Will AI make biology textbook authors redundant? Here's one author's view of ChatGPT

I just used ChatGPT for the first time. Initially, I was concerned about my future as the chatbot near-instantaneously answered my queries on increasingly obscure terms from my field, genetics. Stumping the AI tool, however, took only about 10 minutes.

ChatGPT was released November 30, 2022, from OpenAI/Microsoft. "Chat Generative Pre-trained Transformer" is a little like Google on steroids. But after my brief encounter, I can't help but wonder whether it can handle the nuance, context, humor, and creativity of a human mind. Could it replace me as a textbook author?

My career

I've been writing life science tomes for a long time. My favorite has always been Human Genetics: Concepts and Applications, the first edition published in 1994, at the dawn of the human genome sequencing era. The 14th edition published this week, from McGraw-Hill. A revision takes two years, one for updating and addressing reviewers' suggestions, another for "production," from copyediting through final pages. Then, a year off.

As genetics morphed into genomics, artificial intelligence stepped in, layering the combinatorial information of comparative genomics onto DNA sequences. Training on data sets and then searching for patterns could be used to deduce evolutionary trees depicting species relationships, in ancestry testing and forensics, and in identifying sequences of mutations that appear as a cancer spreads.

ChatGPT is too recent for me to have used it in revising the new edition, but I'm curious now. I could imagine it spitting out definitions, but a textbook is much more than "content." A human author adds perspective, experience, and perhaps knowledge beyond what ChatGPT can extract from the Internet.

Genetics textbooks and generative artificial intelligence

Genetic research unfurls and extracts reams of information, millions and even billions of data points. Train an algorithm on the DNA sequences of a known disease-causing gene, then search for identical or highly similar sequences in cells from other individuals to assist diagnosis.

The type of AI that could rewrite textbooks is called generative, the G in GPT. It learns the patterns and structures of "training" data and generates similar combinations of new data, producing text, images, or other media.

So could ChatGPT write a textbook like mine? I don't think so.

I can imagine generative AI writing a novel similar to those of popular author Colleen Hoover. In fact, I long ago published a fantasy piece in Playgirl after listing the words and phrases in similar articles and

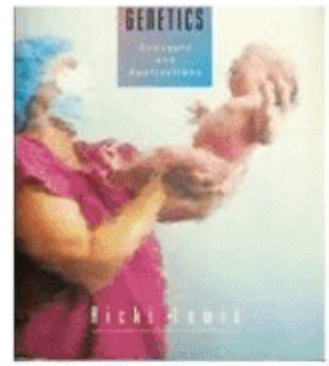
creating a fresh scenario. It involved a tornado and a wheelbarrow in rural Indiana.

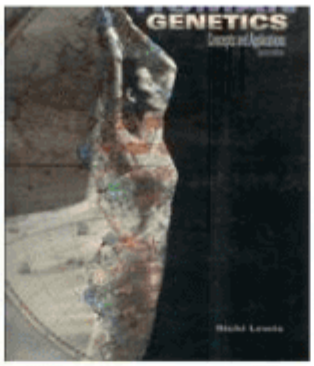
Like Colleen Hoover's fiction and Playgirl fantasies, textbooks have a highly distinctive style. But textbooks have a lot more than a single narrative per chapter. The process also entails selecting photos, designing illustrations, and creating the pedagogical tools – questions, summaries, references, boxed readings. So here's a brief history of textbook publishing, followed by what I suspect AI might not be able to execute as well as a human author could.

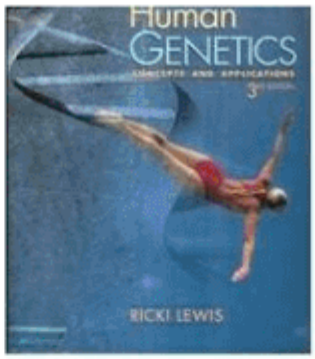
The evolution of a life science textbook

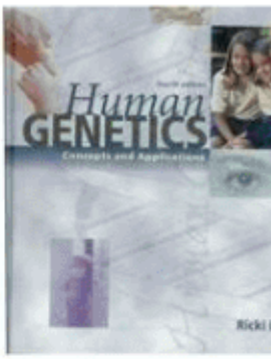
My first textbook, *Life*, was introductory biology, not to be confused with Keith Richards' autobiography with the same title. Back then, sales reps were armed with bells and whistles to boost market share – test banks, instructor's manuals, case workbooks. What a difference today! E-textbooks are embedded with "adaptive learning" multiple choice questions. The learner (once called a student) receives instant feedback on why each incorrect choice is incorrect.

