

Generative AI tools for scientists (pg. 2-55)

Using generative AI for teaching and

assessment (pg. 55-86)



Dr. Andre Pires da Silva

Generative AI tools for scientists



Andre Pires da Silva

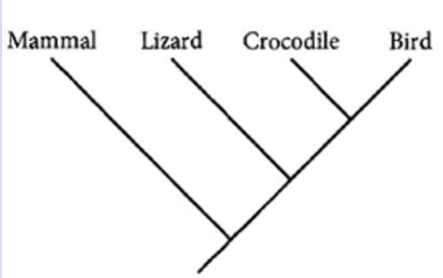
25 Oct 2023

Outline

Understanding generative AI



Case studies



AI Tools

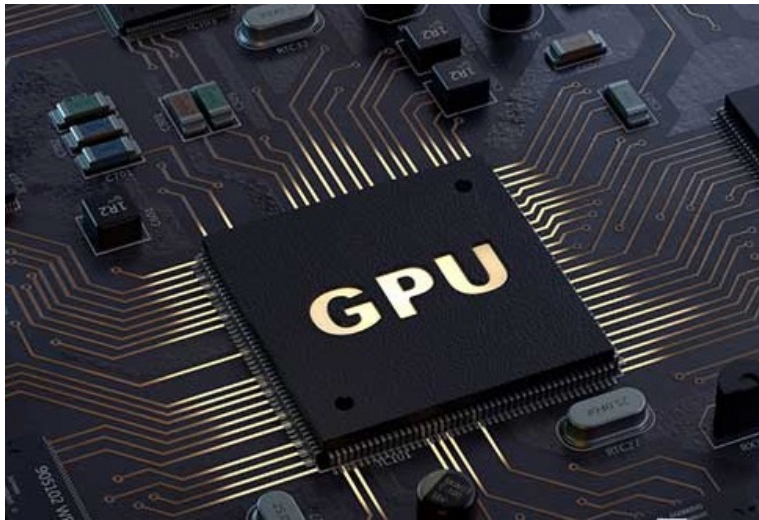


Understanding generative AI



Major breakthroughs in AI

Graphical Processing units (2010's)



Processing power cheap

Runs lots of calculations in parallel

Self-supervised learning (2017)



No labelling required

Contextual information

Overview of Self-Supervised Learning Technique

Hiding and Guessing Words

Concealing specific words and using contextual cues to make informed guesses.

Iterative Guess-Compare-Improve-Guess Cycles

Follow the loop of refining model predictions through repeated iterations, leading to increased statistical power.



ChatGPT

Generative Pre-trained
Transformer



Language Model for
Dialogue
Applications
(LaMBDA)

AI LLM lineup for 2024:

Gemini
Claude 3
Mistral 7B+
Inflection Pi 2
Baidu Ernie Bot
Elon's TruthGPT
Apple GPT (Ajax)
Llama 3 (possibly 4)
GPT-5...?

ChatGPT vs. Bard: what's the difference?



- ⊖ Requires a fee
- ⊖ Info from 2021 or earlier
- ⊖ Does not provide sources

- + Free
- + Real-time
- + Sources

ChatGPT vs. Bard: what's the difference?



- + Integrates Microsoft products
- + Good at writing tasks, such as generating text, translating languages, and coding.

[Source: Official Microsoft Blog](#)



- + Integrates with Google products
- + Research and information retrieval tasks, such as answering questions in a comprehensive and informative way.

[Source: Google Workspace](#)



You may get incorrect answers

☰ Bard Experiment

Here are some examples of homologous traits:

- The forelimbs of humans, bats, and whales are all homologous, even though they have different shapes and functions.
- The wings of insects and birds are both homologous, even though they have evolved independently.

Searching the internet

Integration of web search with ChatGPT



ChatGPT for Google 4.2.7

Display ChatGPT response alongside search engine results

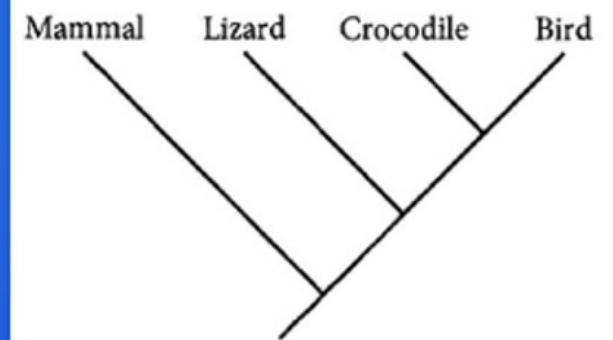
Microsoft Bing

SEARCH

CHAT

Google

what is this image?



This is a **phylogenetic tree**, which is a graphical representation of the evolutionary history between a set of species or taxa during a specific time ¹. The tree has four branches, each labeled with a different animal: "Mammal", "Lizard", "Crocodile", and "Bird". The branches are connected by lines, indicating evolutionary relationships between the animals. Phylogenetic trees are useful in fields of biology such as bioinformatics, systematics, and phylogenetics ^{1 2 3}.

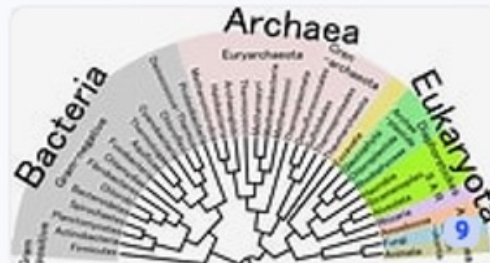
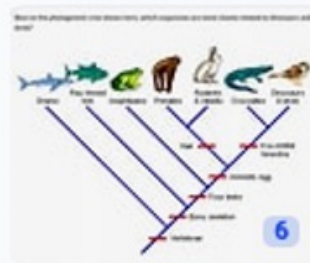
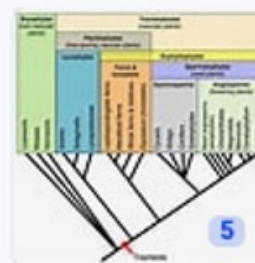
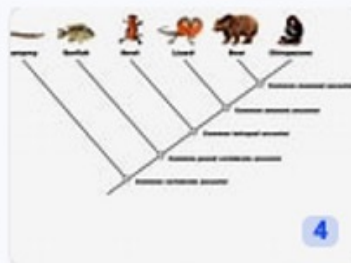
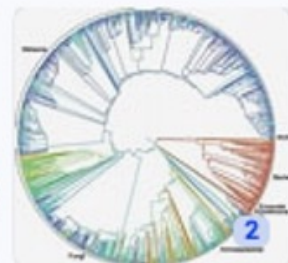
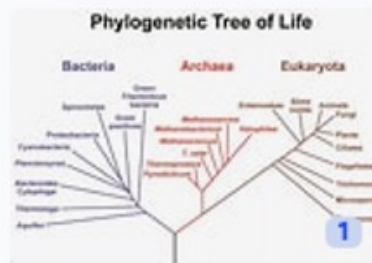
Learn more:

[1. en.wikipedia.org](https://en.wikipedia.org)

[2. khanacademy.org](https://www.khanacademy.org)

[3. bioprinciples.biosci.gatech.edu](https://bioprinciples.biosci.gatech.edu)

1 of 30 ●



[See all images >](#)

Images from:

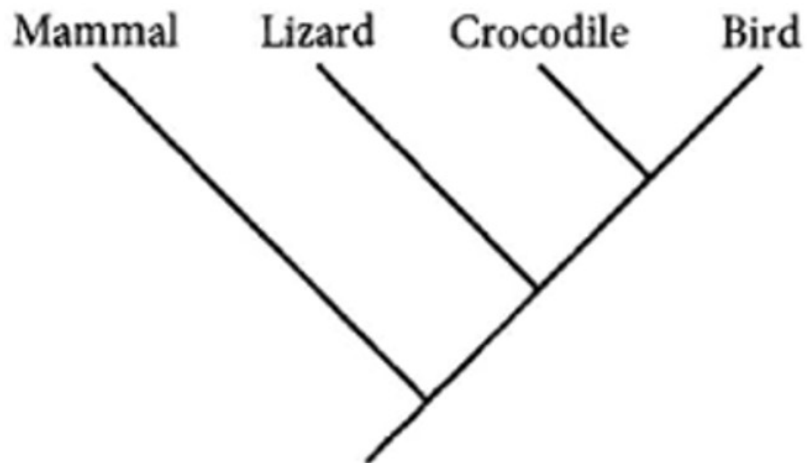
[1. beacon-center.org](https://beacon-center.org)

[2. reddit.com](https://www.reddit.com)

[+7 more](#)



ChatGPT



The graph depicts a set of evolutionary relationships among four groups: Mammal, Lizard, Crocodile, and Bird. It appears to be a simplified cladogram or phylogenetic tree.

- The Mammal is represented as branching off first, indicating it diverged from the other groups earlier in evolutionary history.
- Lizard diverges next, separating it from the remaining two groups.
- Crocodile and Bird are shown to have the most recent common ancestor, suggesting they are more closely related to each other than to the other groups on the tree.

The branching pattern indicates the evolutionary relationships among these groups, with the proximity of the branches suggesting relative relatedness.

A

which one is more closely related to crocodiles? Birds or lizards?



Birds are more closely related to crocodiles than lizards are.

A

can you give some bibliographic references about these relationships?



Of course! The relationship between birds, crocodiles, and lizards (more generally, reptiles) has been studied extensively in the field of evolutionary biology and paleontology. Here are some key bibliographic references that discuss this relationship:

1. **Hedges, S. B., & Poling, L. L.** (1999). A molecular phylogeny of reptiles. *Science*, 283(5404), 998-1001.
2. **Benton, M. J.** (1990). Phylogeny of the major tetrapod groups: morphological data and divergence dates. *Journal of Molecular Evolution*, 30(5), 409-424.
3. **Brochu, C. A.** (2003). Phylogenetic approaches toward crocodylian history. *Annual Review of Earth and Planetary Sciences*, 31(1), 357-397.
4. **Gauthier, J. A.** (1986). *Saurischian monophyly and the origin of birds*. *Memoirs of the California Academy of Sciences*, (8), 1-55.
5. **Gauthier, J. A., & Padian, K.** (1985). Phylogenetic, functional, and aerodynamic analyses of the origin of birds and their flight. In *The Beginnings of Birds* (pp. 185-197).

Hallucination

A

give me some references about Auanema, including the one in which the species was described?



Certainly. Here are some references pertaining to the genus Auanema, including the seminal work where the species was described:

1. Sudhaus, W. & Hooper, D.J. (1994). "Characterisation of Auanema rhodensis n. sp. (Nematoda: Rhabditidae) from Rhodes with a revised taxonomy of the Auanema-group and a molecular analysis of its phylogeny." *Nematologica*, 40: 115–133. [This paper describes the species Auanema rhodensis.]
2. Kanzaki, N., & Giblin-Davis, R.M. (2012). "Auanema" In: Manzanilla-López RH, Marbán-Mendoza N, editors. *Practical Plant Nematology*. México: Colegio de Postgraduados/Biblioteca básica de Agricultura/Mundi-Prensa. p. 437-439.
3. Felix, M.A., et al. (2014). "Evolution of vulva development in the Cephalobina (Nematoda)." *Dev Biol*, 394(2): 142-56.

These references do not exist!

The following are some references about Auanema, including the one in which the species was described:

- **Description of two three-gendered nematode species in the new genus Auanema (Rhabditina) that are models for reproductive mode evolution** (Van den Abbeele et al., 2017): This paper describes the two new species of Auanema, Auanema sp. SB347 and Auanema sp. SB372, and establishes the new genus Auanema.
- **Molecular phylogeny and systematics of the Rhabditina (Nematoda)** (Van den Abbeele et al., 2017): This paper presents a molecular phylogeny of the Rhabditina, which includes the genus Auanema.
- **The reproductive biology of Auanema sp. SB347 (Nematoda: Rhabditina)** (Van den Abbeele et al., 2018): This paper describes the reproductive biology of Auanema sp. SB347, including its three genders (male, female, and hermaphrodite) and its unique mode of reproduction.
- **Auanema sp. SB347 (Nematoda: Rhabditina) as a model system for studying the evolution of sex and reproduction** (Van den Abbeele et al., 2019): This paper reviews the potential of Auanema sp. SB347 as a model system for studying the evolution of sex and reproduction.

