Bringing GenAI to the Genome

Unlocking genome design for protein production

Sarah Bolmer
sarah@triplebar.com

Triplebar

Launching a new food product through biomanufacturing shouldn't be this hard

Triplebar moves the bottleneck to **where it should be**

Development of a great product that **customers love**

CPG average:
- < $1M
- 12-18 months

	Total raised before first product launch	Time from founding to first product launch
IMPOSSIBLE	$182M	5 YEARS
PERFECT DAY	$201M	5 YEARS
GELTOR	$25M	4 YEARS
TurtleTree	$40M	5 YEARS
EVERY	$57M	6 YEARS

Just like ChatGPT has unlocked ›10x productivity…

How can I help?

Help me pass the bar exam

Tools

Absolutely — I can help you develop a strategic, high-retention plan to pass the bar exam. First, let's clarify a few details to tailor the support:

Quick Questions for You:

1. **Which state bar exam are you taking?**
2. **When is your exam date?**
3. **Have you already taken a prep course (e.g. Barbri, Themis, etc.) or are you self-studying?**
4. **What are your strengths/weaknesses (e.g., MBE, essays, performance tests)?**
5. **How much time per day/week can you realistically dedicate to studying?**

In General, Here's What You Need to Focus On:

Core Components of Most U.S. Bar Exams:

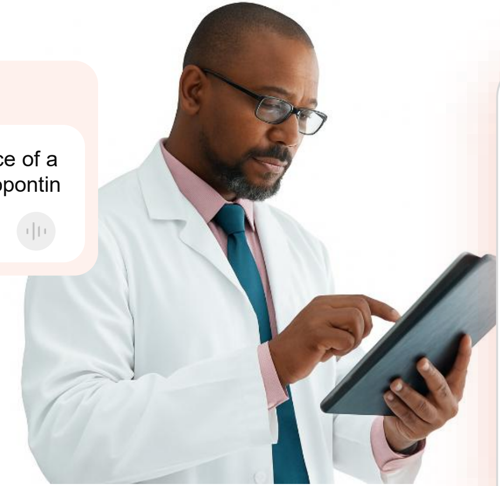
- **MBE (Multistate Bar Exam)** – 200 multiple-choice questions across 7 subjects.
- **MEE (Multistate Essay Exam)** – 6 essays testing issue-spotting and legal analysis.
- **MPT (Multistate Performance Test)** – 2 tasks simulating real legal work.
- **State-specific law** (if applicable) – varies by jurisdiction.

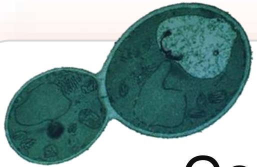
High-Yield Study Strategy:

Triplebar ei

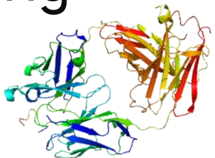
Tell me the genomic sequence of a yeast strain that makes osteopontin

Tools





Generative AI will ›10x productivity in biomanufacturing



Triplebar

We have to solve problems at each part of our value chain

Where can AI solve problems?

Find better products → Make them low cost →

Molecule	Formulation	Bioprocess	Logistics, Distribution, Supply Chain	Consumer insights, marketing

Can we use AI to....

Design molecule to function	*Design formulation to product outcome*	*Design process to low cost, high output*	*Design and de-risk path to customer*	*Make sure we are making what the customer wants*

The good news is that a lot of companies are using AI to do just that…the tool box is growing

Molecule	Bioprocess	Formulation	Logistics, Distribution, Supply Chain	Consumer insights, marketing
brightseed	NotCo	TURING.	BlueYonder Fulfill your potential™	tastewise
Profluent	BCD iLabs	POW.BIO	C3.ai	Native
EvolutionaryScale		Cultivated B	RELEX	NEXTATLAS
shiru	WAGENINGEN UNIVERSITY & RESEARCH		FOURKITES	yabble
DeepMind				Stravito
Cradle				
NURITAS				
BASECAMP RESEARCH				

Strain development is a fundamental bottleneck to innovating and it's a place that could desperately use AI...

