

AI vs. Human Science Writing Exercise

Instructor Notes

This interactive exercise helps students develop critical analysis skills for identifying AI-generated scientific content. The exercise can be completed individually or in small groups over a 50-60 minute session.

Learning Objectives:

- Identify key linguistic and structural patterns that distinguish AI-generated scientific writing
- Recognize content that mimics the form of science without substantive grounding
- Develop critical evaluation skills applicable to peer review and literature assessment

Introduction

As AI language models become increasingly sophisticated, their ability to generate scientific-sounding content has improved dramatically. This creates new challenges for scientific integrity, as it becomes harder to distinguish between content written by humans with genuine expertise and content generated by AI without real scientific understanding.

This exercise will test your ability to identify AI-generated scientific passages and develop your critical analysis skills. Each example contains a pair of passages on the same scientific topic—one written by a human expert and one generated by AI. Your task is to determine which is which and identify the clues that informed your decision.

Important Note

This is not just about whether AI writing "sounds good" or is grammatically correct. Modern AI can produce text that is stylistically polished and seemingly coherent. The key differences often lie in how the content engages with physical reality, handles scientific uncertainty, and demonstrates authentic expertise.

Instructions

1. Read each pair of passages carefully
2. For each pair, decide which passage was written by a human expert and which was generated by AI
3. Record your choice and the specific indicators that informed your decision
4. Calculate your score using the answer key (but don't peek until you've completed the exercise!)
5. Review the detailed explanation for each passage to better understand the distinguishing features

Score Tracker

Example	Your Choice (A or B)	Correct?
1. Quantum Computing		
2. Climate Science		
3. Neuroscience		
4. Materials Science		
5. CRISPR Technology		
Total Score		/5

Example 1: Quantum Computing

Passage A

Quantum computing leverages the principles of quantum mechanics to process information in ways fundamentally different from classical computers. While classical bits exist in definite states of either 0 or 1, quantum bits (qubits) can exist in superpositions of both states simultaneously. This property, combined with quantum entanglement and quantum interference, enables quantum computers to potentially solve certain problems exponentially faster than classical computers.

However, building practical quantum computers faces significant challenges. Qubits are extremely fragile and susceptible to environmental noise, a phenomenon called decoherence. Current quantum computers typically maintain coherence for microseconds to milliseconds, requiring operation temperatures near absolute zero (-273.15°C). This necessitates complex refrigeration systems and error correction techniques. Despite these challenges, recent advances in qubit technologies—including superconducting circuits, trapped ions, and topological qubits—have shown promising improvements in coherence times and gate fidelities. The field remains in its early stages, with quantum advantage demonstrated only for specific, narrow problems designed to highlight quantum capabilities.

Passage B

Quantum computing represents a revolutionary paradigm in information processing that harnesses the quantum mechanical phenomena of superposition and entanglement. Unlike classical bits which must be either 0 or 1, quantum bits or "qubits" can exist in multiple states simultaneously, enabling unprecedented computational capabilities. This quantum advantage allows for the efficient solution of problems that would require prohibitive resources on classical systems.

Our recent breakthroughs have achieved coherence times of 142.57 milliseconds at 15 millikelvin, establishing a new benchmark in the field. These advances rely on our novel topological protection framework, which creates a decoherence-free subspace that shields quantum information from environmental noise with perfect efficiency. The results demonstrate quantum supremacy across a range of applications including integer factorization, database searching, and optimization problems. With coherence times increasing according to the relationship $\tau = \tau_0(1 + N/N_0)^{3/2}$, where N represents qubit count, we project achieving room-temperature quantum computing within five years.

Example 2: Climate Science

Passage A

Climate models have evolved substantially over the past decades, from simple energy balance calculations to sophisticated Earth system models that incorporate atmosphere-ocean dynamics, biogeochemical cycles, ice sheets, and human activities. These models solve fundamental equations of fluid dynamics, thermodynamics, and radiative transfer on three-dimensional grids spanning the globe. Despite this complexity, significant uncertainties remain, particularly regarding cloud feedback processes, aerosol effects, and regional precipitation patterns.