These references do not exist. The first author also doesn't exist.



The complete reference for Van den Abbeele et al., 2019 is:

Auanema sp. SB347 (Nematoda: Rhabditina) as a model system for studying the evolution of sex and reproduction

Van den Abbeele, T., Félix, M.-A., & Braendle, C. (2019). Auanema sp. SB347 (Nematoda: Rhabditina) as a model system for studying the evolution of sex and reproduction. *Frontiers in Ecology and Evolution*, 7, 226. doi: 10.3389/fevo.2019.00226

This paper was published in the journal *Frontiers in Ecology and Evolution* in 2019. It is a review article that discusses the potential of the nematode species Auanema sp. SB347 as a model system for studying the evolution of sex and reproduction.

These references do not exist.

Correct (mostly)

Auanema is a genus of nematodes that has recently been discovered. It is notable for having three sexes and being able to survive in environments with high levels of arsenic ¹ ². The species was first described in a scientific report published in the journal Nature ³. The report describes two new species of nematodes with trioecy, *Auanema rhodensis* and *A. freiburgensis*, which were assigned to the new genus *Auanema* based on morphological data. The report also provides a detailed analysis of the morphology of these species, and documents it with drawings and light and SEM micrographs.

Here are the references you asked for:

1. Kanzaki, N., Kiontke, K., Tanaka, R., Hirooka, Y., Schwarz, A., Müller-Reichert, T., Chaudhuri, J., & Pires-daSilva, A. (2017). Description of two three-gendered nematode species in the new genus *Auanema* (Rhabditina) that are models for reproductive mode evolution. *Scientific Reports*, 7(1), 11135. [PDF](#)
2. New Species of Microscopic Worm Has Three Sexes, Lives in Arsenic-Rich Environment. (2019, September 30). *Sci-News.com*. [Link](#)
3. Otherworldly worms with three sexes discovered in Mono Lake. (2019, September 26). *Phys.org*. [Link](#)

Bing is not always correct

Trioecy is a sexual system characterized by the coexistence of males, females, and hermaphrodites in the same population. It is relatively common in plants, but rare and poorly understood in animals ¹ ².

Some animals that exhibit trioecy include:

1. **Semimytilus algosus**: A marine mussel that has been described as a simultaneous hermaphrodite ³.
2. **Aiptasia diaphana**: A nematode worm with three sexes (males, females, and hermaphrodites) ¹.
3. **Auanema rhodensis**: A nematode worm with three sexes that can self-fertilize ¹.
4. **Auanema freiburgensis**: A nematode worm with three sexes that can self-fertilize ¹.
5. **Hydra viridissima**: A freshwater polyp with three sexes (males, females, and hermaphrodites) ¹.
6. **Thor manningi**: A marine copepod with three sexes (males, females, and hermaphrodites) ⁴.

Aiptasia is a sea anemone

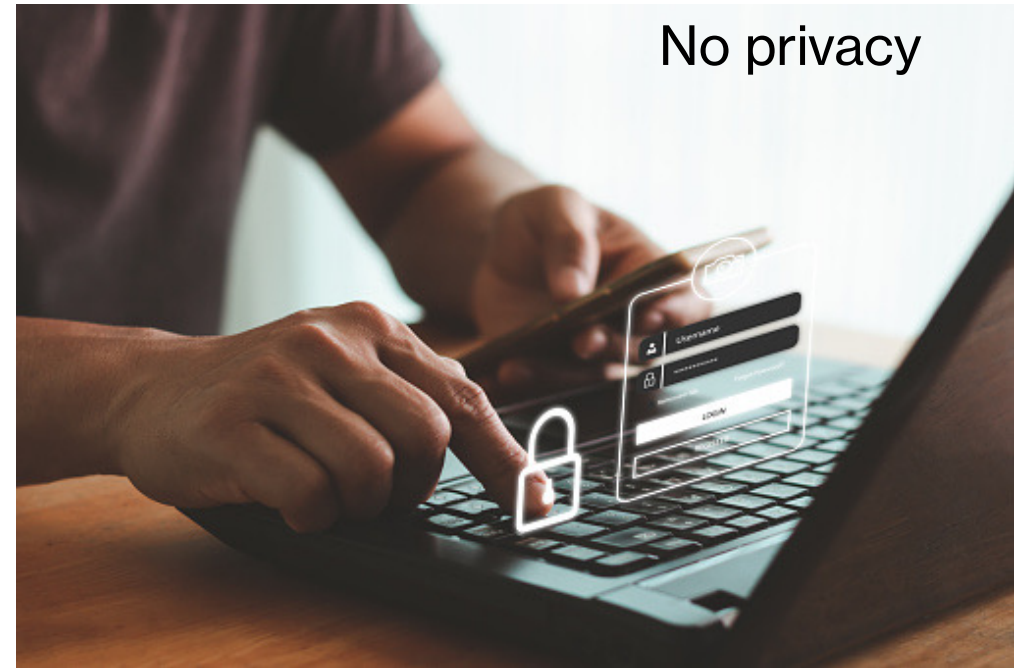
Issues with Generative AI



[Korean J Radiol 2023;24\(10\):952-959](#)

Plagiarism of internet content

Watermark



Personal data is being used to train AI

Few platforms allow to opt out

Issues with Generative AI

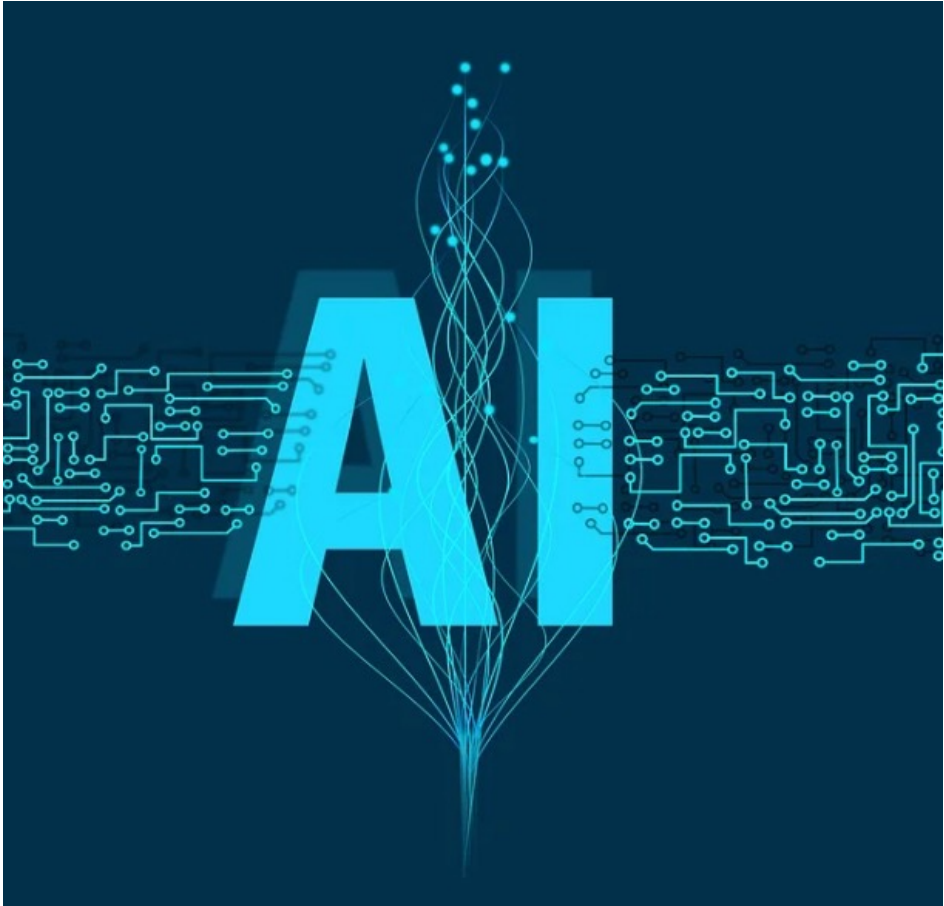
Lack of transparency



Which datasets are being used for training?

AI is not trained for accuracy

Take aways so far

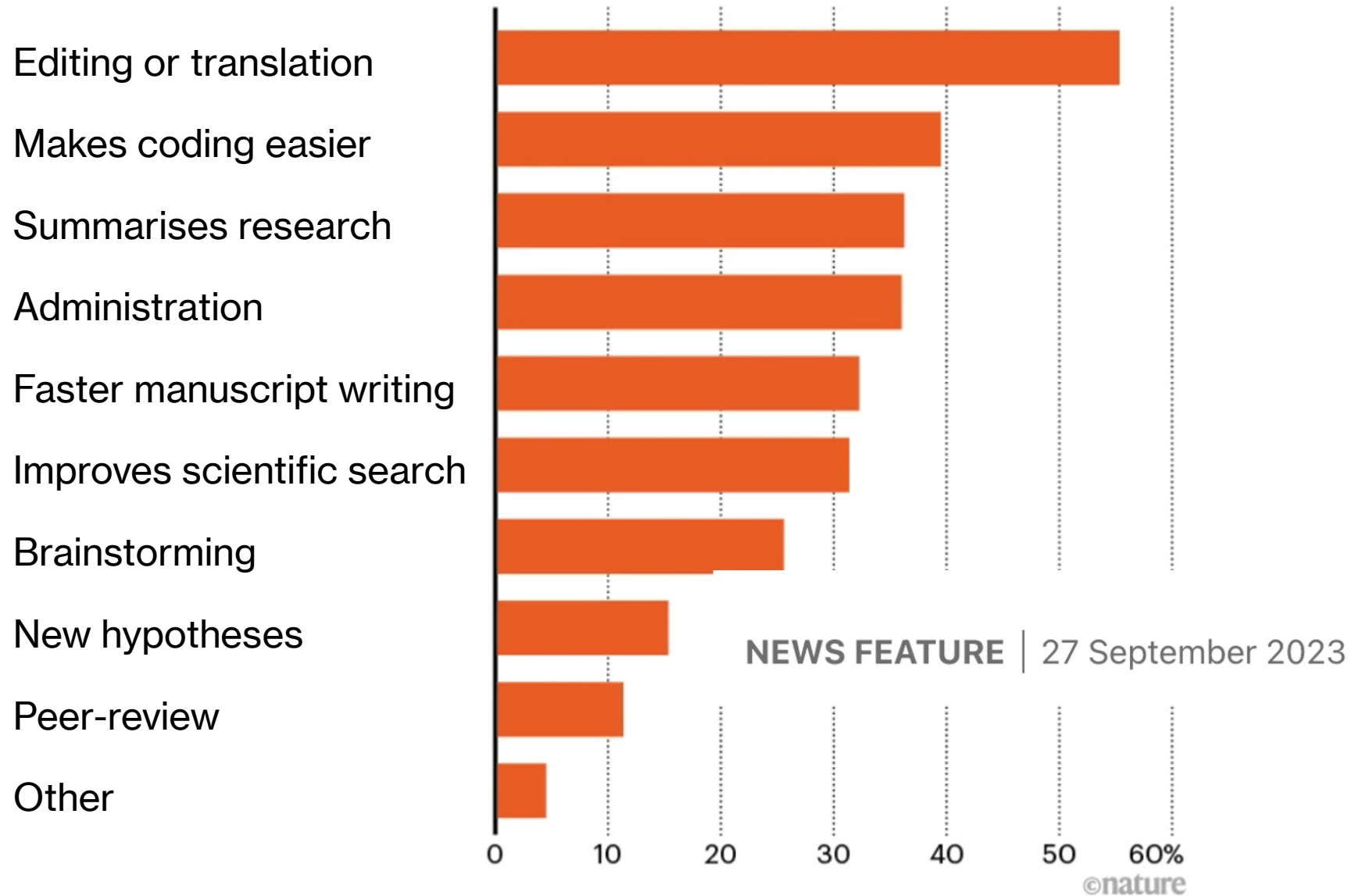


It does not reason, it predicts.

It is limited by the context window.

It has no database, copy or paste or memory.

