‘Virtual Cell’ Reveals Key Process in Bacterial Division

Description

Researchers have successfully simulated nearly all chemical reactions occurring in a living bacterial cell. This groundbreaking virtual model illustrates the processes of DNA copying and cell division, offering insights into the molecular interactions that contribute to life.

Zane Thornburg, a computational biophysicist at the University of Illinois in Urbana-Champaign, co-led the study published on 9 March in *Cell*. He explained that understanding the interplay of proteins, nucleic acids, fats, and other molecules within a cell's wall is crucial to comprehending the essence of life itself.

To create the simulation, Thornburg selected a simplistic bacterial organism, JCVI-Syn3a, which boasts a “minimal” genome consisting of just 493 genes. This organism was developed by trimming away over 400 non-essential genes from the parasite *Mycoplasma mycoides*.

The detailed three-dimensional simulation incorporated various cellular components such as DNA, proteins, and ribosomes, capturing their dynamic behaviour over time. Key molecular interactions, like those involving a DNA-copying enzyme, were based on real-world measurements. However, some aspects were approximated due to limited knowledge; for example, certain JCVI-Syn3a genes were represented as inert spheres.

Initially, the team faced challenges, such as the genome deteriorating faster than it could replicate. After adjustments, they allowed the model to run during the US Thanksgiving holiday, only to return to find that a complete cell cycle had progressed. Thornburg remarked on the significant advancement this represented.

The simulation accurately reflected real-life cellular processes, including the transformation in shape during division. The virtual cell took 105 minutes to divide, mirroring the reproductive timeline of actual cells, though the simulation required six days on a supercomputer, highlighting the complexity involved.

Bernhard Palsson, a bioengineer at the University of California, San Diego, praised this achievement, noting the significance of coherently representing diverse cellular activities during the cell cycle. Future directions for this research may explore further optimization and refinement of the simulation's components.

Vocabulary List:

1. **simulated** //ˈsɪmjəˌleɪtɪd// (verb): made to act like the real thing
2. **interplay** //ˈɪntərpleɪ// (noun): how different things affect each other
3. **genome** //ˈdʒiːnoʊm// (noun): all the genes in a living thing
4. **replicate** //ˈrɛplɪkeɪt// (verb): copy itself to make more cells
5. **inert** //ɪˈnɝt// (adjective): not moving and not reacting with others
6. **optimization** //ˌɑptəmaɪˈzeɪʃən// (noun): making something work better or more efficiently

Comprehension Questions

Multiple Choice

1. What is the name of the bacterial organism used for the simulation?

   Option: JCVI-Syn3a
   Option: Mycoplasma mycoides
   Option: E. coli
   Option: Bacillus subtilis

2. How many genes does the JCVI-Syn3a organism have?

   Option: 493
   Option: 400
   Option: 200
   Option: 600

3. Which journal published the study?

   Option: Nature
   Option: Cell
   Option: Science
   Option: PLOS Biology

4. How long did the simulation take to run on a supercomputer?

   Option: 2 days
   Option: 4 days
   Option: 6 days

Option: 8 days

5. Who co-led the study at the University of Illinois?

Option: Bernhard Palsson
Option: Zane Thornburg
Option: Emma Watson
Option: John Smith

6. What key process does the simulation help illustrate?

Option: Photosynthesis
Option: Respiration
Option: DNA copying and cell division
Option: Protein synthesis

True-False

7. The simulation was published on 9 March.

8. The JCVI-Syn3a organism was created by adding genes to Mycoplasma mycoides.

9. The virtual cell took 105 minutes to divide in the simulation.

10. The researchers found that the genome replicated faster than it could deteriorate.

11. The simulation accurately reflects real-life cellular processes.

12. Zane Thornburg is a computational physicist.

Gap-Fill

13. The simulation illustrates the processes of DNA copying and cell division offering insights into the _____ interactions.

14. Bernhard Palsson praised the significance of coherently representing diverse cellular _____ during the cell cycle.

15. The JCVI-Syn3a organism has a minimal genome consisting of just _____ genes.

16. The simulation required _____ days on a supercomputer.

17. Understanding the interplay of proteins nucleic acids fats and other molecules is crucial to comprehending the essence of _____ itself.