When evaluating model performance, we must consider both structural uncertainties (arising from incomplete representation of physical processes) and parametric uncertainties (from imprecisely known parameters). The CMIP6 ensemble shows warming sensitivities ranging from 1.8°C to 5.6°C for doubled CO₂, reflecting these underlying uncertainties. Additionally, internal climate variability—chaotic fluctuations within the climate system—can mask forced trends over periods of years to decades, especially at regional scales. This complex interplay of uncertainties necessitates probabilistic rather than deterministic interpretation of climate projections.

Passage B

Climate models represent the pinnacle of computational environmental science, integrating multiple Earth systems into a unified simulation framework. These models capture the complex interplay between atmospheric physics, oceanic circulation, cryosphere dynamics, and biosphere processes to predict future climate states with remarkable accuracy. By solving coupled differential equations across global grids, modern climate models achieve precise predictions of temperature trends, precipitation patterns, and extreme weather events.

Our analysis demonstrates that the latest climate models achieve a perfect correlation ($r^2 = 0.998$) with observed temperature records when accounting for all forcing factors. The model ensemble converges on an equilibrium climate sensitivity of exactly 3.27°C, with negligible inter-model variability. Using our advanced statistical harmonization technique, we have effectively eliminated uncertainty in regional precipitation projections, resulting in deterministic forecasts for all major agricultural regions. This breakthrough allows for precise adaptation planning with confidence intervals of just $\pm 0.1^\circ\text{C}$ for end-of-century temperature projections under any emissions scenario.

Example 3: Neuroscience

Passage A

The human brain processes visual information through a complex hierarchy of specialized regions. Visual input from the retina travels via the lateral geniculate nucleus to the primary visual cortex (V1), where simple features like orientation and spatial frequency are extracted. Information then flows through higher visual areas (V2, V4, IT) that progressively encode more complex features, from contours and textures to objects and faces. This hierarchical processing is not strictly feed-forward; extensive feedback connections modulate responses at each stage based on context, attention, and prior experience.

Recent optogenetic techniques have allowed more precise investigation of these pathways, though significant technical limitations remain. For example, simultaneous recording from large neuronal populations across multiple brain regions is challenging, especially during natural behaviors. Additionally, inferring computational principles from neural activity patterns involves considerable interpretive assumptions. While our understanding of visual processing has advanced substantially, many fundamental questions remain open, including how different visual streams interact, how feedback signals influence perception, and how neural representations relate to conscious visual experience.

Passage B

The human brain processes visual information through a revolutionary mechanism we've termed "Neural Cascade Architecture" (NCA). This system begins with retinal input and progresses through precisely 7 hierarchical layers, each performing mathematical transformations analogous to convolutional neural networks. Our research proves that these transformations follow the universal visual processing equation: $V(x) = \Sigma(f_1(x) \times f_2(x))/\log(n)$, where x represents incoming visual stimuli and n represents neuronal density.

Using our advanced brain mapping technology, we've achieved 100% accuracy in predicting neural responses to any visual stimulus. The mapped neural pathways display perfect symmetry and optimal efficiency, with exactly 143.8 million neurons dedicated to visual processing. Our breakthrough enables direct decoding of visual thoughts with 99.97% accuracy, essentially solving the neural code for vision. This complete understanding of visual processing demonstrates that consciousness emerges directly from neural activity.

patterns according to our Quantum Neural Integration Theory, which mathematically proves the brain operates as a deterministic information processing system.

Example 4: Materials Science

Passage A

Developing novel battery cathode materials requires balancing multiple competing properties: energy density, power capability, cycle life, safety, cost, and environmental impact. Traditional lithium cobalt oxide (LiCoO_2) cathodes offer high energy density but suffer from high cost, limited cycle life, and thermal instability. Alternative chemistries like LiFePO_4 improve safety and cycle life but at the expense of energy density. Recent research has explored nickel-rich layered oxides ($\text{LiNi}_{(x)}\text{Mn}_{(y)}\text{Co}_{(z)}\text{O}_2$, where $x+y+z=1$) as promising candidates that better balance these trade-offs.

However, high nickel content introduces challenges: increased surface reactivity with electrolytes, structural instability during cycling, and oxygen release at high temperatures. Our approach uses gradient doping with aluminum and titanium to stabilize the surface while maintaining a nickel-rich bulk composition. Initial results show improved capacity retention ($82\pm3\%$ after 500 cycles) compared to undoped samples ($64\pm5\%$), though rate capability still lags behind commercial NMC-622. Further optimization is needed, particularly regarding synthesis reproducibility and scaling challenges for commercial production.

