GINKGO BIOWORKS

Ginkgo Bioworks
Investor Day

October 3, 2023



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Forward-Looking Statements

This presentation and webcast contain certain forward-looking statements within the meaning of the federal securities laws, including statements regarding our plans, strategies, current expectations, operations and anticipated results of operations, both business and financial, including opportunities for increased operational efficiency, potential customer success, including successful application of our offerings by our customers, the capabilities and potential operational and financial success of our partnerships and collaborations, expectations with regard to the future security and commercial applications of the BIOINT industry, the expansion and potential capabilities of our bioradar network and the national biodefense strategy, the achievement of milestones in our partnership with Google and the expected timing thereof, plans to develop and deploy AI tools for biology and biosecurity for both internal use and external release, and the market environment, all of which are subject to known and unknown risks, uncertainties and other factors that may cause our actual results, performance or achievements, market trends, or industry results to differ materially from those expressed or implied by such forward-looking statements. These forward-looking statements generally are identified by the words "believe," "can," "project," "potential," "expect," "anticipate," "estimate," "intend," "strategy," "future," "opportunity," "plan," "may," "should," "will," "would," "will be," "will continue," "will likely result," and similar expressions. Forward-looking statements are predictions, projections and other statements about future events that are based on current expectations and assumptions and, as a result, are subject to risks and uncertainties. Many factors could cause actual future events to differ materially from the forward-looking statements in this presentation, including but not limited to: (i) volatility in the price of Ginkgo's securities due to a variety of factors, including changes in the competitive and highly regulated industries in which Ginkgo operates and plans to operate, variations in performance across competitors, and changes in laws and regulations affecting Ginkgo's business, (ii) the ability to implement business plans, forecasts, and other expectations, and to identify and realize additional business opportunities, (iii) the risk of downturns in demand for products using synthetic biology, (iv) the uncertainty regarding the demand for passive monitoring programs and biosecurity services, (v) changes to the biosecurity industry, including due to advancements in technology, emerging competition and evolution in industry demands, standards and regulations, (vi) our ability to realize the expected benefits of merger and acquisition transactions, (vii) the outcome of any legal proceedings against Ginkgo, including as a result of recent acquisitions, (viii) our ability to realize the expected benefits from and the success of our Foundry platform programs, (ix) our ability to successfully develop engineered cells, bioprocesses, data packages or other deliverables, and (x) the product development or commercialization success of our customers. The foregoing list of factors is not exhaustive. You should carefully consider the foregoing factors and the other risks and uncertainties described in the "Risk Factors" section of Ginkgo's most recent quarterly report on Form 10-Q filed with the U.S. Securities and Exchange Commission (the "SEC"), and other documents filed by Ginkgo from time to time with the SEC. These filings identify and address other important risks and uncertainties that could cause actual events and results to differ materially from those contained in the forward-looking statements. Forward-looking statements speak only as of the date they are made. Readers are cautioned not to put undue reliance on forward-looking statements, and Ginkgo assumes no obligation and does not intend to update or revise these forward-looking statements, whether as a result of new information, future events, or otherwise. Ginkgo does not give any assurance that it will achieve its expectations.

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Agenda

10:00 am	**Welcome to Investor Day** Jason Kelly | Co-Founder and CEO
10:15 am	**Foundry Tours** Barry Canton | Co-Founder and CTO Patrick Boyle | Head of Codebase Anna Marie Wagner | SVP, Corporate Development & Head of AI
11:00 am	**Cell Engineering Commercial Overview + Strategy** Jen Wipf | SVP, Head of Commercial, Cell Engineering
11:35 am	**Biosecurity Strategy** Matt McKnight | General Manager of Biosecurity
12:10 pm	**Break**
12:15 pm	**Breakout Sessions/Lunch** Biopharma: Jen Wipf | SVP, Head of Commercial, Cell Engineering Industrial Biotech & Agriculture: Kevin Madden | Platform Fellow & Patrick Boyle | Head of Codebase Biosecurity: Matt McKnight | General Manager of Biosecurity Finance/Ops: Mark Dmytruk | CFO & Jason Berndt | Head of Operations
1:15 pm	**Break**
1:30 pm	**AI Fireside Chat** Barry Canton | Co-Founder and CTO Shyam Sankar | Palantir CTO and Ginkgo Bioworks Board Chair Dmitriy Ryaboy | VP, AI Enablement Anna Marie Wagner | SVP, Corporate Development & Head of AI (Moderator)
2:30 pm	**Closing Remarks and Q&A** Jason Kelly | Co-Founder and CEO