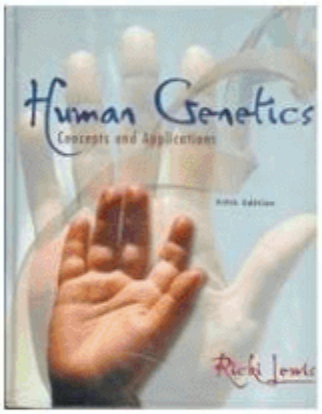
Each edition brought new fonts, design elements, and palettes, to make the new version appear different, because some topics – mitosis, Mendel, DNA – don't change. Tomes were split into shorter versions, like calving icebergs.

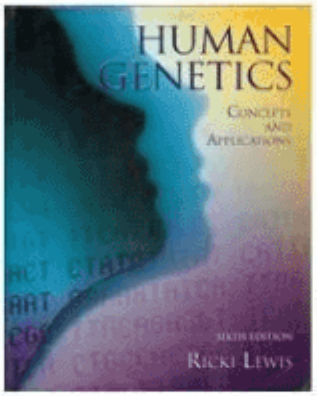


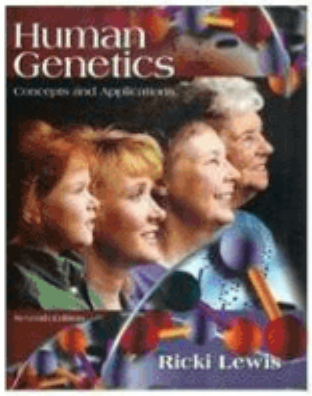


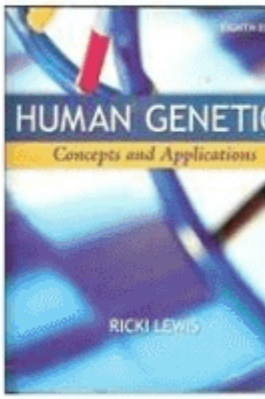


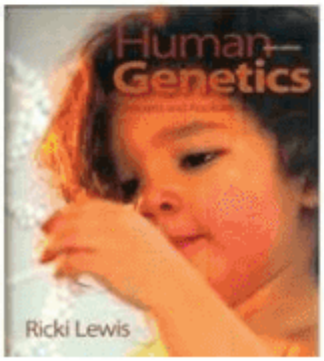


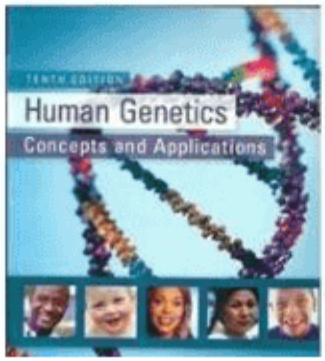


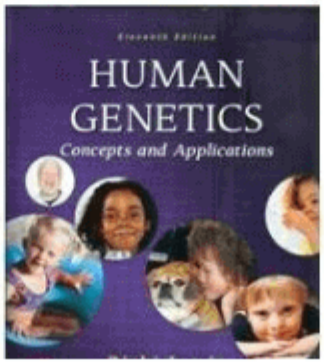












The first E-books date from the 1990s. Now, college tuition includes a fee to license an e-textbook for a limited time. “E” might also stand for “ephemeral.”

New for my 14th edition, a company intensely scrutinized everything I wrote with a DEI lens – diversity, equity, and inclusivity. I recounted discovering my gaffes here.

Because traditional textbooks are costly, occasionally efforts arise to replace them. But cobbling togethera course from online materials, or from lecture notes and test questions, takes more time and effort than most would-be authors may realize. And the free online textbooks that appeared a few years ago lacked the editorial and reviewer scrutiny that an academic publisher provides.

A less tangible skill of creating a textbook is innate writing talent. The elements of style are subtle. How many academics, or ChatGPT, change passive to active voice? Rewrite to omit “there are” and other redundancies? Avoid overusing words? Alter sentence and paragraph lengths? Organize the material into logical A, B, and C heads?

Can AI mimic the creativity of a human mind?

AI may quickly assemble a table listing DNA replication enzymes or compile technology timelines. But how might an algorithm, no matter how well-trained, mimic an author’s choice of examples or develop case studies based on in-person interviews with people who have genetic diseases?

Would AI improve upon my stem cell similes?

> *The difference between a stem cell and a progenitor cell is a little like a college freshman’s consideration of many majors, compared to a junior’s more narrowed focus in selecting courses. Reprogramming a cell is like a senior in college deciding to change major. A French major wanting to become an engineer would have to start over, taking very different courses. But a biology major wanting to become a chemistry major would not need to start from scratch because many of the same courses apply to both majors. So it is for stem cells.*

What about pedagogy? AI could regurgitate fill-in-the-blank or multiple choice questions. But could it create my critical thinking exercise of Venn diagrams of three SARS-CoV-2 variants with a few shared mutations? I ask the reader to apply the genetic code rules to predict which changes are most likely to threaten public health.

I try to make my questions fun.