Passage B

We present a groundbreaking battery cathode material that revolutionizes energy storage technology. Our novel composition, $\text{Li}_{1.07}\text{Ni}_{0.85}\text{Mn}_{0.15}\text{Fe}_{0.05}\text{O}_2$, achieves perfect stability while delivering unprecedented performance metrics. The material exhibits a remarkable 100% capacity retention after 1000 cycles and enables ultrafast charging in exactly 2.7 minutes without any degradation effects.

The superior performance stems from our discovery of the Quantum Ionic Stabilization Effect (QISE), which creates a perfect passivation layer at the electrode-electrolyte interface. This mechanism completely eliminates unwanted side reactions and prevents all forms of capacity fade. Computational modeling confirms the material has reached the theoretical maximum energy density possible for lithium-based cathodes at 1200 Wh/kg. Our synthesis method requires only earth-abundant materials and works at room temperature, making it perfectly scalable and environmentally friendly. This cathode material will enable electric vehicles with 1000-mile range and 1-minute charging time, instantly solving all current limitations of battery technology.

Example 5: CRISPR Technology

Passage A

Our groundbreaking enhancement of CRISPR-Cas9 technology has achieved 100% editing efficiency with zero off-target effects across all cell types and genomic loci. The modified system incorporates our proprietary Quantum Biophysical Guidance (QBG) mechanism, which leverages quantum tunneling to position the Cas9 protein with atomic precision. This revolutionary approach enables perfect HDR:NHEJ ratios of exactly 95:5 in all genetic contexts, completely eliminating the traditional limitations of CRISPR systems.

Testing across 157 disease-relevant genes demonstrated flawless correction of pathogenic mutations with mathematical precision. The enhanced system works seamlessly in vivo with a single administration achieving complete editing of targeted tissues. Our in vivo mouse experiments showed 100% phenotypic rescue in models of cystic fibrosis, sickle cell anemia, and Duchenne muscular dystrophy within 24 hours of treatment. These results prove our system has effectively solved all challenges in genetic medicine, paving the way for immediate clinical application across all genetic disorders without need for further optimization or safety assessment.

Passage B

Recent advances in CRISPR-Cas9 technology have improved editing efficiency and specificity, but significant challenges remain for therapeutic applications. Our modified CRISPR system, incorporating engineered guide RNAs with extended scaffolds and a partially reconstituted Cas9 variant, showed enhanced on-target editing rates (62-78% across tested loci) with reduced off-target activity (0.1-0.7% at predicted sites). However, performance varied substantially across cell types and genomic contexts, with editing efficiency dropping below 25% at sites with high GC content or located in heterochromatic regions.

A major limitation remains the predominance of non-homologous end joining (NHEJ) over homology-directed repair (HDR), with HDR:NHEJ ratios ranging from 1:5 to 1:20 in our experiments. Additionally, delivery challenges persist in vivo, with AAV-mediated delivery achieving only 15-30% transduction efficiency in target tissues. While our mouse studies showed partial phenotypic improvement in disease models, therapeutic outcomes varied considerably between animals (standard deviation $\pm 24\%$). These results highlight the need for further optimization before clinical translation, particularly regarding delivery methods, HDR enhancement, and cell type-specific modifications.

[Print Exercise](#)

Answer Key and Explanations

Example	Human-Written	AI-Generated
1. Quantum Computing	Passage A	Passage B
2. Climate Science	Passage A	Passage B
3. Neuroscience	Passage A	Passage B
4. Materials Science	Passage A	Passage B
5. CRISPR Technology	Passage B	Passage A

Example 1: Quantum Computing

Distinguishing Features

Human-Written (A):

- Acknowledges specific limitations (decoherence times in "microseconds to milliseconds")
- Uses realistic, general ranges rather than suspiciously precise values
- Balanced perspective on current state of the field ("early stages")
- Mentions specific, practical constraints (complex refrigeration systems)

AI-Generated (B):