OUR MISSION

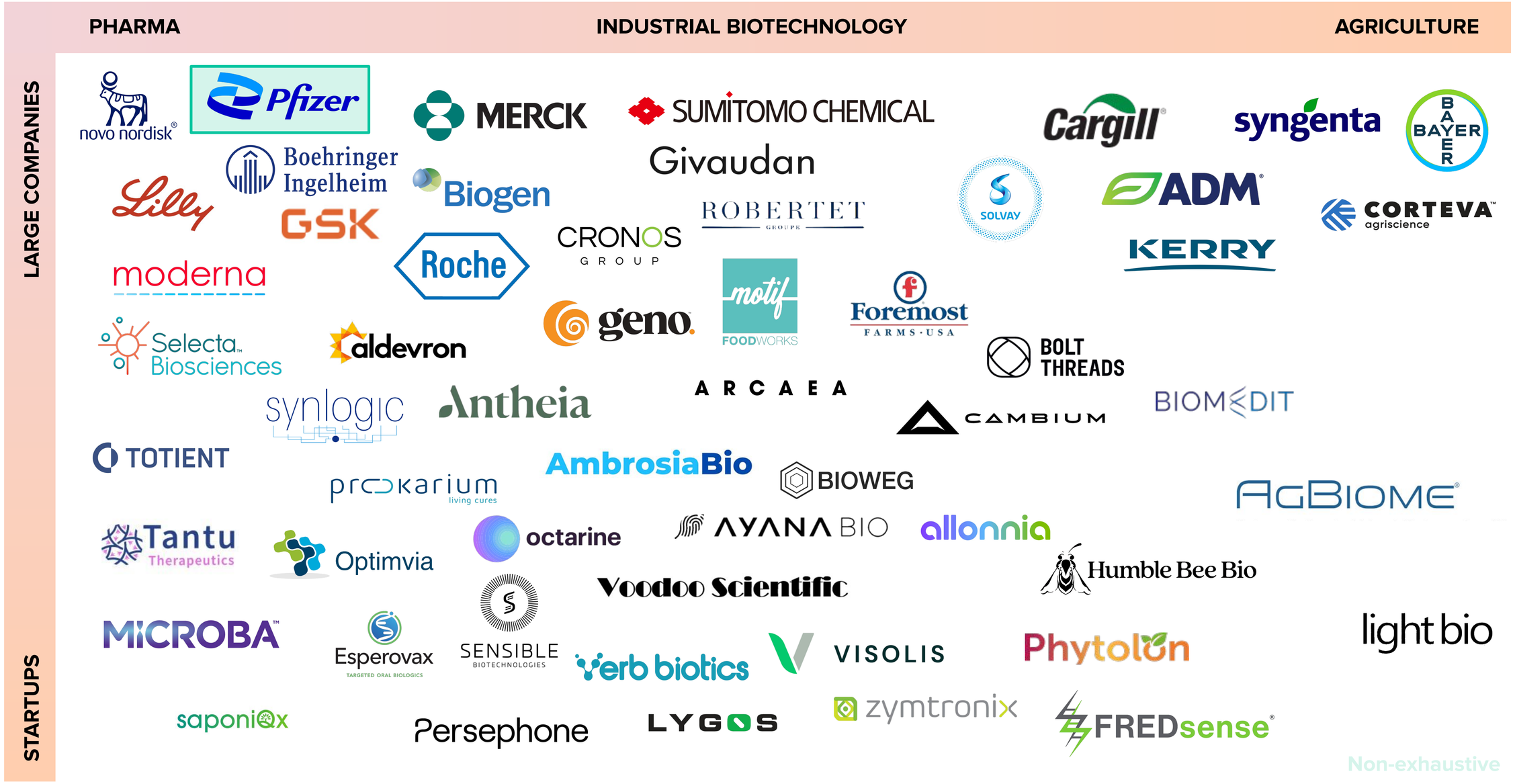
Make biology easier to engineer



Ginkgo intends to change how R&D is done across all biotech markets

Biopharma Breakout
Jen Wipf | SVP, Head of Commercial, Cell Engineering

Industrial Biotech & Agriculture Breakout
Kevin Madden | Platform Fellow & Patrick Boyle | Head of Codebase



Non-exhaustive

Biopharma drug discovery R&D is the largest near-term opportunity for cell engineering services

ENDPOINTS NEWS

Exclusive: Pfizer, Ginkgo sign R&D deal worth up to $331M to develop RNA drugs



Andrew Dunn
Biopharma Correspondent

"RNA therapeutics are proving to be an important platform to advance the world of scientific innovation, and with progress in synthetic biology we have the potential to create new RNA treatments that may benefit patients worldwide. Access to Ginkgo's proprietary platform will help enable Pfizer to search for novel and exciting RNA constructs with improved stability and expression that could lead to more effective treatments."

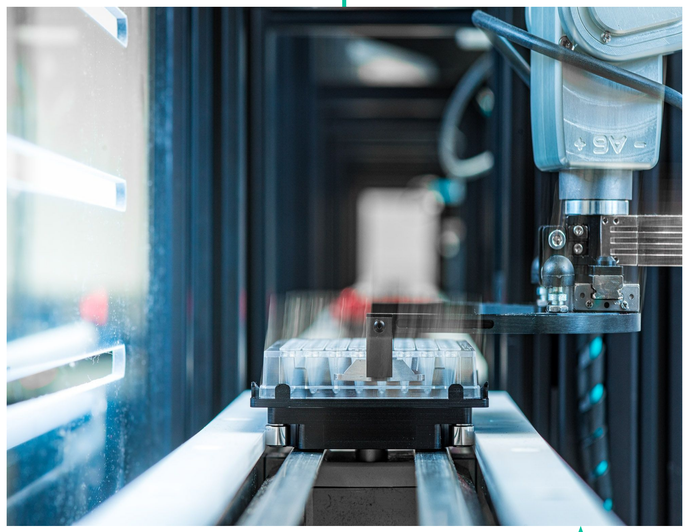
WILL SOMERS, PH.D., HEAD, BIOMEDICINE DESIGN, PFIZER

Ginkgo's technology improves with scale and drives customers to outsource their product development to our platform

Foundry
Generate data

Codebase
Organize and reuse data

AI
Data trains AI models





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Google Cloud

Foundry Tours
Barry Canton | CTO
Patrick Boyle | Head of Codebase
Anna Marie Wagner | Head of AI

Finance/Ops Breakout
Mark Dmytruk | CFO
Jason Berndt | Head of Operations

Data from Codebase is used to build and enhance foundation models and fine-tune applications that allow us to design better Foundry experiments

AI Discussion
Anna Marie Wagner | SVP, Head of AI
Barry Canton | CTO
Shyam Sankar | Palantir CTO
Dmitriy Ryaboy | VP of AI Enablement

