ANTIBIOTICS (lesson 4)

Read the article and complete the tasks that follow:

AI discovers promising antibiotic compounds in Archaea microbes

In a new study published in *Nature Microbiology*, researchers at the University of Pennsylvania used artificial intelligence to identify previously unknown compounds in Archaea that could fuel the development of next-generation antibiotics.

"Previous efforts to find new antibiotics have looked mostly at fungi, bacteria and animals," says César de la Fuente, Presidential Associate Professor in Bioengineering and in Chemical and Biomolecular Engineering in the University of Pennsylvania School of Engineering and Applied Science (Penn Engineering), in Psychiatry and Microbiology in the Perelman School of Medicine and in Chemistry in the School of Arts & Sciences, and the paper's senior author.

In the past, de la Fuente's lab has used AI models to identify antibiotic candidates in a range of unlikely sources, from the DNA of extinct organisms to the chemicals in animal venom. Now, they're applying those tools to a new set of data: the proteins of hundreds of ancient microbes.

Exploring a microbial frontier

Distinct from both bacteria and from eukaryotes (which include plants, animals and fungi), Archaea occupy their very own branch on the tree of life.

Though they resemble bacteria under a microscope, Archaea fundamentally differ in their genetics, cell membranes and biochemistry. These differences allow them to survive in some of Earth's most extreme environments, from superheated undersea vents to blistering hot springs like those in Yellowstone National Park.

Because Archaea often thrive where few other organisms can - enduring crushing pressures, toxic chemicals and extreme temperatures - their biology has evolved in unusual ways. That makes them a promising but largely untapped source of new molecular tools, including compounds that may function like antibiotics but operate differently from those currently in use.

Hunting for antibiotics with AI

To uncover potential antibiotic compounds hidden in Archaea, the researchers turned to artificial intelligence. The team leveraged an updated version of APEX, an AI tool that de la Fuente's lab originally developed to identify antibiotic candidates in ancient biology, including in the proteins of extinct animals like the woolly mammoth.

Having seen thousands of peptides - short chains of amino acids - with known antimicrobial properties, APEX can predict the likelihood that a given sequence of amino acids will have similar effects.

By retraining APEX 1.1 on thousands of additional peptides and information about bacteria that cause diseases in humans, the researchers prepared the tool to predict which peptides in Archaea might inhibit bacterial growth.

Scanning 233 species of Archaea yielded more than 12,000 antibiotic candidates. The researchers dubbed these molecules "archaeasins," which chemical analysis revealed differ from known antimicrobial peptides (AMPs), in particular in their distribution of electric charge.

The researchers then selected 80 archaeasins to test against actual bacteria. "Trying to find new antibiotics one molecule at a time is like looking for needles in a haystack," says Fangping Wan, a postdoctoral fellow in de la Fuente's lab and the paper's other co-first author. "AI speeds up the process by identifying where the needles are likely to be."

On par with existing antibiotics

Antibiotics work in a number of ways. Some punch holes in bacterial membranes, while others shut down the organisms' ability to make proteins. The researchers found that, unlike most known AMPs, which attack a bacterium's outer defenses, archaeasins seem to pull the plug from the inside, scrambling the electrical signals that keep the cell alive.

In tests against a range of disease-causing, drug-resistant bacteria, 93% of the 80 archaeasins surveyed demonstrated antimicrobial activity against at least one bacterium. The researchers then selected three archaeasins to test in animal models.

Four days after a single dose, the archaeasins all arrested the spread of a drug-resistant bacterium often acquired in hospitals. One of the three compounds

demonstrated activity comparable to polymyxin B, an antibiotic commonly used as a last-line of defense against drug-resistant infections.

Task 1. Match the words from the article (1-8) with their correct definitions (a-h).

Term		Definition	
1.	to fuel	**a.**	to stop the progress or movement of something.
2.	extinct	**b.**	at the most basic or essential level.
3.	to thrive	**c.**	having an effect or result that is equal to something else.
4.	untapped	**d.**	to grow or develop well and be successful.
5.	to leverage	**e.**	not yet used or taken advantage of.
6.	to arrest	**f.**	to provide something with what it needs to operate; to encourage.
7.	fundamentally	**g.**	no longer in existence.
8.	comparable to	**h.**	to use something that you already have in order to achieve something new or better.