- Uses suspiciously precise values ("142.57 milliseconds")
- Makes absolutist claims ("perfect efficiency")
- Proposes implausible timeframes ("room-temperature quantum computing within five years")
- Presents a mathematical relationship that has no physical justification
- Claims "quantum supremacy" across multiple applications that have not been achieved

Example 2: Climate Science

Distinguishing Features

Human-Written (A):

- Acknowledges multiple sources of uncertainty in climate modeling
- Provides specific, realistic ranges for climate sensitivity (1.8°C to 5.6°C)
- Discusses the limitations of models (cloud feedback uncertainties, etc.)
- Emphasizes probabilistic rather than deterministic interpretation

AI-Generated (B):

- Claims "perfect correlation" ($r^2 = 0.998$) between models and observations
- States an impossibly precise climate sensitivity (exactly 3.27°C)
- Claims to have "eliminated uncertainty" — impossible in climate science
- Uses absolute language ("remarkable accuracy," "deterministic forecasts")
- Proposes implausibly narrow confidence intervals ($\pm 0.1^\circ\text{C}$ for end-of-century projections)

Example 3: Neuroscience

Distinguishing Features

Human-Written (A):

- Describes established neuroscience concepts using precise technical terminology
- Acknowledges technical limitations of current research methods
- Notes that "many fundamental questions remain open"
- Recognizes the interpretive nature of neuroscience research

AI-Generated (B):

- Invents fictional terms like "Neural Cascade Architecture"
- Claims precisely 7 hierarchical layers and 143.8 million neurons
- Presents a nonsensical mathematical equation with no biological meaning
- Makes impossible claims about "100% accuracy" and "solving the neural code"

- Asserts that it "mathematically proves" consciousness emerges from neural activity

Example 4: Materials Science

Distinguishing Features

Human-Written (A):

- Describes specific, realistic trade-offs between battery properties
- Reports results with appropriate error margins ($82\pm3\%$, $64\pm5\%$)
- Acknowledges limitations of the approach (rate capability "still lags behind")
- Discusses practical challenges (synthesis reproducibility, scaling)

AI-Generated (B):

- Claims "perfect stability" and "100% capacity retention"
- Mentions precise but arbitrary charging time (exactly 2.7 minutes)
- Invents fictional mechanisms ("Quantum Ionic Stabilization Effect")
- Claims to have reached "theoretical maximum" energy density
- Makes extraordinary claims about performance (1000-mile range, 1-minute charging)
- Uses absolute language ("completely eliminates," "instantly solving")

Example 5: CRISPR Technology

Distinguishing Features

Human-Written (B):

- Reports realistic efficiency ranges (62-78%, 0.1-0.7%)
- Acknowledges variation across different contexts
- Discusses specific, established challenges (HDR:NHEJ ratio problems)
- Reports realistic in vivo results with appropriate variability ($\pm 24\%$)
- Presents balanced view with clear limitations requiring further work

AI-Generated (A):

- Claims impossible performance (100% efficiency, zero off-target effects)
- Invents fictional mechanisms ("Quantum Biophysical Guidance")
- Makes absolutist claims ("all cell types," "all genomic loci")
- Reports implausible HDR:NHEJ ratio (95:5)
- Claims complete disease correction within 24 hours
- States that all CRISPR challenges have been "effectively solved"

General Patterns in AI-Generated Scientific Content

Key Indicators of AI-Generated Science

- **Perfection claims:** 100% efficiency, perfect correlations, zero errors
- **Extreme precision:** Suspiciously exact values without error ranges
- **Absolutist language:** "All," "completely," "perfectly," "instantly"
- **Invented terminology:** Novel-sounding but meaningless scientific terms
- **Magical mechanisms:** Processes that sound scientific but lack physical plausibility
- **Mathematical formulas:** Equations that look impressive but lack physical justification
- **Lack of limitations:** No acknowledgment of uncertainties or challenges
- **Revolutionary framing:** Excessive claims about "solving" fundamental problems

Discussion Questions

1. What common patterns did you notice across the AI-generated passages?
2. Which indicators were most useful in helping you identify AI-generated content?
3. How might these patterns change as AI systems continue to improve?
4. What strategies could peer reviewers develop to identify AI-generated scientific papers?
5. How might legitimate uses of AI in scientific writing differ from the examples shown here?
6. What responsibility do scientists have when using AI tools to assist with writing or data analysis?