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Biosecurity is national security

Government Need

concentric by GINKGO

GINKGO BIOWORKS

US Says It Fears Russia May Use Biological Weapons in Ukraine

- US arms official pushes back against Russian disinformation
- Biological Weapons Convention work stymied by fraught debate

Dangerous AI systems need a 'smoke alarm', warn UK ministers

Technology secretary, Michelle Donelan, hopes safety summit will help to establish early warning signs in technology

U.S. Department of Defense

Pentagon Official Calls for Total Force Focus on Emerging Biothreats

JUST IN: Strengthening Biodefense Capabilities Critical to National Defense Strategy, Official Says

China's quest for human genetic data spurs fears of a DNA arms race

AI might help unleash the next pandemic, MIT study says

By Hiawatha Bray Globe Staff, Updated June 28, 2023, 10:41 a.m.

No 10 worried AI could be used to create advanced weapons that escape human control

At global summit in UK, Rishi Sunak will highlight risk of criminals and terrorists using technology to make bioweapons

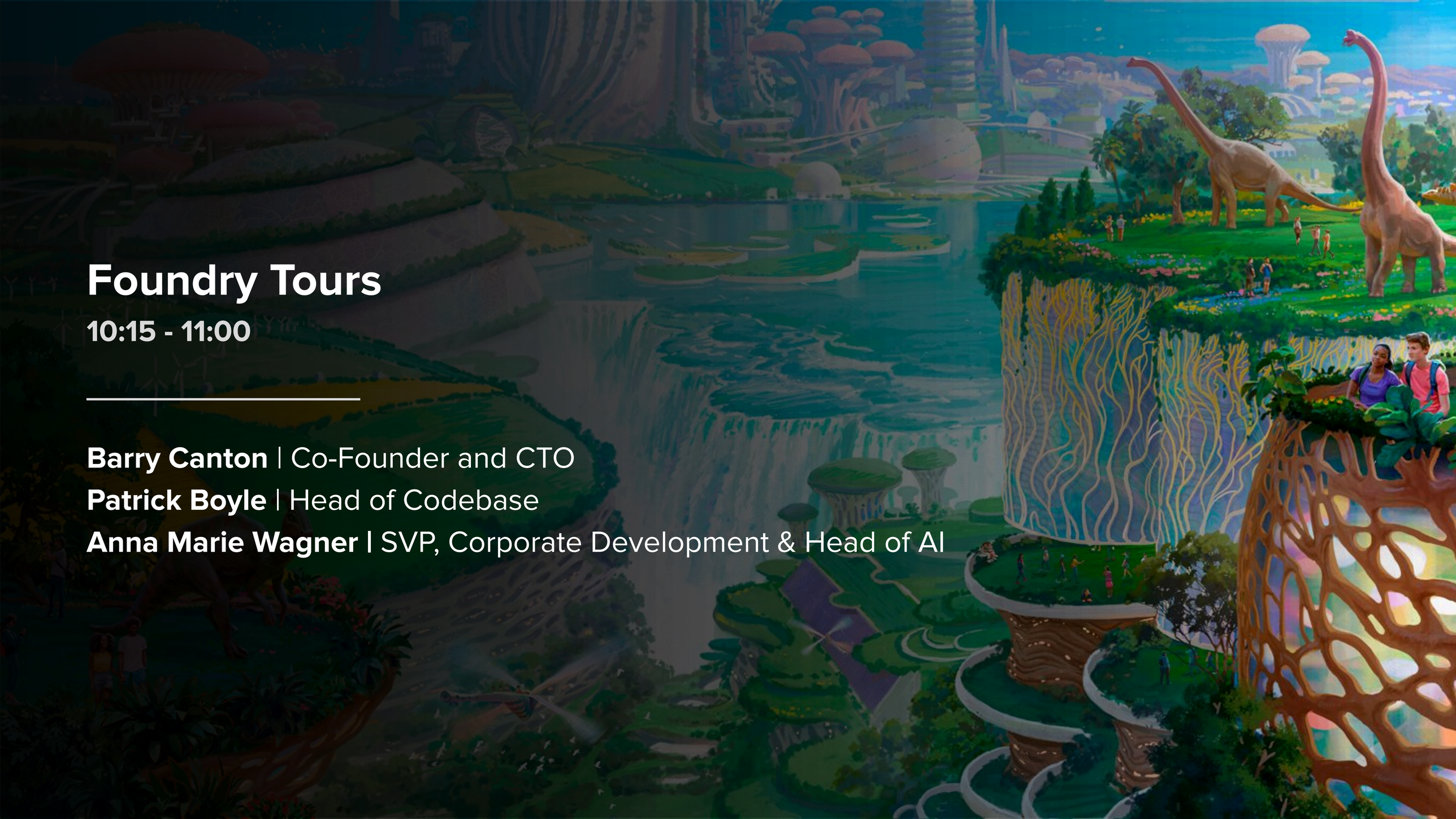
Ginkgo's Integrated Biosecurity Platform



Ginkgo is currently working on a bioradar product to detect, monitor and deter biological threats with the ultimate goal to be able to intercept and shut down any biological threat before it happens

