

Answer Key

Bioinformatics – Biostatistics · Session 3B · Fall 2026

Multimomics, AI and the Data Behind Modern Biology

A. Let's talk omics

Stress rule: in words ending in *-ics*, the main stress falls on the syllable just before the ending (the *-om-* syllable: ge-**NO**-mics).

Word	Letter	IPA
multiomics	C	/ˌmʌlti'ɒsmɪks/
genomics	E	/dʒɪ'noʊsmɪks/
transcriptomics	F	/ˌtrænskɪp'toʊsmɪks/
proteomics	A	/ˌproʊti'ɒsmɪks/
metabolomics	D	/ˌmetəboʊ'loʊsmɪks/
epigenomics	B	/ˌɛpɪdʒɪ'noʊsmɪks/

Suggested definitions (accept any reasonable wording)

- **Multimomics:** combining several “-omics” fields to study one biological problem.
- **Transcriptomics:** the study of all the RNA molecules (transcripts) that cells produce from DNA.
- **Proteomics:** the study of all the proteins in a cell or organism, including their structures and functions.
- **Metabolomics:** the study of the small molecules (metabolites) produced by chemical processes in cells.
- **Epigenomics:** the study of chemical changes to DNA and its packaging that switch genes on or off without changing the sequence.

B. Multimomics is changing the game

1. Previewing (matching)

Word	Definition
multiomics	combining several “-omics” to study one problem
holistic	looking at the whole system, not just one part
novel	new and original
biomarker	a measurable sign of a disease or condition
pathway	a series of connected steps in a cell process
genetic variant	a difference in the DNA sequence between people
single-cell / bulk	studying cells one by one / all together as an average
orders of magnitude	differences of 10×, 100×, 1000×
constitute	to make up (a part of a whole)
signature	a pattern that identifies something
undetectable	impossible to find or measure

Teacher note: in the PDF, the “genetic variant” and “single-cell / bulk” lines run into neighbouring lines. Check the layout on your printed copy.

2. Predicting

Answers are open. Ideas that fit the video:

- **What is multimomics:** combines several data types; a holistic view; multiple angles on one problem; cell processes are connected.
- **Benefits of multimomics:** novel pathways and biomarkers; better understanding of genetic disease; deeper single-cell analysis; detecting rare cell types.

Discussion questions (after the first viewing)

- a. Multiomics studies one biological problem by layering several types of data (transcriptome, proteome, epigenome, etc.) to get a fuller picture.
- b. Mostly positive. Evidence: *novel insights, research is revolutionized, cool, deeper analysis, profound insights, ideally suited, with ease.*
- c. Open.

3. Comprehension (true / false)

#	Answer	Correction
1	False	It uses <i>multiple</i> approaches to understand a single problem.
2	True	
3	True	
4	False	It had <i>never</i> been done specifically for African Americans.
5	False	The variants regulate their genome but <i>could not be found in other populations.</i>
6	True	
7	False	Their transcriptomic signatures are <i>lost and undetectable</i> in bulk approaches; single-cell approaches detect them with ease.

Gap-fill

#	Answer(s)
1	context, discovery
2	problem
3	angles
4	analysis
5	suited
6	orders
7	constitute
8	ease

Final question (return to predictions): open. Students say which predictions were correct and what was missing. Likely missing items: the specific example of mapping quantitative trait loci in African Americans, and the point about rare cell types (1–2%).

C. The Double-Edged Sword of AI

What are the two main sections? What do the icons show?

- **Left: Challenges.** Icons include a bar chart (data noise and sparsity), a line graph (long sequence length), overlapping squares (multi-scale representations), a chip and nodes (multimodal integration, data heterogeneity), cubes (interpretability, reproduction) and a shield/scales/clipboard (ethical and privacy risks).
- **Right: Opportunities.** Five panels: high-throughput biological data, trans-biological migration, understanding and innovation, precision medicine, and win-win cooperation.

Which ideas from the video can you find in the image?

- Genomics + Transcriptomics + Proteomics → Personalized Treatment (layering different “-omics”).
- scMulti-Omics and Spatial Transcriptomics (single-cell analysis).
- Multimodal integration and data heterogeneity (the difficulty of combining layers).

Sort the challenges

Data problems	People and society problems
Data noise and sparsity	Interpretability of results

Data problems	People and society problems
Long sequence length	Reproduction of results
Multi-scale representations	Ethical and privacy risks
Multimodal integration	
Data heterogeneity	

Reproduction of results could also be argued as a data problem. Accept it with a reason.

1. Opportunities Experts (model answers)

Opportunity	What is promising
High-throughput biological data	Huge datasets such as gnomAD, spatial transcriptomics and single-cell multiomics give AI models large amounts of data to learn from.
Trans-biological migration	Knowledge can be carried across levels and species: RNA → protein, and from humans to animals and plants.
Understanding and innovation	Biofunctional discovery, drug design and protein engineering can be faster and more creative.
Precision medicine	Genomic, transcriptomic and proteomic data can be combined to personalize treatment, support digital health and inform clinical decisions.
Win-win cooperation	Sharing resources and working across disciplines benefits both scientists and AI developers.

2. Speaking task (sample arguments; accept any well-supported view)

Role	Possible arguments
Doctor	Multiomics could reveal patterns a single test misses, giving more accurate, personalized treatment. Concern: the system must be explainable so doctors can justify decisions.
Data scientist	Rich, integrated data improves predictions. Concerns: noisy, sparse and heterogeneous data, and results that may not be reproducible.
Patient representative	Personalized treatment is attractive. Concerns: privacy of genetic data, informed consent, and fairness for groups under-represented in datasets (compare the video's point about African-American data).
Hospital manager	Potential for better outcomes and efficiency. Concerns: cost, staff training, legal responsibility and public trust.

Sample conclusion: *The hospital should adopt the system, but only if data are protected, the results can be explained to doctors and patients, and the system is tested on diverse populations and monitored regularly.*

Look for the target structures (*One major benefit is... / A serious concern is... / As a result... / On the one hand... on the other hand... / It has the potential to... / We should make sure that...*) and for reasons that use both the video and the infographic.