18. The detailed three-dimensional simulation incorporated various cellular components such as DNA proteins and _____.

Answer

Multiple Choice: 1. JCVI-Syn3a 2. 493 3. Cell 4. 6 days 5. Zane Thornburg 6. DNA copying and cell division
True-False: 7. True 8. False 9. True 10. False 11. True 12. False
Gap-Fill: 13. molecular 14. activities 15. 493 16. six 17. life 18. ribosomes

Vocabulary quizzes

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

1. What term describes materials that can be broken down by natural processes?

Option: Invasive
Option: Biodegradable
Option: Reconstructed
Option: Synthetic

2. What device is used to increase an engine's efficiency and power by forcing more air into the combustion chamber?

Option: Supercharger
Option: Turbocharger
Option: Compressor
Option: Exhaust

3. Which word describes something that has never been done or experienced before?

Option: Commonplace
Option: Routine
Option: Unprecedented

Option: Mundane

4. What term refers to the complete set of genes or genetic material present in a cell or organism?

Option: Phenotype
Option: Genotype
Option: Genome
Option: Chromosome

5. What type of vehicle is typically associated with luxury and often used for special occasions?

Option: Sedan
Option: Limousine
Option: Coupe
Option: Hatchback

6. What word describes the remains or impression of a prehistoric organism preserved in petrified form?

Option: Fossil
Option: Specimen
Option: Artifact
Option: Relic

7. Which term is used to classify mammals that give birth to live young rather than laying eggs?

Option: Eutherian
Option: Marsupial
Option: Monotreme
Option: Ovoviviparous

8. What is the term used to measure the power output of engines?

Option: Torque
Option: Kilowatt
Option: Horsepower
Option: RPM

9. What does the acronym CRT stand for in display technology?

Option: Cathode Ray Tube
Option: Crystal Red Technology
Option: Color Ratio Technique
Option: Current Response Time

10. What term refers to the detail an image holds and is often measured in pixels?

Option: Clarity
Option: Resolution
Option: Aspect Ratio
Option: Contrast

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

11. The _____ of resources has led to increased competition and innovation.

12. Companies often seek to _____ new technologies to enhance their products.

13. The archaeologists _____ the ancient structure based on the remnants found at the site.

14. The _____ is the ratio of the width to the height of an image or screen.

15. Certain species are considered _____ because they can disrupt local ecosystems.

16. The _____ between different species is crucial for maintaining ecological balance.

17. The flight training included a _____ environment for pilots to practice safely.

18. Engineers often consider _____ to improve the performance of vehicles.

19. Humans usually have a total of twelve _____ in their permanent dentition.

20. The team focused on the _____ of processes to increase efficiency and reduce costs.

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

21. The scientists made a significant breakthrough in renewable energy technology.
22. The new packaging materials are fully biodegradable and environmentally friendly.
23. The theory introduced a new paradigm in the field of physics.
24. Invasive species can cause significant harm to local ecosystems.
25. The biologist collected a specimen for further study and analysis.

26. The changes in climate are leading to unprecedented challenges for communities worldwide.
27. Eutherian mammals are characterized by their live births and complex placental structures.
28. The turbocharger significantly improved the engine's performance and efficiency.
29. The outdated CRT technology has been largely replaced by LCD and LED displays.
30. The car's horsepower is a key factor in its speed and acceleration capabilities.

Answer

Multiple Choice: 1. Biodegradable 2. Turbocharger 3. Unprecedented 4. Genome 5. Limousine 6. Fossil 7. Eutherian 8. Horsepower 9. Cathode Ray Tube 10. Resolution
Gap-Fill: 11. scarcity 12. exploit 13. reconstructed 14. aspect ratio 15. invasive 16. interplay 17. simulated 18. modification 19. molars 20. optimization
Matching sentence: 1. breakthrough 2. biodegradable 3. paradigm 4. invasive 5. specimen 6. unprecedented 7. eutherian 8. turbocharger 9. CRT 10. horsepower

CATEGORY

1. Sci/Tech - LEVEL6

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