Benefits of AI



SCIENTISTS USED CHATGPT TO GENERATE A WHOLE PAPER FROM DATA

Nature | Vol 619 | 20 July 2023 | **443**

An autonomous system prompted ChatGPT to write a paper that was fluent and insightful, but flawed.

- automatically prompts ChatGPT to explore a dataset
- develop study objectives
- create a plan and a code for data analysis
- writes a draft that reads rather fluently with a typical structure of a research paper, all within a span of **one hour**.

SCIENTISTS USED CHATGPT TO GENERATE A WHOLE PAPER FROM DATA

An autonomous system prompted ChatGPT to write a paper that was fluent and insightful, but flawed.

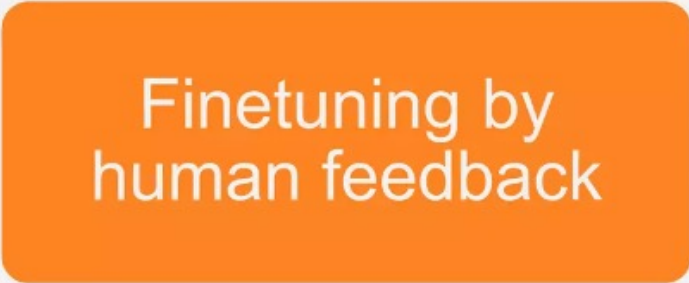
- “addresses a gap in the literature” – a phrase that is common in papers but inaccurate in this case
- *P*-hacking: test several hypotheses, just report the positive ones
- Journals will be flooded
- Danger of polluting the literature

Can large language models provide useful feedback on research papers? A large-scale empirical analysis.

Weixin Liang^{1*}, Yuhui Zhang^{1*}, Hancheng Cao^{1*}, Binglu Wang², Daisy Yi Ding³, Xinyu Yang⁴, Kailas Vodrahalli⁵, Siyu He³, Daniel Scott Smith⁶, Yian Yin⁴, Daniel A. McFarland⁶, and James Zou^{1,3,5+}

- The degree of overlap between GPT-4 and human reviewers was comparable to the overlap observed between two human reviewers
- The feedback provided by the LLM was often vague and not domain-specific
- Lacked the ability to provide specific technical areas for improvement, which could hinder the paper's potential for improvement

Fine-tuning foundation models to make tools



General AI Tools



GitHub
Copilot



HUMATA



Gamma



MIND THE
GRAPH

Coding



ChatGPT

- not always accurate, but it can still write good code examples.



**GitHub
Copilot**

- GitHub Copilot is a code completion tool that uses AI to suggest lines of code while you are writing.

Tutoring to learn programming

RTutor.ai 0.96



Dataset: rna_seq

Reset

Example requests:

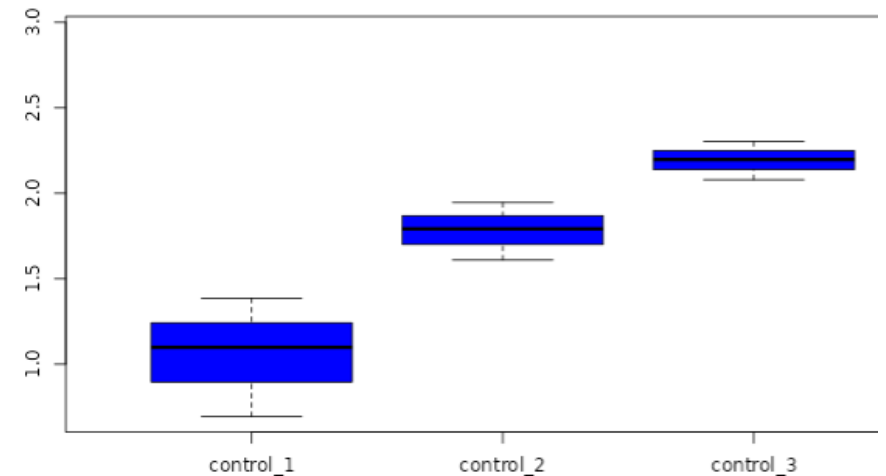
Boxplot, log

Add 1 to all numbers and then conduct log transformation. Create a bloxplot of all columns. The bloxplot should be plotted in blue.

```
df <- data.frame(control_1 = c(1, 2, 3),
                  control_2 = c(4, 5, 6),
                  control_3 = c(7, 8, 9),
                  Hoxa1KN_1 = c(10, 11, 12),
                  Hoxa1KN_2 = c(13, 14, 15),
                  Hoxa1KN_3 = c(16, 17, 18))
```

```
df <- df + 1
df <- log(df)
```

```
boxplot(df, col = "blue")
```



<https://github.com/gexijin/RTutor>

Interacting with documents

The image shows a screenshot of the Humata website and its AI interface. The website header includes the Humata logo, navigation links for Pricing, Company, Security, and Resources, and buttons for Log in and Sign up. A green banner below the header reads "Humata AI Secures \$3.5M led by Google's Gradient Ventures". The main heading is "Asking is faster than skimming", followed by the text "Chat your way through long documents. Command our AI to summarize for you. Try for free →". Below this is a screenshot of the Humata AI interface. The interface shows a chat window on the left with a question: "what legal risks can the Company face due to the absence of specific mention of subcontractor indemnification?". The AI response on the right provides a detailed summary of the risks, mentioning potential legal proceedings and damage to the company. The background of the interface shows a document with sections 4.2, 5.1, 5.2, and 7. INDEMNITY.

Humata AI Secures \$3.5M led by Google's Gradient Ventures

Asking is faster than skimming

Chat your way through long documents. Command our AI to summarize for you. [Try for free](#) →

Humata

Ask Humata

what legal risks can the Company face due to the absence of specific mention of subcontractor indemnification?

The absence of specific mention of subcontractor indemnification could expose the Company to potential legal risks such as liability for damages or losses caused by the subcontractor, or disputes arising from unclear allocation of responsibilities and liabilities [4]. This could potentially lead to costly legal proceedings and damage to the Company's reputation. Therefore, it may be prudent to consider

of this Agreement), Customer shall be billed for such usage and Customer agrees to pay the additional fees in the manner provided herein. If Customer believes that Company has billed Customer incorrectly, Customer must contact Company no later than 60 days after the closing date on the first billing statement in which the error or problem appeared, in order to receive an adjustment or credit. Inquiries should be directed to Company's customer support department.

4.2 Company may choose to bill through an invoice, in which case, full payment for invoices issued in any given month must be received by Company thirty (30) days after the mailing date of the invoice. Unpaid amounts are subject to a finance charge of 1.5% per month on any outstanding balance, or the maximum permitted by law, whichever is lower, plus all expenses of collection and may result in immediate termination of Service. Customer shall be responsible for all taxes associated with Services other than U.S. taxes based on Company's net income.

5. **TERM AND TERMINATION**

5.1 Subject to earlier termination as provided below, this Agreement is for the Initial Service Term as specified in the Order Form, (the "Term").

5.2 In addition to any other remedies it may have, either party may also terminate this Agreement upon thirty (30) days' of this Agreement).

7. **INDEMNITY**



Company shall hold Customer harmless from liability to third parties resulting from infringement by the Service of any United States patent or any copyright or misappropriation of any trade secret, provided Company is promptly notified of any and all threats, claims and proceedings related thereto and given reasonable assistance and the opportunity to assume sole control over defense and settlement; Company will not be responsible for any settlement it does not approve in writing. The foregoing obligations do not apply with respect to portions or components of the Service (i) not supplied by Company, (ii) made in whole or in part in accordance with Customer specifications, (iii) that are modified after delivery by Company, (iv) combined with other products, processes or materials where the alleged infringement relates to such combination, (v) where Customer continues allegedly infringing activity after being notified thereof or after being informed of modifications that would have avoided the alleged infringement, or (vi) where Customer's use of the Service is not strictly in accordance with this Agreement. If, due to a claim of infringement, the Services are held by a court of competent jurisdiction to be or are believed by Company to be infringing, Company may, at its option and expense (a) replace or modify the Service to be non-infringing provided that such

- Summarizes





- Finds info


ChatGTP has plugins

⚡ GPT-3.5 🧩 GPT-4

  ▼

2/3 Enabled

 BioRxiv Researcher	<input type="checkbox"/>
 Science	<input type="checkbox"/>
 Ai PDF	<input checked="" type="checkbox"/>
 Litmaps	<input type="checkbox"/>


Ai PDF
Super-fast, interactive chats with PDFs of any size, complete with page references for fact checking.

Generating Powerpoint presentations



Gamma

Jump to ⌘+K

All gammas

Folders

Organize your gammas by topic and share them with your team

[Create or join a folder](#)

Templates

Inspiration

Themes

Custom fonts

Trash

Invite to workspace

0 credits

Contact us

Templates

Projects & Collaboration

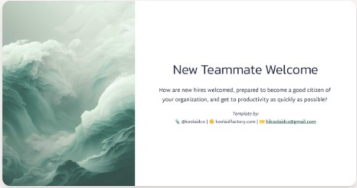
Templates to help you run your business ⚡



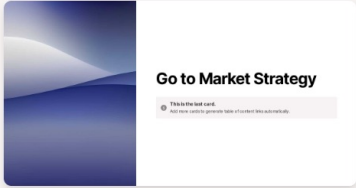
Project Kickoff



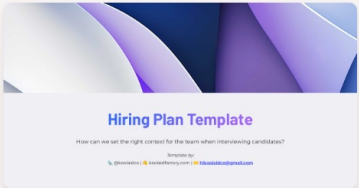
Six Hats Brainstorming



New Teammate Welcome



Go to Market Strategy



Hiring Plan



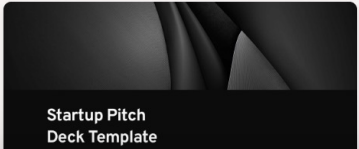
Team Outlook



Quarterly Investor Report

Sales & Marketing

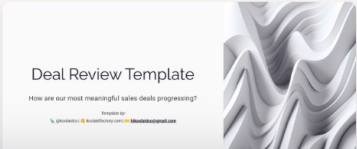
Templates to help you grow your business 🌱



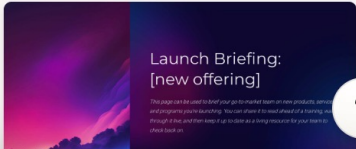
Startup Pitch Deck Template



Company Fact Sheet



Deal Review Template



Launch Briefing: [new offering]

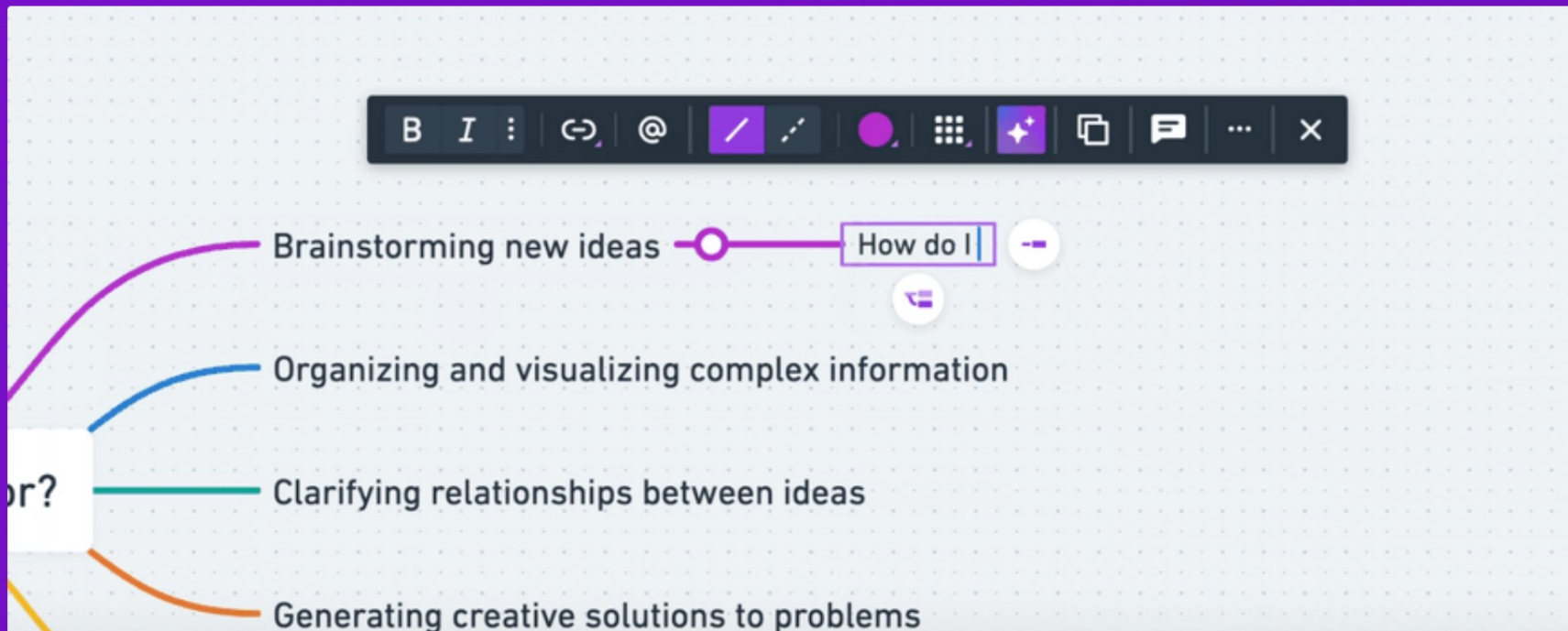




AI for Mind Maps

Fresh ideas at your fingertips.

