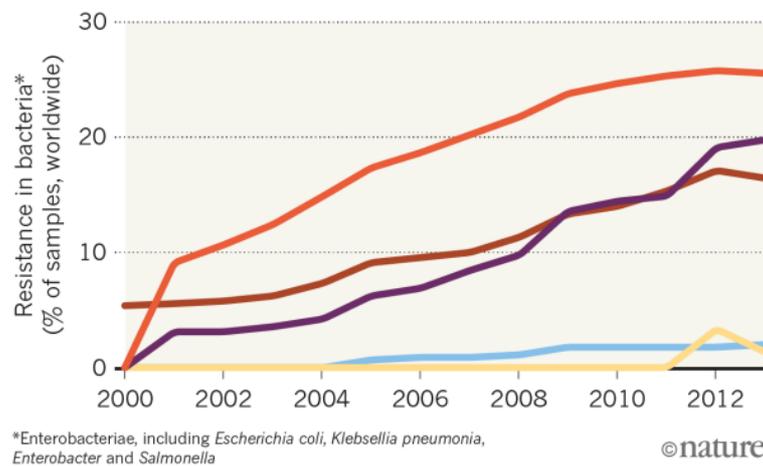


Fig 9.1⁹

⁹ <https://www.nature.com/news/spread-of-antibiotic-resistance-gene-does-not-spell-bacterial-apocalypse-yet-1.19037>

(a) With reference to Fig 9.1, describe the trend of resistance to Fluoroquinolones.

Suggested answer: upward trend, increasing sharply before reaching a plateau + correct quoting of two data pairs

(A doctor couldn't have done much anyway)
(He became so weak)
(No wonder they called it 'consumption')

(One day, father took him to the death parlour)
(The poor went there with their 'coffin money')
(It was the area within Sago Lane and Banda Street)
(The dead and the dying slept side-by-side)
(The room was crammed)
(One row of bamboo mats on each side of the room)
(With a neat aisle in between)
(Just like the format I wish the students would adopt for their comparison essays)

(b) Suggest an explanation for the trend.

Suggested answer:

Increased use of the Fluoroquinolones increased selection pressure
Antibiotic-resistant bacteria have a selective advantage and have a higher chance of surviving, reproducing and passing on the favourable alleles to the next generation

(Surrounded by people)
(Yet intensely lonely)
(There was pain)
(Until pain meant nothing)
(There was no help)

10 How might the proportion of antibiotic-resistant bacteria in a population increase drastically in a short period of time?

Suggested answer: Conjugation with transfer of plasmid which contains genes for antibiotic-resistance
Transformation, uptake of foreign naked DNA coding for antibiotic resistance
Transduction, generalized or specific

(My brother never came back)

11 What are some mechanisms by which drug resistance can be enhanced?

Suggested answer: Overexpression of a drug's molecular target
Modification of the target site of antibiotics
Expression of multidrug transporters

*(A few months back, I heard my grandson coughing)
(Coughing just like my brother did)
(I took him to the hospital)
(Demanded it was an emergency)
(My daughter chided me for overreacting)
(A course of antibiotics was all it took)*

12 Antibiotic therapy can instigate a SOS response in bacteria by stimulating the formation of lethal amounts oxidative radicals which activates RecA. This triggers the antibiotic-induced DNA repair and mutagenesis pathway, as well as horizontal gene transfer pathways and triggers biofilm formation¹⁰. What is a potential benefit of RecA inhibitors?

Suggested answer: Decrease the rate of evolution of antibiotic resistance, prolonging the effectiveness of antibiotics

*(But my heart still leaps everytime I hear him cough)
(It could be latent)
(What about RR¹¹, MDR¹²....)*

13 According to the Centers for Diseases Control and Prevention, at least 2 million people become infected with antibiotic-resistant bacteria and more than 23,000 people die annually as a consequence of these infections. Examples such resistant pathogens are Penicillin-Resistant Streptococcus pneumonia (PRSP), Methicillin-Resistant Staphylococcus aureus (MRSA), Vancomycin-Resistant Enterococci (VRE) and Multiple-Drug-Resistant Gram-Negative Bacilli (MDRGNB)¹³. Why might this be of international concern?

Suggested answer: Increase in healthcare costs, greater demand for medical resources, lowered productivity if infections require a longer time to treat
Accept any valid point

*(Now, they memorize statistics, textbook answers and summarized theories)
(Occasionally, some would put up their hands)*

¹⁰ [https://www.cell.com/ccbio/pdf/S2451-9456\(16\)30046-0.pdf](https://www.cell.com/ccbio/pdf/S2451-9456(16)30046-0.pdf)

¹¹ Rifampicin-resistant

¹² Multiple drug resistant (tuberculosis)

¹³ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5354621/>

(‘Please, Miss’) (‘Excuse me, sir’)

14 The benefits of antibiotics are becoming undone by indiscriminate use and under-dosing. Do you suggest that doctors take a ‘wait-and-see’ approach, or continue to dispense antibiotics freely?

Suggested answer: Accept any valid point

(But there are no answers)

(Human society has come a long way)

(I have seen that)

(There are pros and cons of every invention)

(Every discovery)

(The bacteria are constantly evolving)

(And we are constantly making new discoveries)

(No doubt, human foresight is limited)

(Not everyone understands how technologies work)

(But we will go a long way)

END OF PAPER