Biosecurity Breakout

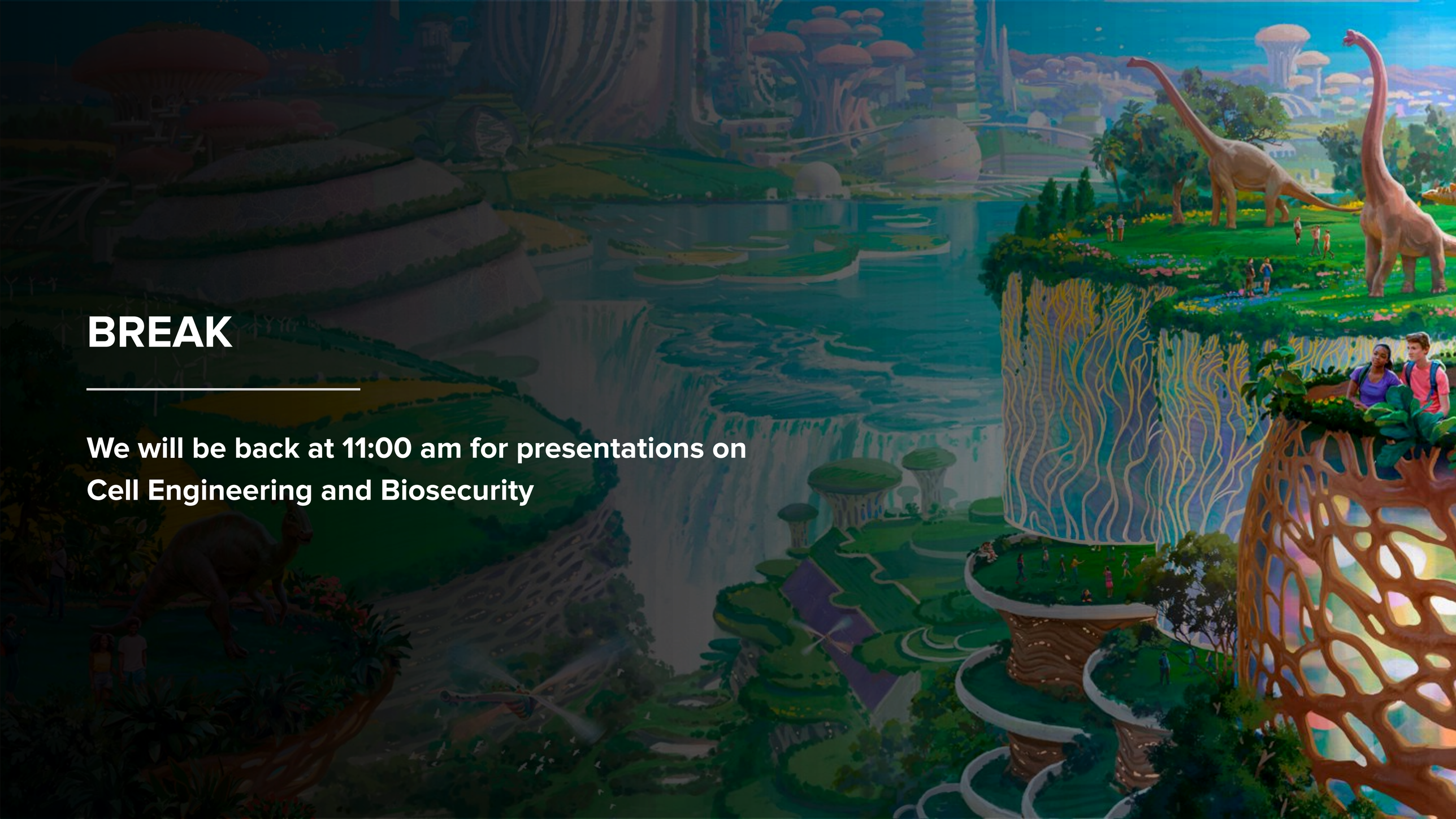
Matt McKnight | General Manager of Biosecurity



Foundry Tours

10:15 - 11:00

Barry Canton | Co-Founder and CTO
Patrick Boyle | Head of Codebase
Anna Marie Wagner | SVP, Corporate Development & Head of AI



BREAK

We will be back at 11:00 am for presentations on
Cell Engineering and Biosecurity