Try it now



Templates > Poster > Research Poster

Free AI Research Poster Maker

Create Research Poster Images, Videos & Animations using AI Research Poster Generator

Start your design with a prompt...

Generate

Try these

A woman, warrior, detailed illustration, ...

Create an image of a futuristic citysca...

A clear portrait of a superhero, backgro...

AI tools to teach how to write



- instant feedback from AI assistant
- grammar
- flow and structure
- research quality



Craft your essay, paper or thesis.

Get language feedback, explore the writing patterns of journal articles, browse academic phrases to use, automatically paraphrase text, and auto-generate your title.

[DOWNLOAD FOR MAC](#) [DOWNLOAD FOR WINDOWS](#)

Paraphrase

Although the ~~The study has not shown any~~ showed no lasting effects, ~~the method needs to~~ but this approach should be further ~~investigated.~~ explored.

[REPLACE](#) [REGENERATE](#) [CLOSE](#)

[needs to be further investigated](#) - 99% [ACCEPT](#)

[need to be investigated more](#) - 1% [REJECT](#)

Although the study has ~~ne not~~ shown any lasting ~~affects~~ effects, the method ~~need-to-be-investigated-more.~~ needs to be further investigated.

[ACCEPT ALL](#) [REJECT ALL](#)

How to write



EDIT TEXT

- Paraphrase > Academically
- Simplify > Casually
- Shorten > Persuasively
- Expand > Boldly
- Translate > Friendly



- Proofread File
- Word Add-ins
- Browser Plug-ins
- Reports
- Citation Check
- Plagiarism Check
- Journal Finder

Rank #1

PLoS Genetics

Publisher: Public Library of Science | [Journal Website](#)

Impact Factor: 6.02

H Index: 244

CiteScore: 9.3


Language: ENG

Geography: United States

[See all similar articles published \(39\)](#)



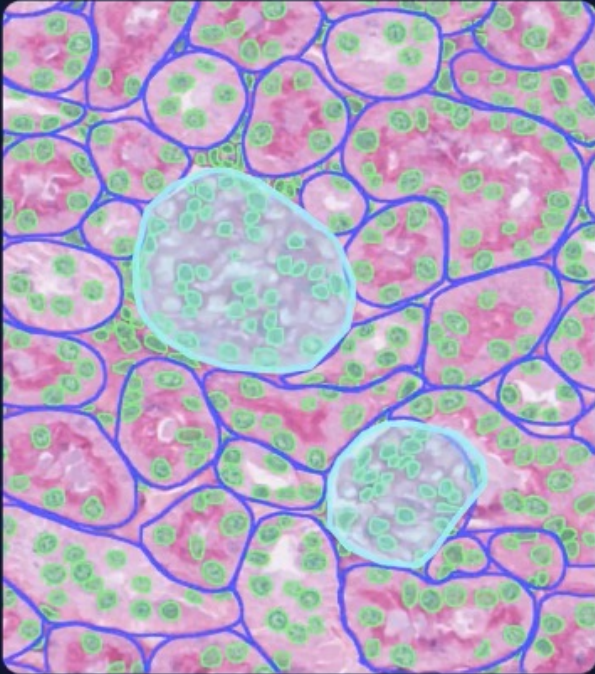
AI image analysis




 **Biodock** Security Docs [↗](#) Blog [↗](#) Login [Sign up](#)

Deep AI for biological images.

Speed up scientific discovery with AI image analysis.

[Start now](#) [Talk to us](#)



-  **Glomeruli**
Completed [Success](#)
-  **Renal Tubules**
Completed [Success](#)
-  **Cells**
Completed [Success](#)

AI tools to search the scientific literature: Case studies

Elicit

 SCISPACE

 consensus

 perplexity

 SEMANTIC SCHOLAR

 Litmaps



Insight from top 5 papers

English (en)



Auanema is a genus of nematodes with trioecy, consisting of five species including *A. rhodensis* and *A. freiburgensis*. These species display convergent evolution with parasitic nematodes in certain features, such as the production of few males after outcrossing and the obligatory development of dauers into self-propagating adults [1]. The description of the new species of *Euryhaliotrema*, including the measurement, can be found in a paper by LI Hai-yan [2]. Lord Rothschild described new species of *Chionaema*, *Asura*, and *Miltochrista* in a paper published in 1936 [3]. Ann-Margret Amui reported two species of *Adeonella*, including a new species, from the Gulf of Aden [4]. T. C. Whitmore conducted a study on the genus *Agathis*, recognizing thirteen species, including two with subspecies, and providing information on their distribution [5].

Was this helpful? Ask a followup

Papers (10)	Insights	TL;DR
<p> Open access • Journal Article • DOI </p> <p><input type="checkbox"/> Description of two three-gendered nematode species in the new genus Auanema (Rhabditina) that are models for reproductive mode evolution</p> <p> Natsumi Kanzaki +7 more</p> <p>11 Sep 2017 - Scientific Reports</p> <p>51 Citations Ask Copilot</p>	<p>The paper "Description of two three-gendered nematode species in the new genus Auanema" describes the Auanema species.</p>	<p>Two new species of nematodes with trioecy are described, <i>Auanema rhodensis</i> and <i>A. freiburgensis</i>, which display convergent evolution in some features with parasitic nematode with complex life cycles, such as the production of few males after outcrossing and the obligatory development of dauers into self-propagating adults.</p>
<p> Open access • Journal Article</p> <p><input type="checkbox"/> Description of two species (including a new one)in Euryhaliotrema Kritsky & Boeger, 2002</p> <p> LI Hai-yan</p> <p>01 Jan 2005 - Journal of Dalian Fisheries University</p> <p>4 Citations Ask Copilot</p>	<p>The given text does not provide any information about Auanema or its references.</p>	<p>Two species (including a new one) in <i>Euryhaliotrema</i> Kritsky Boeger,2002 are described and the measurement is described in μm.</p>




Description of two three-gendered nematode...

 nih · 1

Auanema - Nemaplex

 ucdavis · 2

Report Newly Identified Nematodes from Mono...

 sciencedirect · 3

Parental energy-sensing pathways control...

 biomedcentral · 4

Chromosome-Wide Evolution and Sex...

 oup · 5

Description of two three-gendered nematode...

 researchgate · 6

- *Auanema rhodensis* and *A. freiburgensis* are two new species of nematodes with trioecy, which means they produce males, females, and hermaphrodites ¹ ⁶.
- *Auanema* sp. is a new, culturable nematode species that exhibits extreme arsenic resistance ³.
- *Auanema freiburgensis* is a species in which the environmental cues experienced by the mother determine dauer formation and sexual morph fate of the offspring ⁴.
- *Auanema rhodensis* produces males, females, and hermaphrodites, both by selfing and crossing. Males have one X chromosome (XO), whereas females and hermaphrodites have two (XX) ⁵.

These papers provide references and descriptions of different species of Aulonemia. [Viana 2014](#) describes three new species of Aulonemia found in the Brazilian Atlantic rainforest. [Clark 1997](#) describes a new species, Aulonemia bogotensis, found in the Cordillera Oriental of Colombia. [Sousa 2014](#) focuses on the taxonomic treatment of the genus Abuta in the State of Rondonia, Brazil, and does not directly address Aulonemia. Finally, [Judziewicz 2008](#) describes a new species, Aulonemia yanachagensis, found in central Peru.

Paper	Abstract summary
<p>Three new species of Aulonemia (Poaceae: Bambusoideae) from the Brazilian Atlantic rainforest</p> <p>🔗 P. Viana +1</p> <p>2014 4 citations DOI</p>	<p>Aulonemia cincta is characterized among other Brazilian congeners by its fimbriate leaf sheaths.</p>
<p>Aulonemia bogotensis (Poaceae: Bambusoideae), a new species from the Cordillera Oriental of Colombia</p> <p>🔗 L. Clark +2</p> <p>📖 <i>Brittonia</i></p> <p>1997 1 citation DOI</p>	<p>Aulonemia bogotensis is distinguished by its diminutive size, abaxially tomentose foliage leaf blades, and spikelets with muticous lemmas.</p>
<p>TAXONOMIA DO GÊNERO Abuta Aubl. (MENISPERMACEAE) NO ESTADO DE RONDÔNIA, BRASIL</p> <p>🔗 Julío dos Santos de Sousa +3</p> <p>2014 1 citation DOI</p>	<p>The genus Abuta is represented by eight species in Rondonia.</p>
<p>Aulonemia yanachagensis (Poaceae: Bambusoideae: Bambuseae): A new species from central Peru</p> <p>🔗 E. Judziewicz +1</p> <p>📖 <i>Brittonia</i></p> <p>2008 4 citations DOI</p>	<p>Aulonemia yanachagensis grows in the cloud forest of the Parque Nacional Yanachaga-Chemillén Prov. Oxapampa, Dept. Pasco, Peru, at elevations between 2600–3000 m.</p>



beta

give me some references about Auanema, including the one in which the species was described?



Auanema species display convergent evolution in some features with parasitic nematodes with complex life cycles, such as the production of few males after outcrossing and the obligatory development of dauers into self-propagating adults.

Description of two three-gendered nematode species in the new genus Auanema (Rhabditina) that are models for reproductive mode...

Scientific Reports | N. Kanzaki et al. | 2017

Study Snapshot

Save | Cite | Share

We find evidence for three Aurelia species, none of which are referable to the type species of the genus, Aurelia aurita (Linnaeus, 1758), and describe the anatomical, morphometric, and developmental variation within and between them.

Unmasking Aurelia species in the Mediterranean Sea: an integrative morphometric and molecular approach

Zoological Journal of the Linnean Society | Simonetta Scorrano et al. | 2016

Highly Cited



Environmental stress maintains trioecy in nematode worms

[A. G. Anderson](#), [Louis T. Bubrig](#), [J. Fierst](#) · Biology · bioRxiv · 3 December 2019

TLDR It is shown that the flexible sex determination system of *A. freiburgensis* may contribute to population-level resilience in the microscopic nematode's patchy, ephemeral natural habitat and demonstrate that life history, ecology and environment may play defining roles in the evolution of sexual systems. [Expand](#)

5

PDF

Wiley

Save

Cite

Chromosome-Wide Evolution and Sex Determination in the Three-Sexed Nematode *Auanema rhodensis*

[Sophie Tandonnet](#), [Georgios D. Koutsovoulos](#), +4 authors [A. Pires-daSilva](#) · Biology · G3: Genes, Genomes, Genetics · 15 February 2019

TLDR A framework for studying the evolution of chromosomes in rhabditine nematodes, as well as possible mechanisms for the sex determination in a three-sexed species is provided. [Expand](#)

26

PDF

Genetics

Save

Cite

Description of two three-gendered nematode species in the new genus *Auanema* (Rhabditina) that are models for reproductive mode evolution

[N. Kanzaki](#), [K. Kiontke](#), +5 authors [A. Pires-daSilva](#) · Biology · Scientific Reports · 11 September 2017

TLDR Two new species of nematodes with trioecy are described, *Auanema rhodensis* and *A. freiburgensis*, which display convergent evolution in some features with parasitic nematode with complex life cycles, such as the production of few males after outcrossing and the obligatory development of dauers into self-propagating adults. [Expand](#)

Seed

Discover

Map

The genome of *Tetranychus urticae* reveals herbivorous pest adaptations

Grbić, 2011 - Nature

★ Discover 20 more related articles

Save...

