‘Virtual Cell’ Simulates Key Process of Bacterial Division

Description

For the first time, researchers have simulated almost every chemical reaction in a living bacterial cell. This simulation models how a bacterial cell copies its DNA and divides into two. Understanding these processes could help explain how the mix of proteins, nucleic acids, fats, and other molecules within a cell leads to life, according to Zane Thornburg, a computational biophysicist at the University of Illinois.

To study bacterial life, Thornburg focused on a simple example: a bacterial cell with a minimal genome called JCVI-Syn3a. This organism was created by reducing the genome of the parasite *Mycoplasma mycoides* to just 493 essential genes.

Thornburg developed a three-dimensional simulation that included the cell’s DNA and other vital molecules. The simulation used actual measurements to simulate the interactions between molecules, like a DNA-copying enzyme that acted when partners came close together. However, some aspects were simplified because dozens of JCVI-Syn3a genes are still not fully understood.

The goal was to simulate the time it takes for the cell to copy its DNA and divide, known as the cell cycle. Initial attempts faced issues, such as the genome breaking apart too quickly. After adjustments, the simulation ran over the US Thanksgiving break in November, revealing a complete cell cycle upon their return, which marked a significant breakthrough.

The simulation accurately reflected how the cell swells and elongates during division. It took 105 minutes for the virtual cell to divide, a duration similar to real cells, but the simulation required six days on a supercomputer, highlighting the complexity involved. Bernhard Palsson, a bioengineer, noted that capturing all these cellular processes coherently during the cell cycle is a significant achievement.

Vocabulary List:

1. **simulated** //ˈsɪmjəˌleɪtɪd// (verb): to make a model that copies real things
2. **genome** //ˈdʒiːnoʊm// (noun): all the genes of a living thing
3. **enzyme** //ˈɛnzaɪm// (noun): a protein that helps chemical reactions happen
4. **interactions** //ˌɪntəˈrækʃənz// (noun): when two or more things affect each other
5. **breakthrough** //ˈbreɪkˌθru// (noun): an important new discovery or success
6. **supercomputer** //ˌsuːpərkəmˈpjuːtər// (noun): a very powerful and fast computer

Vocabulary quizzes

Multiple Choice (Select the Correct answer for each question.)

1. What factor is often challenged during a meteor shower?

   Option: Visibility
   Option: Altitude
   Option: Density
   Option: Ecosystem

2. Which type of system is designed for flexibility and durability?

   Option: Robotic
   Option: Reusable
   Option: Certified
   Option: Simulated

3. What type of mission may involve exploring new ecosystems?

   Option: Breakthrough
   Option: Intervention
   Option: Expedition
   Option: Transfer

4. Which term refers to the variety of life in a particular ecosystem?

   Option: Ecosystem
   Option: Breakthrough
   Option: Biodiversity
   Option: Microbial

5. Which technology is often used to simulate complex biological interactions?

   Option: Robotic
   Option: Supercomputer
   Option: Genome
   Option: Anomaly

6. What type of organisms are often involved in the microbial ecosystem?

   Option: Robotic
   Option: Microscopic
   Option: Fragile
   Option: Reusable

7. What is often required to combat environmental anomalies?

   Option: Visibility
   Option: Intervention
   Option: Transfer

Option: Deadline

8. Which structure contains the complete genetic information of an organism?

Option: Microbial
Option: Genome
Option: Enzyme
Option: Altitude

9. What process involves water infiltrating through small openings?

Option: Seep
Option: Transfer
Option: Breakthrough
Option: Fragment

10. What is often a critical point that can jeopardize a project?

Option: Ecosystem
Option: Fragment
Option: Deadline
Option: Robotic

Gap-Fill (Fill in the blanks with the correct word from the vocabulary list.)

11. The spacecraft needed to _____ at the station to complete the transfer.

12. The fireball broke apart into several _____ that fell to the ground.

13. Operating the robotic system at high altitude can be very _____.

14. The _____ of microbial life can indicate the health of an ecosystem.

15. Scientists studied the strange _____ detected in the data.

16. Researchers discovered a new _____ that could improve biological processes.

17. The project required _____ to adapt to unforeseen challenges.

18. A significant _____ in technology was achieved during the research phase.

19. The study focused on _____ interactions within the soil environment.

20. The system was built to be _____ under various operational conditions.

Matching Sentences (Match each definition to the correct word from the vocabulary list.)

21. The sky was illuminated by a fireball that streaked across the night.
22. Fog often reduces visibility for drivers on the road.
23. Robotic systems are increasingly used in manufacturing for their precision.
24. The product was certified for safety and effectiveness before it could be sold.
25. Emergency intervention may be necessary in the event of a natural disaster.
26. The rainforest is a rich ecosystem known for its high levels of biodiversity.
27. An ecosystem consists of all living and non-living things in a particular environment.
28. The density of the population influences urban planning and resource management.
29. The scientist ran a simulated experiment to predict the outcome.
30. The research team utilized a supercomputer to analyze vast amounts of data.

Answer

Multiple Choice: 1. Visibility 2. Robotic 3. Expedition 4. Biodiversity 5. Supercomputer 6. Microscopic 7. Intervention 8. Genome 9. Seep 10. Deadline
Gap-Fill: 11. dock 12. fragments 13. challenging 14. density 15. anomaly 16. enzyme 17. flexibility 18. breakthrough 19. microbial 20. robust
Matching sentence: 1. fireball 2. visibility 3. robotic 4. certified 5. intervention 6. biodiversity 7. ecosystem 8. density 9. simulated 10. supercomputer

CATEGORY

1. Sci/Tech - LEVEL4

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