Cell Engineering Commercial Overview + Strategy

11:00 - 11:30

Jen Wipf | SVP, Head of Commercial, Cell Engineering



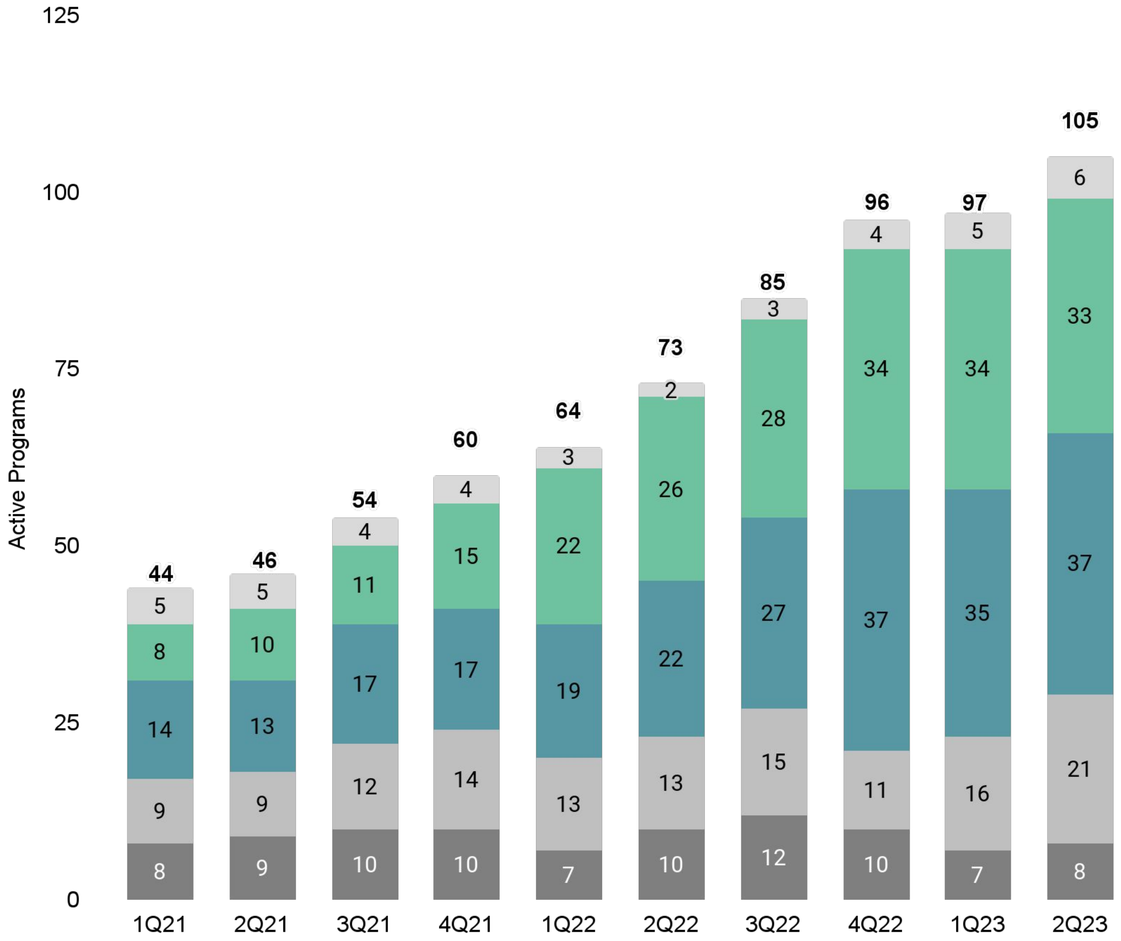
Why are companies outsourcing to our platform?

Customers are outsourcing to us because we are helping them with their most important problems

- Get More Data per R&D Dollar
- Access Existing Large Data Asset and Scientific Experts to Help Navigate it
- Launch Work Fast
- Save Laboratory CapEx
- Replace Fixed Cost with Variable Cost

Continued diversification of programs allows for rapid scaling

Active Programs by Industry



Make-up of Active Programs

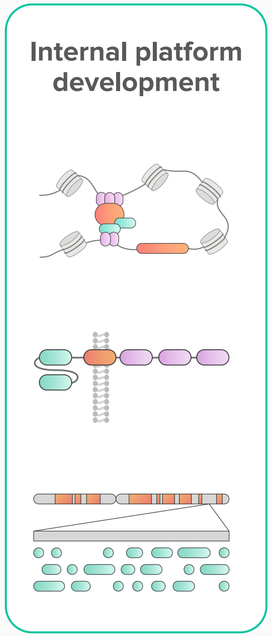
	Q1 2021	Q2 2023
Government	11%	6%
Pharma & Biotech	18%	31%
Food & Agriculture	32%	35%
Industrial & Environmental	20%	20%
Consumer & Technology	18%	8%

Reported as current active programs

Ginkgo's unique technology stack and scale make us a compelling partner to the Pharmaceutical industry

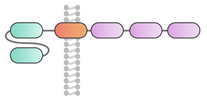
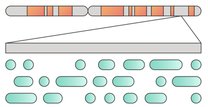
DISCOVERY

MANUFACTURING

Cell Therapy	Gene Therapy	Small Molecule	Biologics	Microbiome	RNA Tx & Vaccines
Leading CGT platform company	Selecta Biosciences	Boehringer Ingelheim	Selecta Biosciences	MICROBA	SENSIBLE BIOTECHNOLOGIES
Internal platform development 	Biogen	Roche	TOTIENT	Tantu Therapeutics	prokarium living cures
		saponiQx	Lilly	synlogic	Esperovax TARGETED ORAL BIOLOGICS
		Optimvia	novo nordisk®	Persephone	Pfizer
		Antheia			aldevron
		MERCK	MERCK		moderna

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Ginkgo's unique technology stack and scale make us a compelling partner to the Pharmaceutical industry

DISCOVERY	Cell Therapy	Gene Therapy	Small Molecule	Biologics	Microbiome	RNA Tx & Vaccines
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			Antheia			aldevron
			MERCK →	MERCK		moderna

MANUFACTURING

	2022	2023
novo nordisk®	Collaboration signed to discover novel expression hosts for biologic production	Pilot phase completed and first milestone achieved, moving the program into a development phase
MERCK	Focused on engineering of up to 4 enzymes (biocatalysts) for Merck's API production process	Second multi-program collaboration focused on biologics production

Our recent deal with Pfizer demonstrates how the breadth and depth of our tech stack differentiates us from competitors

Pfizer's Needs	Ginkgo's Advantage
Advance the discovery and development of novel RNA molecules across priority research areas	**Deep Expertise**: Ginkgo's Codebase assets and project experience allow us to meet customer needs across the R&D lifecycle within a therapeutic modality
High throughput screening to test stability and expression of potential RNA constructs for particular treatments	**Scale:** The scale of Ginkgo's Foundry enables the screening of a large search space of mRNA and circRNA constructs and testing of construct characteristics
Efficient production, circularization, improved stability, and enhanced translation of RNA constructs	**Flexibility:** The customizable nature of our platform including; circRNA, mRNA, and other RNA modalities

Resulting Partnership

Ginkgo Bioworks Announces Multi-Target RNA Discovery Collaboration with Pfizer

BOSTON, Sept. 27, 2023 -- Ginkgo Bioworks (NYSE: DNA) today announced a collaboration with Pfizer (NYSE: PFE) focused on the discovery of RNA-based drug candidates. In the collaboration, Pfizer will leverage Ginkgo's proprietary RNA technology to advance the discovery and development of novel RNA molecules across priority research areas. Ginkgo will receive an upfront payment and is eligible to receive research fees and development and commercial milestone payments, up to an aggregate total of $331 million across three programs. Ginkgo is entitled to potential further downstream value in the form of royalties on sales.