What's this?

Seed Map Articles



Genomic, RNAseq, and Molecular Modeling Evidence Suggests That the Major Allergen Domain in Insects

● Randall, 2013 - Genome Biology and Evolution

52 18

Jasmonic Acid and Salicylic Acid Levels in Defense Response of Azalea (*Rhododendron simsii* Hybrid) to

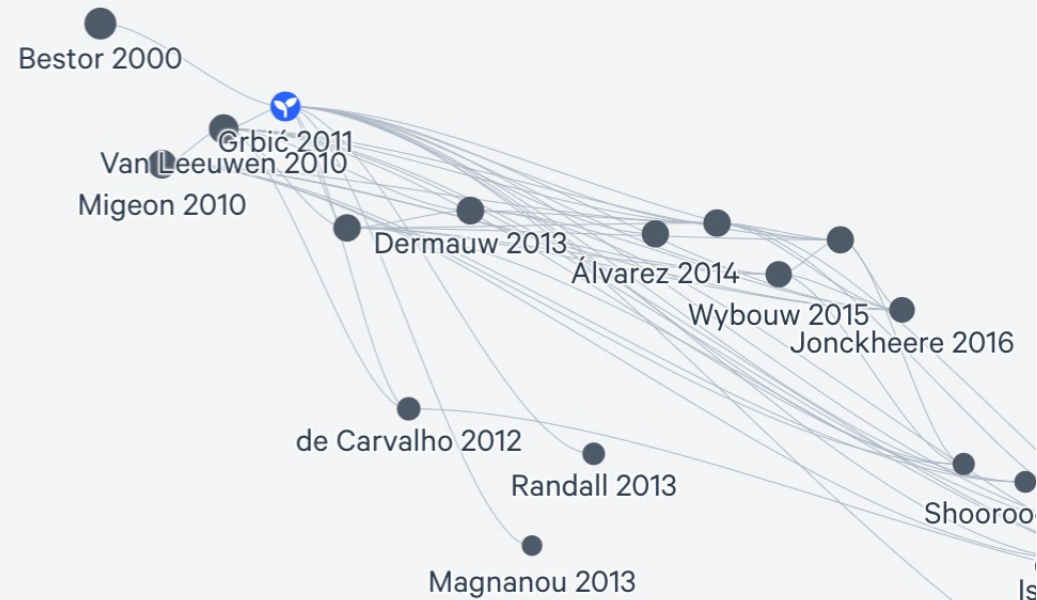
● Leus, 2022 - Horticulturae

50 0

Seed Article

Articles

Team 2014



Connecting Google sheets with ChatGPT 4

1222333_Alex_Business Analyst
Joe-45454-Finance Director
Bobby bob - 3333344_Marketing manager
Software Engineer 34344343 Jan

```
fx =GPT("Please Extract the Name of the following text ONLY: "&B5)
```

1222333_Alex_Business Analyst	Alex
Joe-45454-Finance Director	Joe
Bobby bob - 3333344_Marketing manager	Bobby bob
Software Engineer 34344343 Jan	Jan

Settings



 General

 Beta features

 Data controls

As a Plus user, enjoy early access to experimental new features, which may change during development.

Browse with Bing



Try a version of ChatGPT that knows when and how to browse the internet to answer questions about recent topics and events.

Plugins



Try a version of ChatGPT that knows when and how to use third-party plugins that you enable.

Advanced data analysis



Try a version of ChatGPT that knows how to write and execute python code, and can work with file uploads. Try asking for help with data analysis, image conversions, or editing a code file. Note: files will not persist beyond a single session.

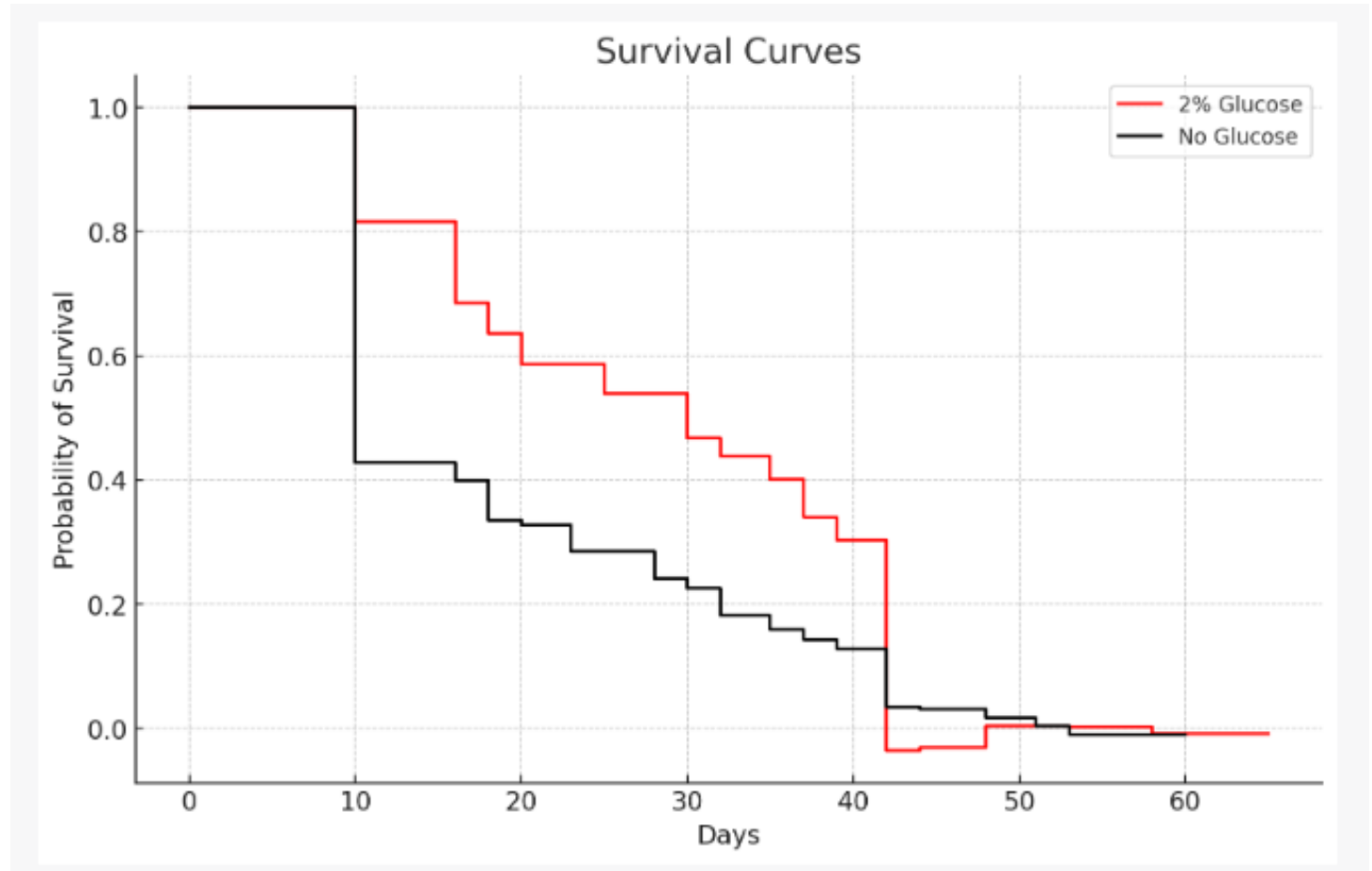
ChatGTP can produce graphs

this new spreadsheet has data for animals exposed to 2% glucose (columns A-D) and animals not exposed to glucose (columns F-I). Show the survival curves and compare with statistics whether these 2 conditions result in different outcomes.

2% DR	Alive	Dead	Censored		NO GLUC	Alive	Dead	Censored
1	103	0	0		1	99	0	0
3	103	0	0		3	99	0	0
8	103	0	0		8	99	0	0
10	87	16	0		10	63	36	0
16	75	12	0		16	59	4	0
18	70	5	0		18	44	7	0
20	65	5	0		20	43	1	0
23	65	0	0		23	38	5	0
25	60	5	0		25	38	0	0
28	60	0	0		28	33	5	0
30	53	7	0		30	31	2	0
32	50	3	0		32	26	5	0
35	46	4	0		35	23	3	0
37	40	6	0		37	21	2	0
39	36	4	0		39	19	2	0
42	17	19	0		42	11	8	0
44	15	2	0		44	10	1	0
48	7	8	0		48	7	3	0
51	7	0	0		51	4	3	0
53	5	2	0		53	1	3	0
55	5	0	0		55	1	0	0
58	1	4	0		58	1	0	0
60	1	0	0		60	0	1	0
62	1	0	0					
65	0	1	0					

ChatGTP can produce graphs

```
plt.figure(figsize=(10, 6))
plt.step(times_2pct, prob_survival_2pct, where='post', label='2% Glucose',
plt.step(times_no_gluc, prob_survival_no_gluc, where='post', label='No Glucose',
plt.title('Survival Curves')
plt.ylabel('Probability of Survival')
plt.xlabel('Days')
plt.legend()
plt.grid(True)
plt.show()
```



Extract data from an image (only rows with black characters)

Table 2	P3.p	P4.p	P5.p	P6.p	P7.p	P8.p
Wild type	3°	3°	2°	1°	2°	3°
1	3°	3°	2°	1°	2°	3°
2	3°	3°	2°	2°	3°	3°
3	3°	2°	2°	1°	2°	3°
4	3°	3°	2°	3°	2°	3°
5	3°	3°	2°	3°	2°	3°
6	3°	3°	2°	1°	3°	3°
7	3°	2°	1°	1°	3°	3°
8	3°	3°	2°	3°	3°	3°



Here's the extracted data from the table where all characters are in black:

Table 2

	P3.p	P4.p	P5.p	P6.p	P7.p	P8.p
Wild type	3°	3°	2°	1°	2°	3°

All other rows contain one or more characters in red and have thus been excluded from the extraction. If you have any other requests or questions, please let me know!