Would ChatGPT come up with end-of-chapter queries based on the inheritance of wiry hair among the tribbles of *Star Trek*? Trace a rare blood type in a family on *General Hospital*? Create a pedigree for SORAS (soap opera rapid aging syndrome), the condition that permeates the Newman family on *The Young and the Restless*?

Borrowing from science fiction continues in an evolution chapter, asking the learner to identify the principle that these themes illustrate:

> *In Seveneves by Neal Stephenson, the moon shatters. In two years the pieces will smash into the Earth and make the planet uninhabitable for centuries. Some people already living on huge space stations survive, and others are selected to join them. Everyone else dies under the*

> *barrage of moon junk and intense heat. Above, on the "Cloud Ark," the human species dwindles, but eventually resurges from seven surviving women, with help from assisted reproductive technologies to make babies. Five thousand years after the moon blows up, the human population, ready to inhabit a healed Earth, has resurged to 3 billion*. (A POPULATION BOTTLENECK)
>
> In *Children of the Damned*, all of the women in a small town are suddenly impregnated by genetically identical beings from another planet. (NON-RANDOM MATING)
>
> In Dean Koontzi's *The Taking*, giant mutant fungi kill nearly everyone, sparing only young children and the few adults who protect them. The human race must reestablish itself from the survivors. (FOUNDER EFFECT)

What about history? AI might easily assemble chronologies. But would it combine the 1961 deciphering of the genetic code by Marshall Nirenberg and Heinrich Matthaei in a "Glimpse of History" boxed reading with Katalin Karikó and Drew Weissman's invention of the first mRNA-based vaccine?

Finally, can AI use humor? Would it deliver an end-of-chapter question like this one on forensic DNA testing:

> *Rufus the cat was discovered in a trash can by his owners, his body covered in cuts and bite marks and bits of gray fur clinging to his claws—gray fur that looked a lot like the coat of Killer, the huge hound next door.*

ChatGPT weighs in

Testing ChatGPT was easy.

It earns an A+ in returning definitions of obscure technical terms, like *tetrachromacy* (enhanced color vision from a fourth type of cone cell) and *chromothripsis* (shattered chromosomes).

ChatGPT accurately distinguishes *gene therapy* from *gene editing*. The tool doesn't oversimplify gene therapy as "replacing" a gene, but returns *"Gene therapy involves introducing new or modified genes into a person's cells to correct or replace a faulty gene or to provide a therapeutic function."* That definition covers all bases.

My new textbook edition has a boxed reading on how the viruses behind flu and COVID differ. Again, ChatGPT returns more than I'd want to know about the two pathogens, comparing and contrasting. I could envision a student using the response in an assignment – I'm glad my professor days are over!

ChatGPT clearly distinguishes *driver* and *passenger* mutations in cancer, although my textbook definition begins with context:

> *A driver of a vehicle takes it to the destination; a passenger goes along for the ride.*

A disclaimer for ChatGPT reads *"While we have safeguards, ChatGPT may give you inaccurate information."* Apparently it also makes errors of omission, which I discovered when I asked it about something else I'd written about: how to make an Impossible Burger. Not simply the ingredients, but the biotechnology behind this brilliant invention.

ChatGPT's explanation starts accurately enough:

> *The Impossible Burger is a plant-based burger patty designed to mimic the taste and texture of traditional beef burgers. While I don't have access to the exact recipe or process used by Impossible Foods, I can provide a general overview of how plant-based burgers like the Impossible Burger are typically made.*

It then lists general steps of making the variations on the traditional veggie burger theme found in supermarkets. But Impossible burgers are not at all like others!

That's just not good enough, despite the humanizing effect of the first person answer.

ChatGPT apparently didn't read my article, Anatomy of an Impossible Burger, which I posted here at *DNA Science* in May 2019. That's about as straightforward a headline as I could come up with.

My source? The Patent and Trademark Office database! It took only a few minutes of searching. The patent application is 52 pages, filed in 2017 following years of published research. It includes hundreds of related patents and publications, many in mainstream media. *ChatGPT couldn't find any?*

The tool had no access to the exact recipe or process? The approach genetically alters yeast cells to produce a soybean's version of hemoglobin, called leghemoglobin, which imparts the "mouthfeel" and appearance of dead cow flesh.

Not only did I blog about the Impossible Burger in 2019, but I published a version in the thirteenth edition of my textbook, three years ago!

But I'm relieved, not insulted at flying under the ChatGPT radar, for it's nice to know that my skill set is not yet obsolete. Although I do have an issue with typing ChatGPT. In earlier drafts it repeatedly came out of my brain as GTP, perhaps after the DNA nucleotide GTP – guanosine triphosphate.

Ricki Lewis has a PhD in genetics and is a science writer and author of several human genetics books. She is an adjunct professor for the Alden March Bioethics Institute at Albany Medical College. Follow her at her website or X @rickilewis