Pfizer GINKGO BIOWORKS

Our sales approach is designed for scale

Enterprise Sales

In addition to bringing on new partners, we are focused on expanding our relationships with our existing partners

- New partners are a great **platform for future growth**
- Sales to existing customers can be handled through lower-touch account management process
  - Customer acquisition **cost has already been incurred**
  - **Success of initial programs** increases our partners' conviction in Ginkgo's platform
  - Familiarity with contracting and approval processes **accelerates deals**

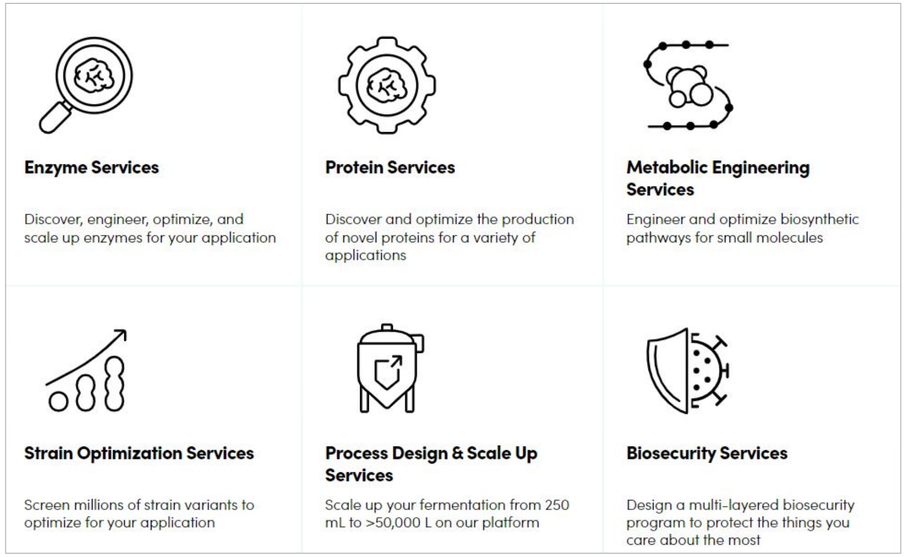
Sumitomo Chemical, Bayer, Solvay, Syngenta, Boehringer Ingelheim, Merck, Novo Nordisk, Pfizer

Non-exhaustive

Product Marketing

We are focusing on services underpinned by the types of work Ginkgo executes well

- Targeted **product marketing** based on key services to keep the top of the funnel full
- Increased **deal standardization** accelerates deals, increases conversion rates, and reduces fees per deal
- **Expanded deal capacity** per sales person