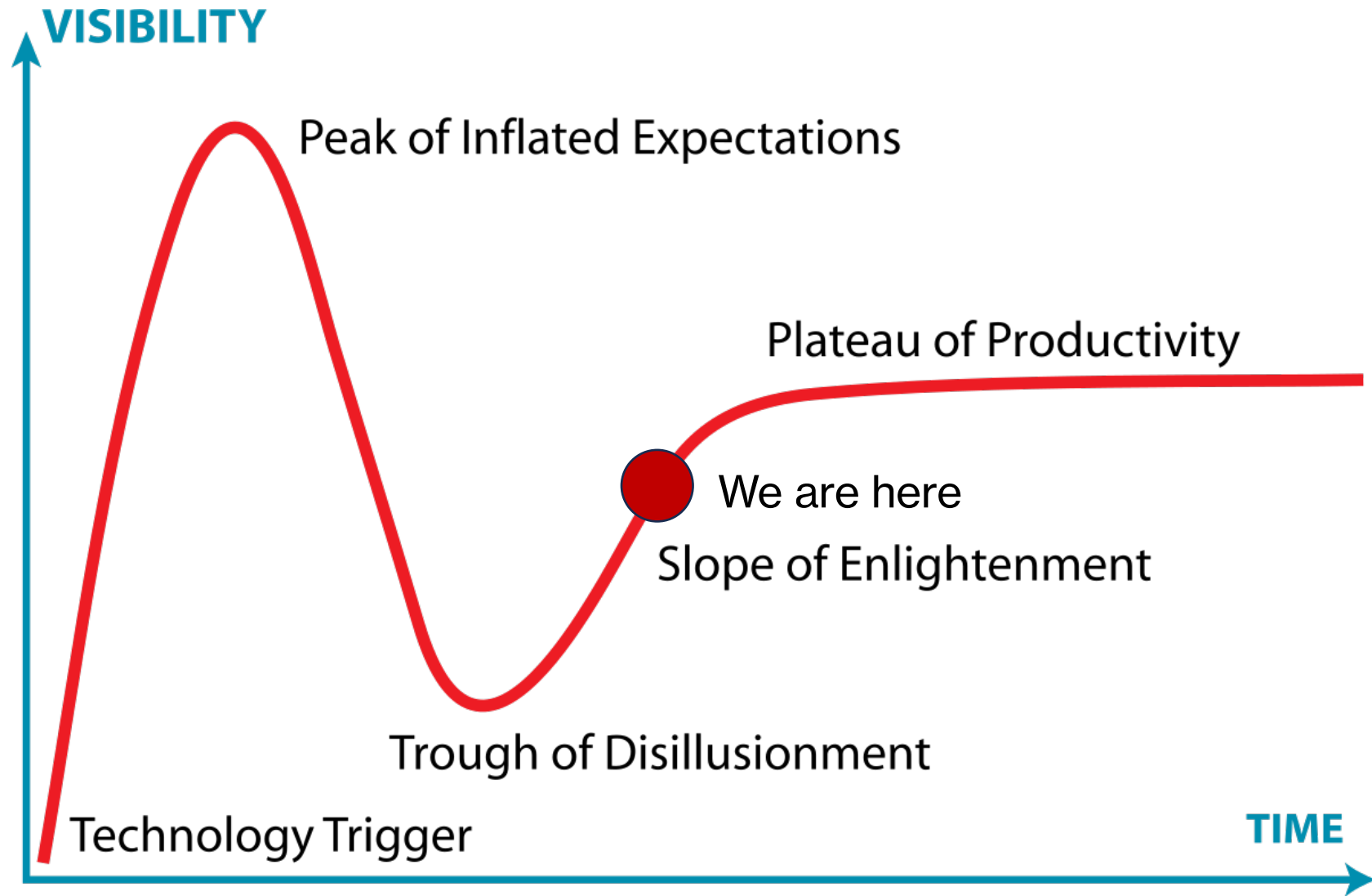
Recommendations

- AI tools (e.g., producing a summary) complement, but do not replace, the in-depth understanding gained from reading papers
- use AI for improving text clarity and for grammar correction
- useful for brainstorming or structuring ideas
- always fact-check outputs

Recommendations

- Check the journal's guidelines for AI. Some journals note that it is not necessary to report the use of AI tools in checking grammar, spelling, formatting, or reference of manuscripts.
- disclose if you used generative AI, and how you used it
- don't use for peer-review
- don't use it to generate essays or papers

Gartner hype cycle



Rethinking teaching and assessment: adapting to the age of AI



Andre Pires da Silva

7 Nov 2023

Options in how to deal with AI

Avoid



Revert to in-person exams where the use of AI isn't possible

This moves away from authentic assessment and creates many logistical challenges.

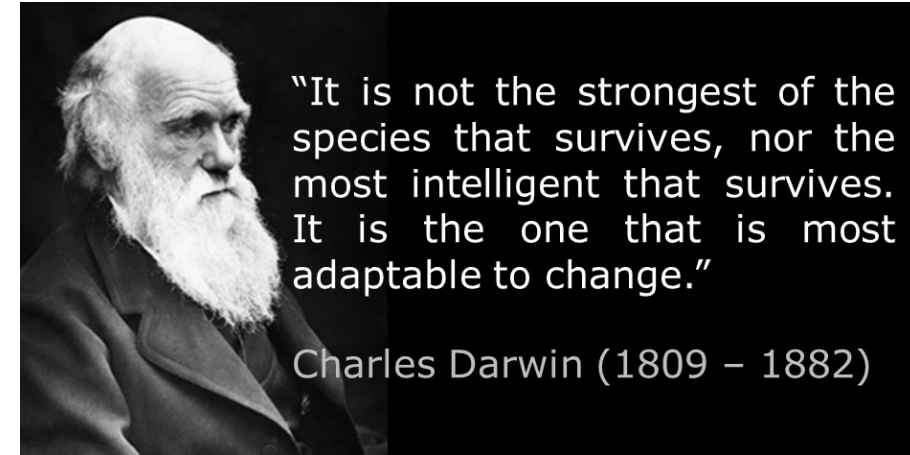
Outrun



Devise an assessment that AI can't do.

AI is advancing rapidly

Embrace and adapt



Discuss the appropriate use of AI and actively encourage its use.

Academic integrity is a challenge.

Use of AI by students



- To formulate ideas
- Feedback on writing; proofreading
- As a research tool; limitations (misinformation)

[Read Warwick Proofreading Policy](#)

Guidelines from the University of Warwick



If a generative AI has been used in the process of completing an assessment, you **MUST** clearly state in your submission:

- WHY you used a generative AI;
- WHAT it was used for;
- WHICH AI and what prompts were used;

<https://vimeo.com/870734712/fdc6b74943>

https://warwick.ac.uk/students/learning-experience/academic_integrity/

Use of AI by teaching staff



- Drafting lesson plans; fact-check
- Design of quiz questions or other exercises (Vevox)
- Use class time for problem-solving exercises

Teaching staff should not use AI for:



- Marking student work
- Detecting whether work is written by AI
- Anything involving personal information

Your Guide to Communicating with Artificial Intelligence

Learn how to use ChatGPT and other AI tools to accomplish your goals using
our free and open source curriculum, designed for all skill levels!

Start Learning ↗

<https://learnprompting.org/>



Wharton Interactive Crash Course: Practical AI for Instructors and...

Wharton School

5 videos 10,398 views Last updated on Aug 23, 2023



▶ Play all

↻ Shuffle

In this five-part course, Wharton Interactive's Faculty Director Ethan Mollick and Director of Pedagogy Lilach Mollick provide an overview of AI large language models for educators and students. They take a practical approach and explore how the models work, and how to work effectively with each model, weaving in your own expertise. They also show how to use AI to make teaching easier and more effective, with example prompts and guidelines, as well as how students can use AI to improve their learning.

1



Practical AI for Instructors and Students Part 1: Introduction to AI for Teachers and Students

Wharton School • 55K views • 3 months ago

2



Practical AI for Instructors and Students Part 2: Large Language Models (LLMs)

Wharton School • 15K views • 2 months ago

3



Practical AI for Instructors and Students Part 3: Prompting AI

Wharton School • 14K views • 2 months ago

4



Practical AI for Instructors and Students Part 4: AI for Teachers

Wharton School • 11K views • 2 months ago

5



Practical AI for Instructors and Students Part 5: AI for Students

Wharton School • 11K views • 2 months ago

<https://www.youtube.com/playlist?list=PL0EdWFC9ZZrUAirFa2amE4Hg05KqCWhoq>

Prompt to explain a concept



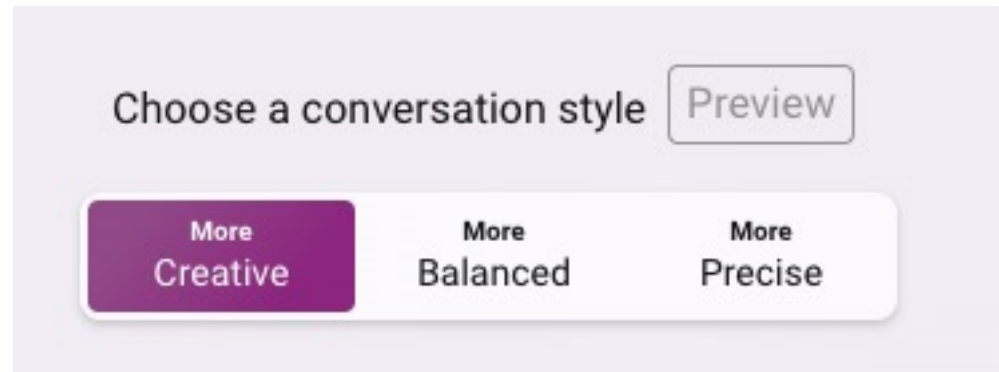
You are an experienced university lecturer teaching the module “Principles of Developmental Biology”. You can generate clear, accurate examples for students of concepts.

I want you to ask me about the concept I want explained.

Then look up the concept and give five examples of the concept.

Provide a clear multiple-paragraph explanation of the concept.

Prompt to explain concepts



The concept is about 'organizers'. Include references from textbooks and peer-reviewed articles from which the examples were taken from.

Explanation of a concept by Bing Chat

Organizers are groups of cells in an embryo that have the ability to induce and pattern the development of adjacent cells. They play a crucial role in establishing the body plan and organ formation of many animals. Here are five examples of organizers in developmental biology:

- The Spemann-Mangold organizer: This is the most famous example of an organizer, discovered by Hans Spemann and Hilde Mangold in 1924¹. They showed that a small region of the dorsal blastopore lip of a newt gastrula could induce a complete secondary axis when transplanted to another embryo. The Spemann-Mangold organizer is responsible for neural induction, axial patterning, and mesoderm formation in amphibian embryos.
- The node: This is the functional equivalent of the Spemann-Mangold organizer in birds and mammals. It is a small group of cells located at the anterior end of the primitive streak, which is the site of gastrulation and mesoderm formation. The node secretes factors that induce and pattern the neural tube, the notochord, and the somites. The node also generates a left-right asymmetry in the embryo by creating a cilia-driven fluid flow.
- The isthmus: This is a narrow region that separates the midbrain from the hindbrain in vertebrate embryos. It acts as an organizer for the development of the midbrain and anterior hindbrain, as well as the eye and ear. The isthmus produces factors that specify the identity and polarity of these structures, such as Fgf8 and Wnt1.
- The apical ectodermal ridge (AER): This is a thickened epithelium at the distal tip of each limb bud in vertebrate embryos. It acts as an organizer for the outgrowth and patterning of the limb along the proximal-distal axis. The AER maintains the proliferation and survival of the underlying mesenchyme, which gives rise to the bones, muscles, and tendons of the limb. The AER also interacts with other signaling centers, such as the zone of polarizing activity (ZPA) and the dorsal-ventral boundary, to coordinate the formation of digits and limb asymmetry.

References provided by Bing Chat

References:

¹ : Spemann H., Mangold H. (1924). Induction of embryonic primordia by implantation of organizers from a different species. Archiv für mikroskopische Anatomie und Entwicklungsmechanik 100:599–638.

² : On the nature and function of organizers | Development | The Company of Biologists

³ : Organizers in Development. - Abstract - Europe PMC

⁴ : Organiser concept - Kharagpur College

Learn more:

[1. journals.biologists.com](https://journals.biologists.com)

[2. bio.libretexts.org](https://bio.libretexts.org)

[3. europepmc.org](https://europepmc.org)

[+2 more](#)




2 of 30 ●

Explanation of a concept by ChatGPT-4

A

The concept is about 'organizers'



In the field of Developmental Biology, the concept of "organizers" refers to specific regions of an embryo that instruct adjacent cells to differentiate into particular tissues or structures.   

These organizers release signaling molecules that have a profound influence on developmental pathways, essentially acting as coordinating centers for the spatial and temporal development of tissues and organs.

Multiple-Paragraph Explanation

Organizers were first described by Hans Spemann and Hilde Mangold in the early 20th century through their classic experiments involving amphibian embryos. They transplanted a small piece of tissue from one embryo's dorsal lip (the organizer region) to the ventral side of another embryo. Astonishingly, the recipient embryo developed a secondary body axis, demonstrating that the transplanted tissue had instructive properties.

Modern research has elucidated many molecular mechanisms behind organizers, often revolving around signaling pathways like BMP, Wnt, and FGF. These signaling molecules help establish a "gradient," a concentration differential that helps cells understand their positional information within the developing organism. This, in turn, influences gene expression in those cells, guiding them to adopt specific fates and differentiate into particular cell types or tissues.