Molecule

Formulation

Bioprocess

Logistics, Distribution, Supply Chain

Consumer

Cell engineering (strain development)

Can we use AI to.... tell us **HOW** to make a product

Triplebar

Imagine if you could design a strain to make your product the same way you ask a question of ChatGPT

eiMICRO - an *in silico* organism design SaaS - makes years of strain engineering a thing of the past

Triplebar eiMICRO

Make this protein:
GAGAGTCAGGTCGTGTGAAAACCAATG
CGTCGACTTCAGGGCCCAATTACTCG
GTCATTTATAATCGTTTTCTCTCGAATT
TTGAGCACAATGTAGATAATGTCTTCA
GCTATCAGATGTTAT

\+ Tools

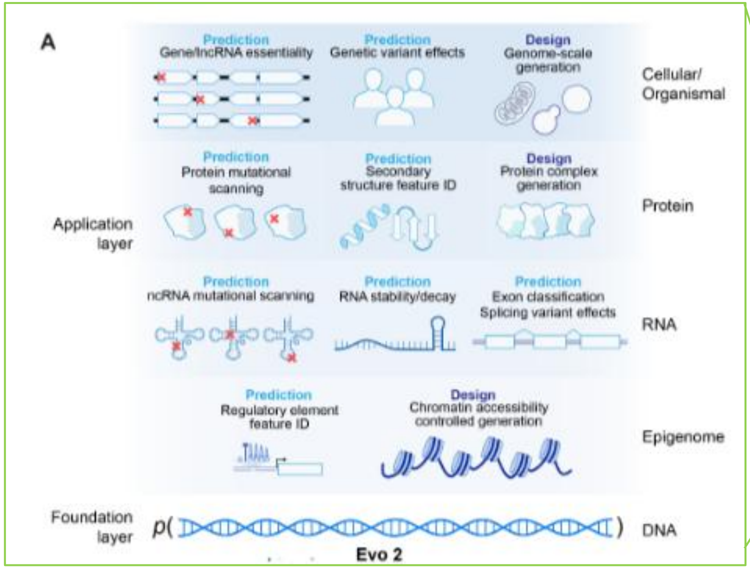
Yes, for this protein, you're looking at:

- **Predicted productivity**: 35 g/L in 96 hours
- **Predicted costs**
  - at US Plant: $25/kg
  - at EU Plant: $28/kg

The genome sequence for this outcome:

The path to unlocking strain design is through genome language models: large language models built on th language of the genome

Evo2 – Arc Institute



Zhang et al Scientific Large Language Models: A Survey on Biological & Chemical Domains. ACM Comput. Surv. 57, 6, Article 161 (June 2025), 38 pages. https://doi.org/10.1145/3715318

Brixi, G., Durrant, M. G., Ku, J., et al. (2025). Genome modeling and design across all domains of life with Evo 2 (preprint). bioRxiv

Triplebar

Genome scale AI isn't going to solve strain development without the right data

Not the right data

Most AI companies train on data from natural diversity, which doesn't contain examples of biomanufacturing tasks

EvolutionaryScale
BCR BASECAMP RESEARCH
Google DeepMind
Arc Institute
Isomorphic Laboratories
xaira

Application specific data at Gen AI scale

Not enough data

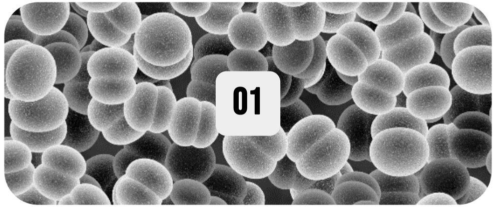
Liquid handling automation cant find millions of phenotypically different organisms and their causative mutations

Cradle
GINKGO BIOWORKS
Lonza

THE TRIPLEBAR PLATFORM SOLVES BIOMANUFACTURING BY ENABLING BIO AI

Screen 10M+ cells/day for functional performance AND sequence the 0.1% that are better

HOW IT WORKS:

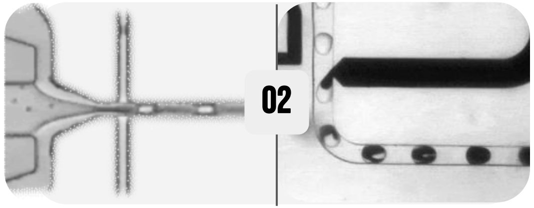


Generate variants

to sample full genome search space

1,000 mutations per genome
x **1,000,000** genomes per round

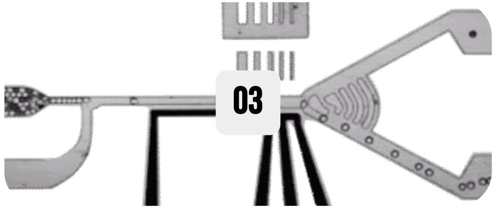
1B mutations tested



Encapsulate in micro-reactor systems

at 10M+/day

Cultivate each cell in conditions that mimic bioreactors



Measure, enrich & iterate

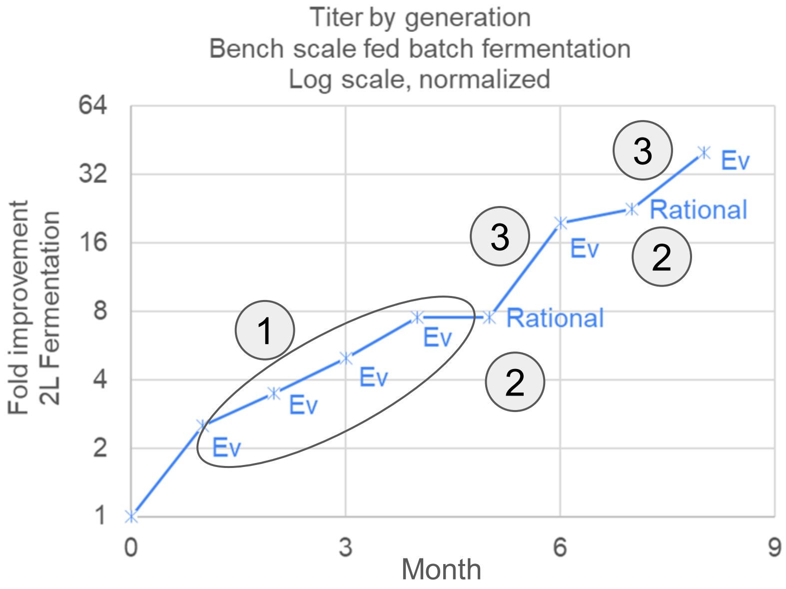
Screening directly for higher protein titer and sort, real-time

Enrich population for improved variants

Multi-omic sequencing of every non-neutral variant

This is evolution at *hyperspeed*

With this throughput, we repeatedly find better producing strains that scale



Ev= Directed evolution of cell line on Triplebar platform
Rational = Rational edit to cell line

Case Study: Bioactive protein

1. Consistent 40-50% improvement generation over generation

2. Semi-rational libraries address bottlenecks:
    a. Signal sequence
    b. Transcript

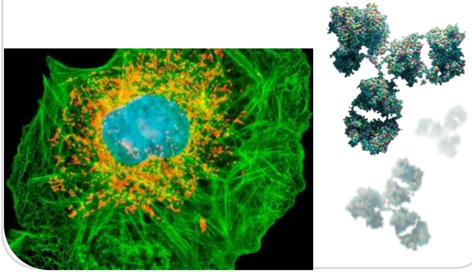
3. Large and novel improvements are discovered once known bottlenecks are removed

Triplebar

By fusing microfluidic screening with generative AI, **Triplebar will compress cellular engineering from years to days**

EVOLUTIONARY DESIGN

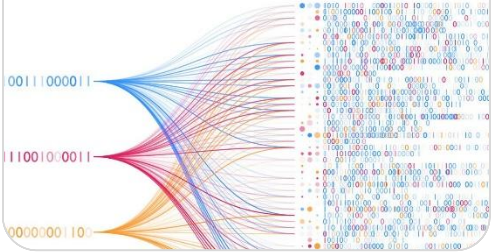
Genome, transcriptome, and phenotypic performance from millions of organisms that have been evolved to high performance



+

ARTIFICIAL INTELLIGENCE

Generative AI models trained on natural evolution then fine-tuned for biomanufacturing with the largest application specific data sets **ever generated**



=

ei

(Evolutionary Intelligence)

in silico design tools that predict strain improvement to improve yield and decrease cost

Triplebar's is building multi-modal and multi-layer models to **incorporate the best of natural diversity and our application specific data**

Data

Triplebar multiomic phenotype data

Natural diversity

Models (& Strategy)

Genome 2 Phenotype Model (G2PM)

Additional parallel heads update parameters to match measured phenotype

Seq2express

Parallel head approach similar to AlphaGenome but with data from relevant organisms

Pre-trained gLM

Hyena-like models similar to EVO2

Output

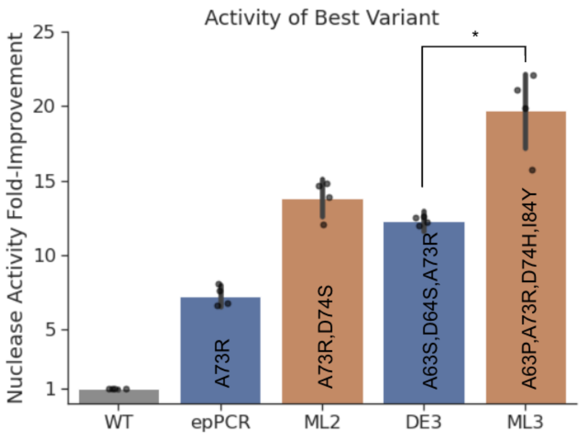
Mutations that improve performance in target application