Momentum in cell engineering is accelerating

We continue to sign large deals with Tier 1 customers

Pfizer

Biogen

Boehringer Ingelheim

BAYER

Repeat customers continue to grow

MERCK

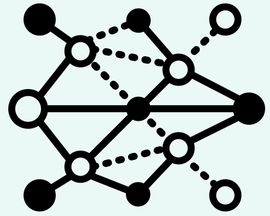
SUMITOMO CHEMICAL

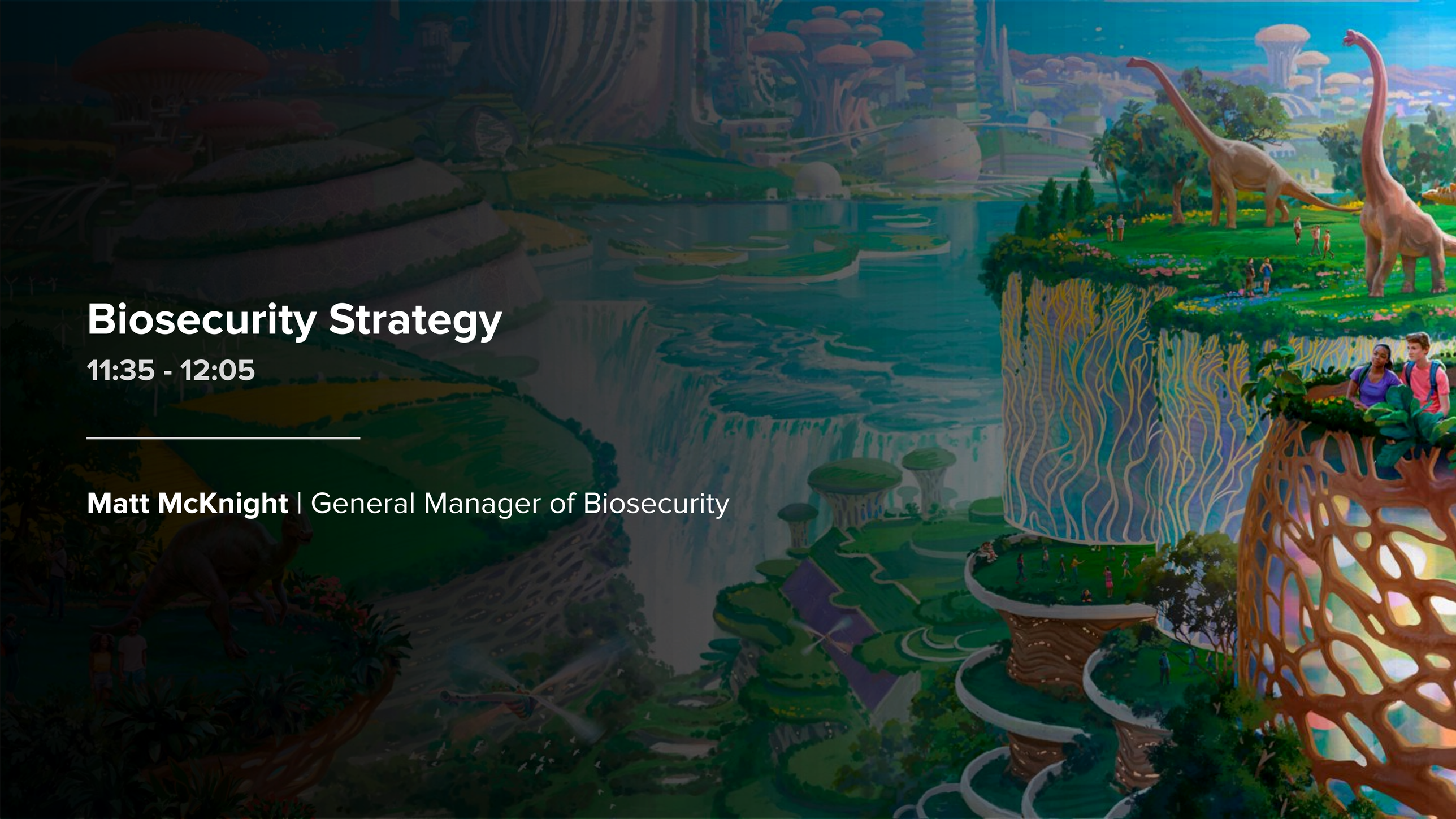
novo nordisk®

Product marketing and success-based pricing is working and driving easier sales



AI is accelerating our current projects and opening up new deal opportunities



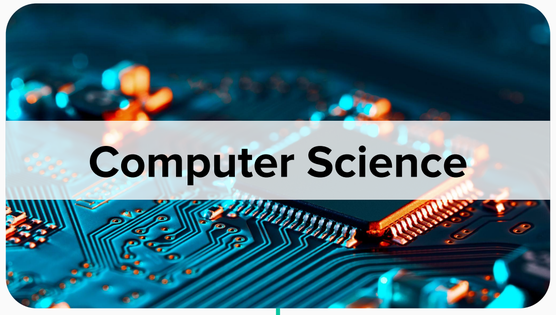


Biosecurity Strategy

11:35 - 12:05

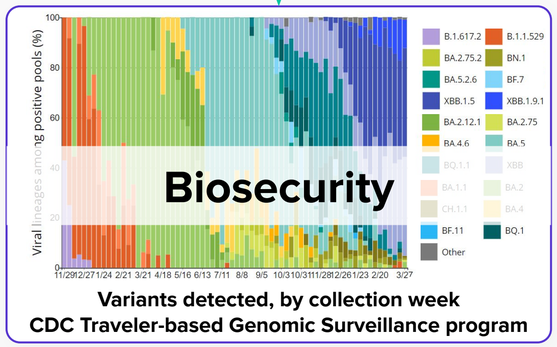
Matt McKnight | General Manager of Biosecurity

Given the power of new biological technologies, it is crucial to build biosecurity in tandem with the bioeconomy









Variants detected, by collection week
CDC Traveler-based Genomic Surveillance program

Ginkgo Bioworks Announces Biosecurity Initiative, Using Deep Learning to Reduce the Global Threat of Biological Weapons and Infectious Disease

June 27, 2018

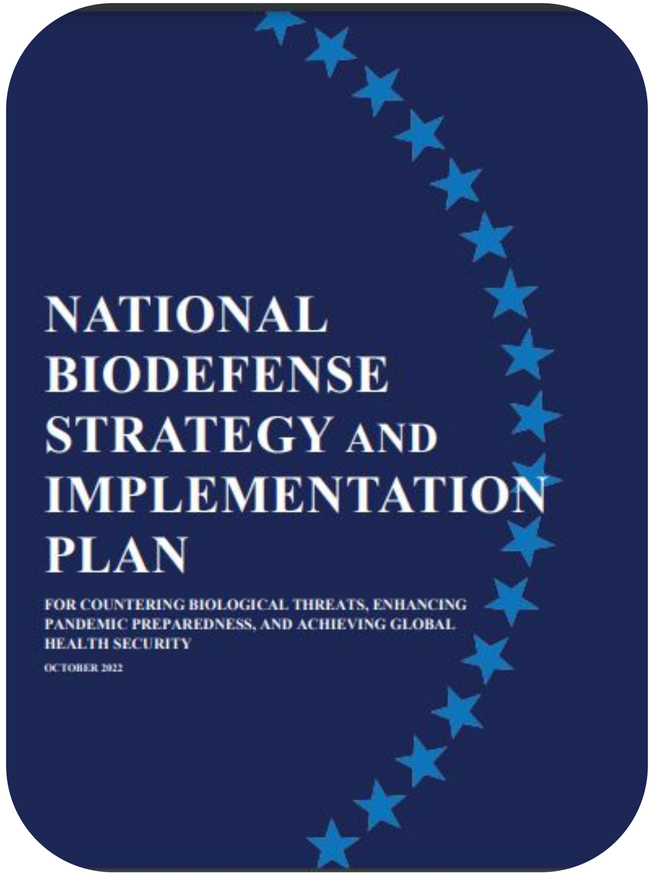
GINKGO BIOWORKS

Ginkgo Bioworks and Google Cloud Partner to Build Next Generation AI Platform for Biological Engineering and Biosecurity

August 29, 2023

GINKGO BIOWORKS

Our ambition is to build a technical system that rapidly identifies and neutralizes biological threats anywhere on the planet



"The United States actively and effectively assesses, prevents, prepares for, responds to, and recovers from naturally occurring, accidental, and deliberate biological threats impacting humans, animals, plants, and the environment and creates a world free from catastrophic biological incidents."