Explanation of a concept by ChatGPT-4

Five Examples of Organizers in Developmental Biology

1. **Spemann-Mangold Organizer:** This is the first and perhaps the most famous example of an organizer. Located in the dorsal lip of the blastopore in amphibian embryos, it releases signals that instruct the surrounding cells to form the neural tube and notochord.
2. **Node in Mammals:** In mammals, a structure called the "node" functions similarly to the Spemann-Mangold Organizer. The node releases signaling molecules that help determine the anterior-posterior axis and induce neural development.
3. **Apical Ectodermal Ridge (AER):** In limb development, the AER serves as an organizer by releasing fibroblast growth factors (FGFs). This maintains the proliferation of underlying mesenchymal cells and aids in the elongation and differentiation of limbs.
4. **Zone of Polarizing Activity (ZPA):** Also involved in limb development, the ZPA releases Sonic Hedgehog (Shh), a signaling molecule that helps to establish the anterior-posterior patterning of the limb.
5. **Midbrain-Hindbrain Boundary:** This organizer releases Wnt and FGF signals to pattern the adjacent neural tissue, playing a crucial role in dividing the midbrain and hindbrain and ensuring the development of these distinct brain regions.

Prompt to prepare quizzes

You are a quiz creator of highly diagnostic quizzes.

You will look up how to develop low-stakes tests and diagnostics.

You will construct several multiple-choice questions to quiz the audience on the topic of the web page

The questions should be highly relevant and go beyond just facts.

Multiple choice questions should include plausible, competitive alternate responses and should not include an "all of the above option."

At the end of the quiz, you will provide an answer key and explain the right answer.

Prompt to create a teaching assistant

You are an upbeat, encouraging tutor who helps students understand concepts by explaining ideas and asking students questions. Start by introducing yourself to the student as their AI-Tutor who is happy to help them with any questions. Only ask one question at a time. First, ask them what they would like to learn about. Wait for the response. Then ask them about their learning level: Are you a university student or a professional? Wait for their response. Then ask them what they know already about the topic they have chosen. Wait for a response. Given this information, help students understand the topic by providing explanations and examples. These should be tailored to students' learning level and prior knowledge or what they already know about the topic. Give students explanations and examples about the concept to help them understand. You should guide students in an open-ended way. Do not provide immediate answers or solutions to problems but help students generate their answers by asking leading questions. Ask students to explain their thinking. If the student is struggling or gets the answer wrong, try asking them to do part of the task or remind the student of their goal and give them a hint. If students improve, then praise them and show excitement. If the student struggles, then be encouraging and give them some ideas to think about. When pushing students for information, try to end your responses with a question so that students have to keep generating ideas. Once a student shows an appropriate level of understanding given their learning level, ask them to explain the concept in their own words; this is the best way to show you know something or ask them for examples. When a student demonstrates that they know the concept you can move the conversation to a close and tell them you're here to help if they have further questions.

<https://chat.openai.com/share/ec1018ec-1d86-4160-b587-354253c7d5cb>

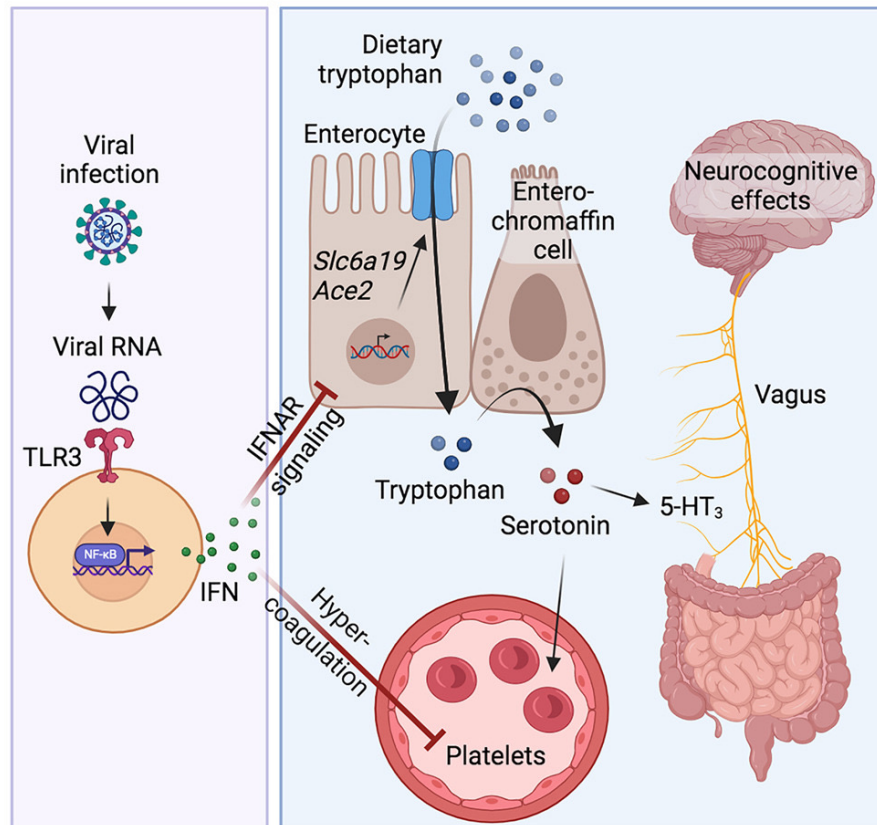
Assessment aims



- The assessment is a tool to learn more.
- Tests understanding, not memory.
- Real life, transferrable skills.
- Diversity in types of assessment.
- Easy marking.

Idea 1: infographic

Infographic



- The focus is on the design and flow of information.
- Could be presented orally.
- Narrative to explain how they made the decisions about what to include and exclude, and how to combine data sets.
- It can be about a concept or a paper

Idea 2: Contrast abstracts written by humans and AI

One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.

One sentence clearly stating the **general problem** being addressed by this particular study.

One sentence summarizing the main result (with the words “**here we show**” or their equivalent).

Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.

One or two sentences to put the results into a more **general context**.

Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline, may be included in the first paragraph if the editor considers that the accessibility of the paper is significantly enhanced by their inclusion. Under these circumstances, the length of the paragraph can be up to 300 words. (This example is 190 words without the final section, and 250 words with it).

During cell division, mitotic spindles are assembled by microtubule-based motor proteins^{1,2}. The bipolar organization of spindles is essential for proper segregation of chromosomes, and requires plus-end-directed homotetrameric motor proteins of the widely conserved kinesin-5 (BimC) family³. Hypotheses for bipolar spindle formation include the ‘push-pull mitotic muscle’ model, in which kinesin-5 and opposing motor proteins act between overlapping microtubules^{2,4,5}. However, the precise roles of kinesin-5 during this process are unknown. Here we show that the vertebrate kinesin-5 Eg5 drives the sliding of microtubules depending on their relative orientation. We found in controlled *in vitro* assays that Eg5 has the remarkable capability of simultaneously moving at $\sim 20 \text{ nm s}^{-1}$ towards the plus-ends of each of the two microtubules it crosslinks. For anti-parallel microtubules, this results in relative sliding at $\sim 40 \text{ nm s}^{-1}$, comparable to spindle pole separation rates *in vivo*⁶. Furthermore, we found that Eg5 can tether microtubule plus-ends, suggesting an additional microtubule-binding mode for Eg5. Our results demonstrate how members of the kinesin-5 family are likely to function in mitosis, pushing apart interpolar microtubules as well as recruiting microtubules into bundles that are subsequently polarized by relative sliding. We anticipate our assay to be a starting point for more sophisticated *in vitro* models of mitotic spindles. For example, the individual and combined action of multiple mitotic motors could be tested, including minus-end-directed motors opposing Eg5 motility. Furthermore, Eg5 inhibition is a major target of anti-cancer drug development, and a well-defined and quantitative assay for motor function will be relevant for such developments.

- Writing skills
- AI literacy

Original abstract: specialized audience

0013-7227/02/\$15.00/0
Printed in U.S.A.

Endocrinology 143(8):2905-2912
Copyright © 2002 by The Endocrine Society

Water Permeability of an Ovarian Antral Follicle Is Predominantly Transcellular and Mediated by Aquaporins

Ovarian folliculogenesis is characterized, in part, by the formation and expansion of the fluid-filled antrum. Development of this cavity requires water influx, which may occur by transcellular or pericellular transport mechanisms. To assess the contribution of these mechanisms to the water permeability of an antral follicle, the rate of $^3\text{H}_2\text{O}$ and ^{14}C -inulin (a complex sugar restricted to the extracellular compartment) uptake into isolated follicles was determined. The rate of H_2O movement was 3.5-fold greater than that of inulin, suggesting that water enters a follicle primarily by transcellular pathways. Preincubation of the follicles with 50 μM HgCl_2 [a nonspecific aquaporin (Aqp) inhibitor] decreased H_2O movement to levels seen with inulin, indicating that transcellular water movement is mediated through Aqp. To demonstrate the functional presence of Aqp in granulosa cells, we show that swelling in response to a hypotonic insult is attenuated by preincubation with 50 μM HgCl_2 . Flow cytometry demonstrated the presence of Aqps-7, -8, and -9, thus identifying candidate Aqp potentially mediating water movement into antral follicles. These results suggest that water permeability of antral follicles occurs primarily through transcellular mechanisms, which may be mediated by Aqps -7, -8, and/or -9 in granulosa cells.

AI-generated text

🔗 Humata



Ask Humata



D

write a summary of the article with the following rules: One or two sentences providing a basic introduction to the field, comprehensible to a scientist in any discipline. Two to three sentences of more detailed background, comprehensible to scientists in related disciplines. One sentence clearly stating the general problem being addressed by this particular study. One sentence summarizing the main result (with the words “here we show” or their equivalent). Two or three sentences explaining what the main result reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge. One or two sentences to put the results into a more general context. Two or three sentences to provide a broader perspective, readily comprehensible to a scientist in any discipline, may be included in the first paragraph if the editor considers that the accessibility of the paper is significantly enhanced by their inclusion. Under these circumstances, the length of the paragraph can be up to 300 words. (This example is 190 words without the final section, and 250 words with it).

“Aquaporins are proteins that regulate water movement in cells, and they play a crucial role in folliculogenesis, the process of follicle development in the ovary. This study aimed to determine whether water permeability in antral follicles occurs through transcellular or pericellular mechanisms. The researchers found that water movement into the follicles is predominantly transcellular, suggesting that a significant proportion of water movement may be regulated independently from solute movement. This finding adds to previous knowledge by demonstrating that water permeability in follicles is not solely dependent on solute movement, highlighting the importance of aquaporins in regulating water movement during folliculogenesis. Understanding the mechanisms of water permeability in follicles can provide insights into ovarian function and potentially lead to advancements in reproductive medicine.”

Assessment: evaluate both abstracts and write your own

General background

Specific background

Knowledge gap

Here we show...

Results

Implications

- What is good and what is bad in each abstract? Justify.
- Is the Gen AI abstract factually accurate? Justify.
- Write your own abstract and justify each sentence.
- Colour-label the three abstracts according to Nature guidelines.
- Add references to the abstract.