Predicted expression profiles for any sequence

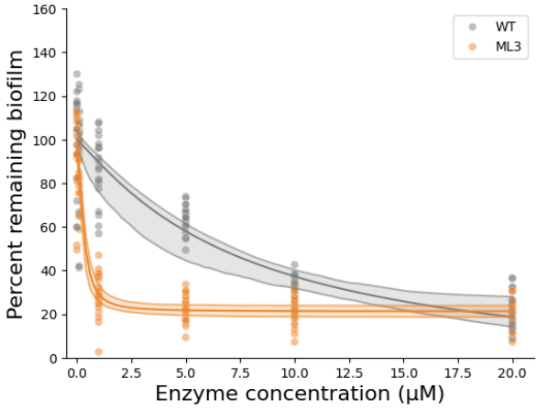
Understanding of the genomic patterns inherent in natural evolution

This isn’t theory — Our Google DeepMind collaboration demonstrated the power of functional data at scale

Google DeepMind x Triplebar



ML-guided directed evolution powered by PbSeq discovers highest improved mutants, up to 20x, compared to HyTS directed evolution alone



Improved enzymes show improved activity over wild-type in real world environment. In this case, biofilm disruption

Combining directed evolution and AI is powerful

› **100,000 data points** on sequence-function relationship over 3 generations of directed evolution

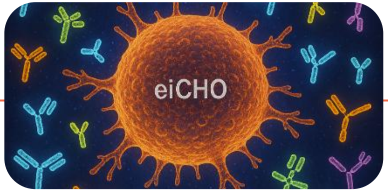
› **20-fold improvement** in enzyme function predicted by a neural network trained on this data

Thomas, N et al. Engineering highly active and diverse nuclease enzymes by combining machine learning and ultra-high-throughput screening. Cell Systems. [doi]

Triplebar is building two products

We have strong demand for a product in the largest, ultra-premium market in biomanufacturing, **therapeutic antibodies**…

…and then will license access to the model that made that breakthrough possible to scale rapidly to **the rest of biomanufacturing**



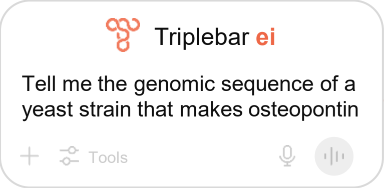
eiCHO

Best-in-class cell line for biologics production

Sold by a leading CDMO
(value share back to Triplebar)

Built at Triplebar through a combination of directed evolution and AI-guided organism design

⇄



eiMICRO

SaaS tool for predictive organism engineering

Available to all through a subscription service

Includes data from all Triplebar's previous projects + new microbe-specific training

Triplebar

Triplebar's first product is a next generation CHO cell line for biologics production: eiCHO

1957	1980s	1990s-2010s	Current	Future
CHO isolated	Suspension DHFR selection	Suspension GS Selection Transposase	Suspension GS Selection Hyper Transposase AI-driven vector design	Suspension GS Selection Hyper Transposase AI-driven vector design **AI-driven genome design**
	<1g/L	1-2 g/L Headline: 3g/L	5-7 g/L Headline: 10+g/L	10+g/L across modalities Headline: 20+g/L

eiCHO eiMICRO

Triplebar's second product is the model itself - an *in silico* organism design tool: eiMICRO

Triplebar **eiMICRO**

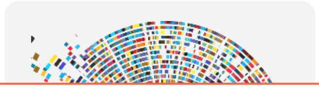
Make this protein:
GAGAGTCAGGTCGTGTGAAAACCAAT
GCGTCGACTTCAGGGCCCAATTACTC
GGTCATTTATAATCGTTTTCTCTCGAA
TTTTGAGCACAATGTAGATAATGTCTT
CAGCTATCAGATGTTAT

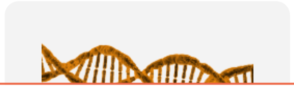
Tools

Yes, for this protein, you're looking at:

- Predicted productivity: **35 g/L in 96 hours**
- Predicted costs:
  - at US Plant: **$25/kg**
  - at EU Plant: **$28/kg**

The genome sequence for high titer:





Achieve cost leadership through strain improvement

Insights for optimization of existing strains

Know how to make a commercially viable product in seconds, not years

Immediate read out of the strain sequence to make your protein, its predicted productivity, and its production cost

Lots of reasons to believe breakthroughs are coming...

Can we use AI to....accelerate sustainable food and ag?

Molecule	Cell	Bioprocess	Formulation	Logistics, Distribution, Supply Chain	Consumer insights, marketing

Triplebar

THE FUTURE OF BIO-MANUFACTURING

WILL BE BUILT WITH EVOLUTIONARY INTELLIGENCE

Sarah Bolmer
sarah@triplebar.com

JOIN US → triplebar.com