Task 2. Complete the collocations by choosing the correct word from the options in brackets. Only one option is correct based on the article.

1. antibiotic _____ *(discovery / resistance /research)*

2. drug-_____ bacteria *(active / defensive / resistant)*

3. ancient _____ *(microbes / antibiotics / genes)*

4. last-line of _____ *(treatment / defense / research)*

5. amino acid _____ *(groups / chains / lines)*

6. hospital-_____ infections *(spread / taken / acquired)*

7. antimicrobial _____ *(bacteria / proteins / peptides)*

8. distribution of electric _____ *(energy / charge / flow)*

9. chemical _____ *(analysis / reaction / research)*

10. potential antibiotic _____ *(compounds / cures / effects)*

Task 3. Fill in the gaps with the most appropriate word from the list below. Use each word only once. Three extra words are given and will not be used.

peptides – extreme – promising – unlikely – fundamentally – drug-resistant – frontier – blistering – distinct – potential

1. Scientists are searching for antibiotic candidates in a range of _____ sources, including animal venom.

2. Archaea are _____ from both bacteria and eukaryotes, occupying their own branch on the tree of life.

3. These microbes can survive in extreme environments like _____ hot springs where temperatures are incredibly high.

4. Because of their unique biology, Archaea are a _____ source for new molecular tools.

5. The AI was used to uncover _____ antibiotic compounds hidden in the microbes.

6. The new compounds were effective against several types of _____ bacteria that are difficult to treat with current medicines.

7. Though they resemble bacteria under a microscope, Archaea are _____ different in their genetics and biochemistry.

Task 4. Paraphrase the sentences using one word from the box:

identify – venom – frontier – resistant – fundamentally – ancient – untapped – compounds – peptides – extreme – analysis – discovered

1. Scientists found more than 12,000 molecules.
   → Scientists _____ more than 12,000 molecules.
2. Many short chains of amino acids had antimicrobial activity.
   → Many _____ showed antimicrobial properties.
3. The new molecules may help fight bacteria that do not respond to drugs.
   → They may help against drug-_____ bacteria.

4. Yellowstone National Park has very hot springs.
   → Yellowstone is home to _____ hot springs.
5. Their biology has not been fully used yet.
   → Their biology is still _____.
6. Archaea look like bacteria but are different at the basic level.
   → Archaea are _____ different from bacteria.
7. The researchers studied the molecules carefully.
   → They carried out a chemical _____ of the molecules.
8. Scientists tested 80 archaeasins against bacteria.
   → 80 antibiotic _____ were tested against bacteria.
9. The discovery of new antibiotics in Archaea opens a new area of science.
   → It opens a new _____ in microbiology.

Task 5. Rewrite using reporting verbs:

Example: *Experts claim that bacteria adapt quickly to antibiotics.*
→ Bacteria are claimed to adapt quickly to antibiotics.

1. Scientists believe that Archaea are an untapped source of antibiotics.
→Archaea _____ an untapped source of antibiotics.

2. Researchers reported that 93% of archaeasins showed activity.
→93% of archaeasins _____ activity.

3. The team explained that archaeasins attack bacteria from the inside.
→Archaeasins _____ to attack bacteria from the inside.

4. The study suggested that Archaea could provide next-generation antibiotics.
→Archaea _____ to provide next-generation antibiotics.

5. Experts claim that AI speeds up the search for new drugs.
→AI _____ to speed up the search for new drugs.

Task 6. Change the relative clause into a reduced form.

Example: *The bacteria that were discovered in hot springs may resist antibiotics.*
→ The bacteria discovered in hot springs may resist antibiotics.

1. Archaea are microbes that can survive in extreme environments.
   →Archaea are microbes _____ in extreme environments.

2. Researchers tested 80 archaeasins, which were predicted by AI.

→ Researchers tested 80 archaeasins _____ by AI.

3. The team used an AI tool that was developed to identify antibiotic candidates.

→The team used an AI tool _____ to identify antibiotic candidates.

4. The study focused on microbes that live in very unusual conditions.

→The study focused on microbes _____ in very unusual conditions.

5. The researchers published a paper that described new antibiotic compounds.

→The researchers published a paper _____ new antibiotic compounds.