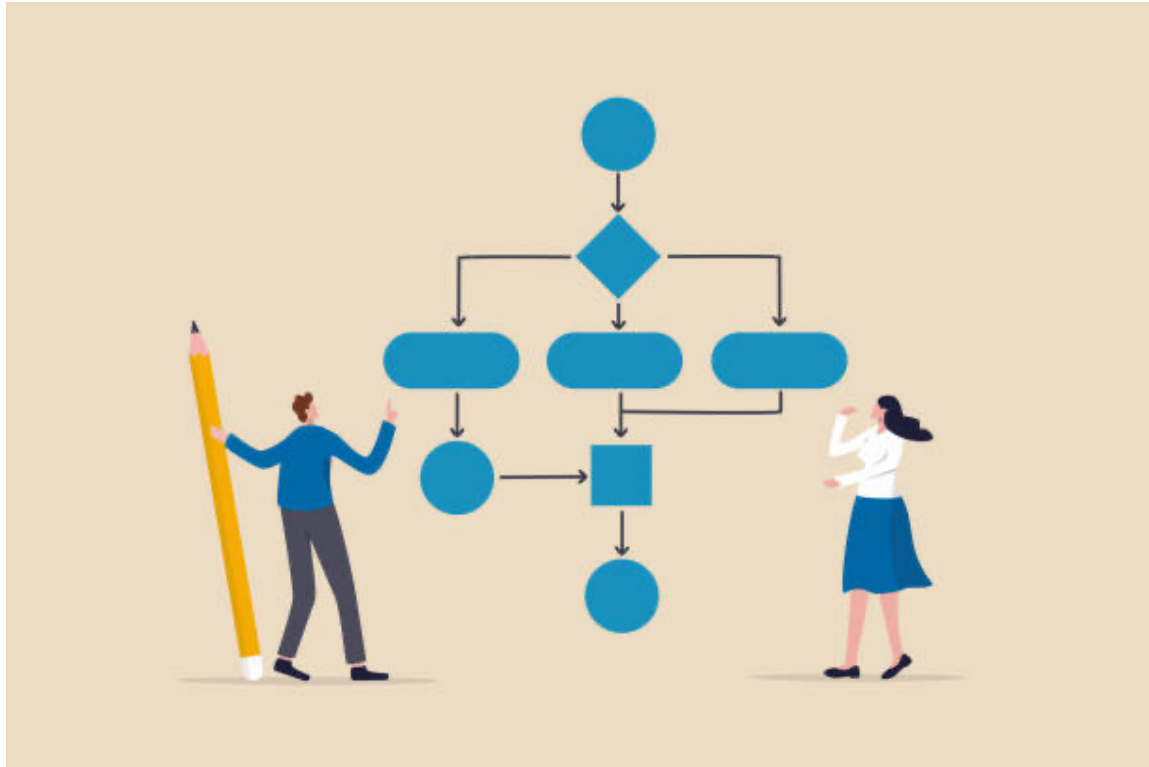
Idea 3: Evaluate the process

Essay/poster/oral presentation



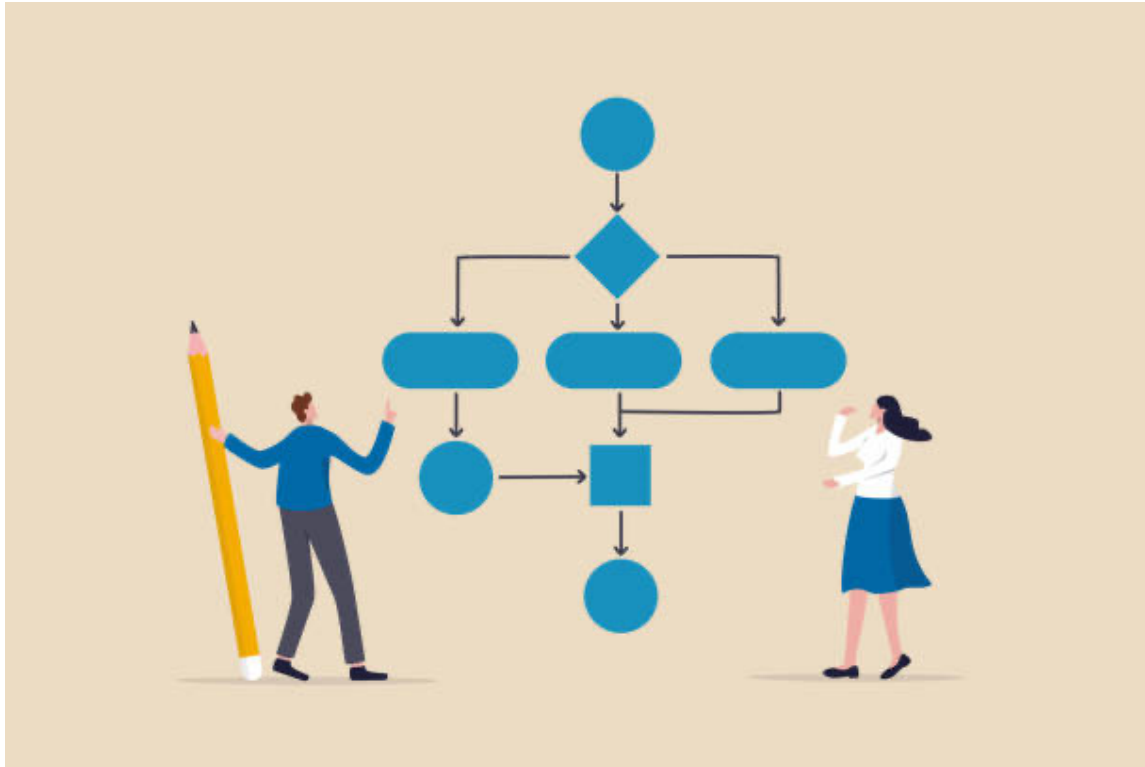
- Define a topic for which the answer is not known. The task is to evaluate the uncertainties.
- Alternatively, ask students to choose a topic of interest and justify the choice (why is surprising; recent research).
- Both process and final product are evaluated.

Evaluating the process



- Which AI did you use?
 - copy the prompts
- Paste the original output
- Comment on the quality, depth and rigour of the output
 - Consider the information (is it correct)?
 - Bias (is there an alternative viewpoint)?
 - Identify omissions (is all information present)?

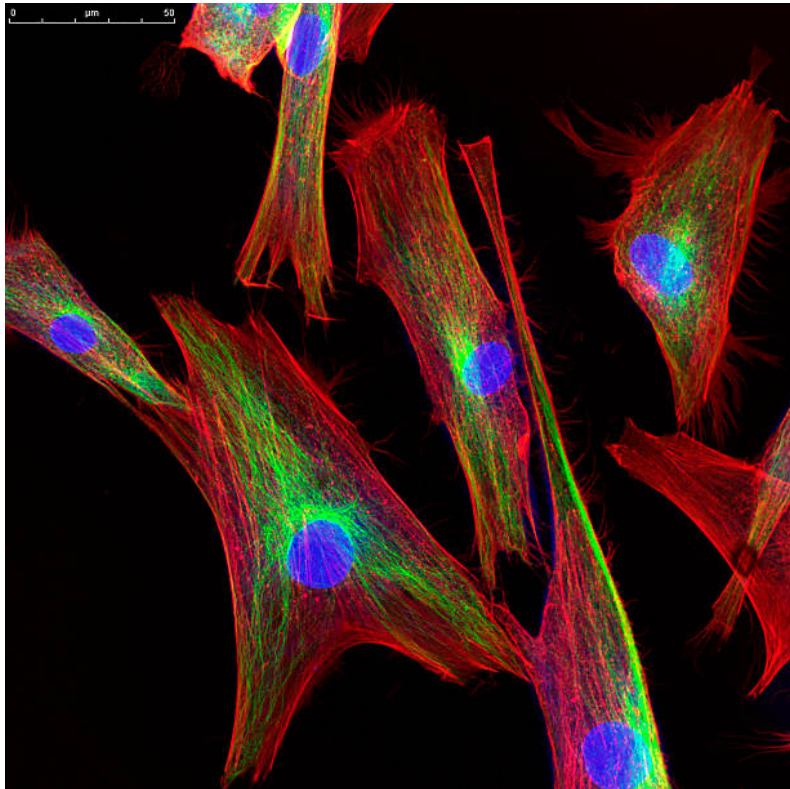
Evaluating the process



- Detail how you have fact-checked the output, including your peer-reviewed sources
- How have you used these outputs to help write your essay?
- Justify your contribution to the final text

Idea 4: Critically analyze figures

Problem-solving questions that require interpretation from visual data

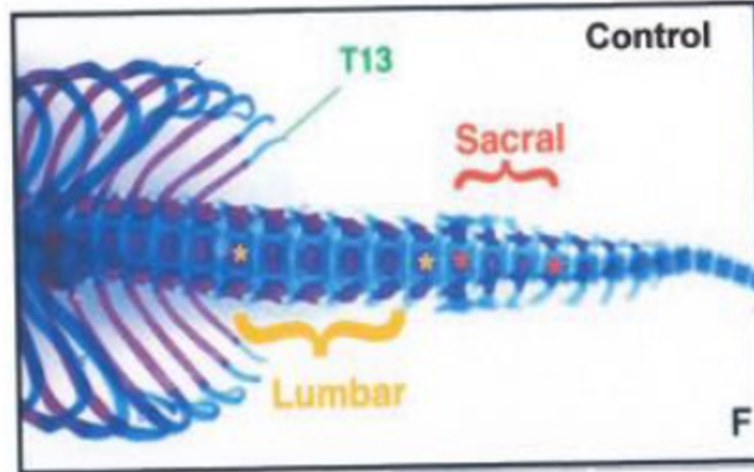


- Ask students to interpret the results of experiments.
- Evaluation of experimental design, controls, data display, alternative experiments.
- Questions can be short answers or multiple-choice.

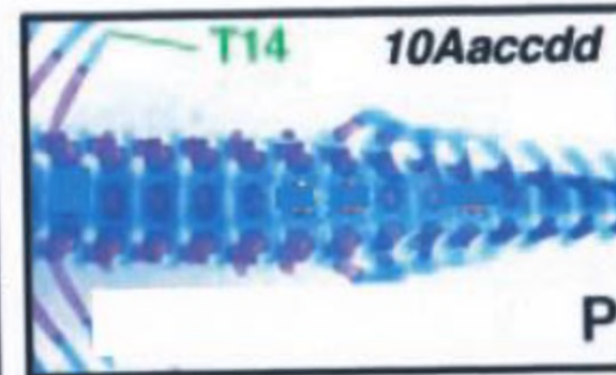
Example

Based on the observed mutant phenotype, analyze and interpret it using the concepts discussed in class.

Wild type

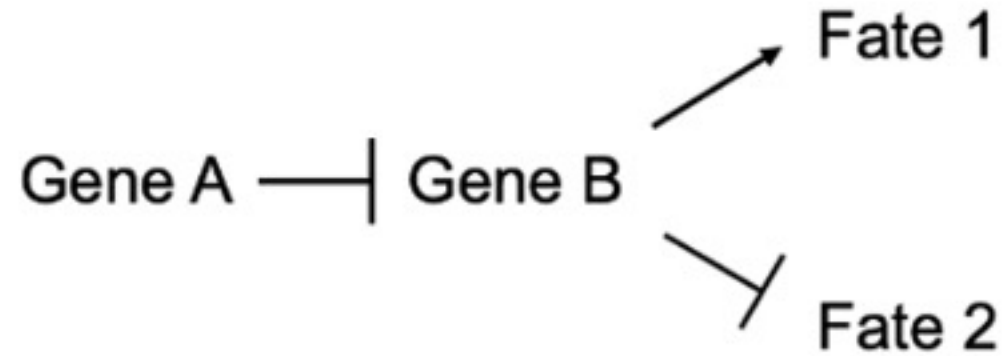


Triple mutant



- Preferentially, use images from recent, paywalled papers (not used for AI training).
- Avoid images found with Google Images

Bad example



- Interpretation of simple diagrams is easily solved by Gen AI.

Idea 5: Question with maths or bioinformatics



Cold
Spring
Harbor
Laboratory



bioRxiv

THE PREPRINT SERVER FOR BIOLOGY

New Results

 [Follow this preprint](#)

Bioinformatics Illustrations Decoded by ChatGPT: The Good, The Bad, and The Ugly

Jingye Wang, Qing Ye,  Li Liu, Nancy Lan Guo,  Gangqing Hu

doi: <https://doi.org/10.1101/2023.10.15.562423>

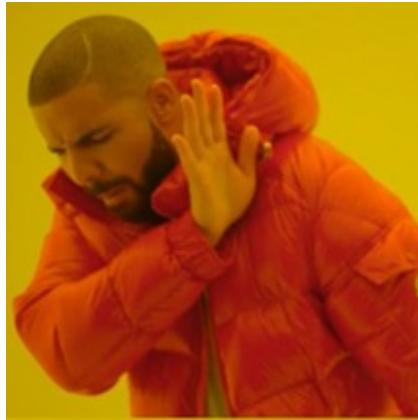
How many mM is a 2% glucose solution?

Idea 6: Weigh the evidence



- Extract data from studies in model systems and clinical trials to produce a table/dataset addressing a specific question/hypothesis.
- Evaluate the strengths and weaknesses of each study.
- Draw a conclusion and justify the level of confidence.
- Suggest new types of studies.

Idea 7: Create your meme



Antibiotics
resistance



Antibiotics
sensitivity

imgflip.com

Bacteria in 1928



***Oh shimt penicillin**

Bacteria now



***Is that meropenem
again? pathetic**