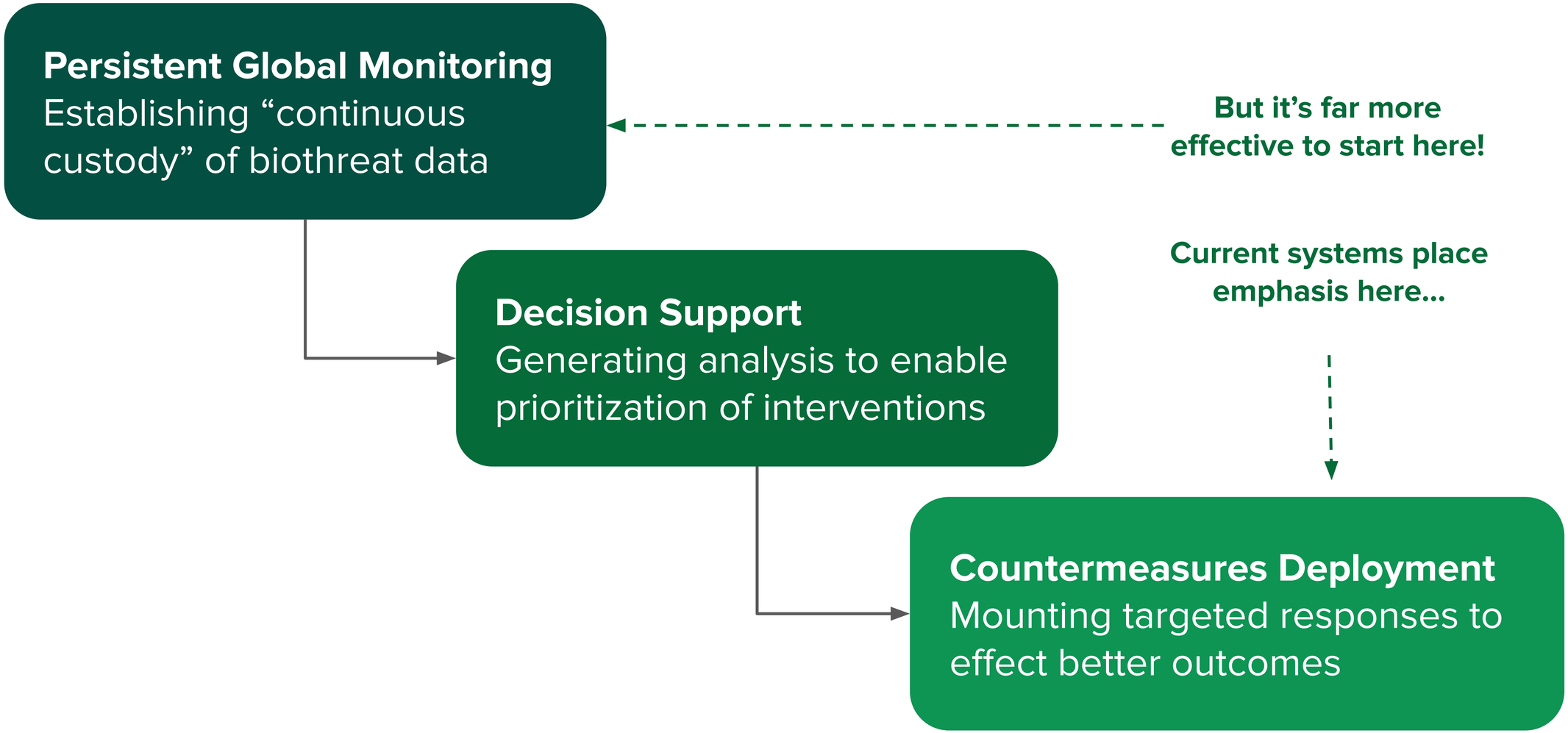
Vision of the National Biodefense Strategy

From Last Supper to First Breakfast: The Defense Tech Ecosystem

Palantir · Follow
Published in Palantir Blog · 8 min read · Sep 8

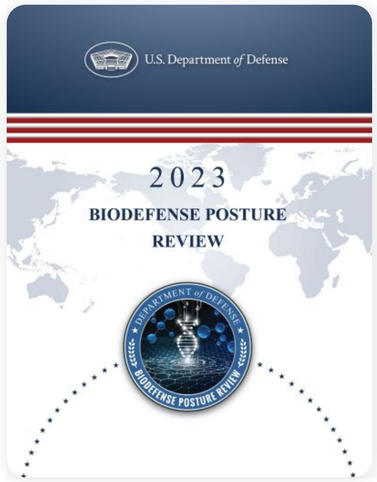
Biosecurity starts with early warning

Countering threats requires understanding them—and biological threats are no different



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Governments are also recognizing that early warning systems must be a national security priority



"A prioritized need for early warning and development of the ability to rapidly detect, characterize, report, forecast, & share relevant information (including sequence data)…"



"Launching a real-time Biothreats Radar to monitor threats and risks as and when they appear."

IARPA, Ginkgo Bioworks and Draper Announce New Technologies to Detect Engineered DNA

Ginkgo Bioworks and XpresCheck Expand CDC's Traveler-Based Genomic Surveillance Program to Detect Influenza Variants

IARPA Awards B24IC Research Contract to Ginkgo Bioworks to Develop Breakthrough Biointelligence and Biosecurity Innovations

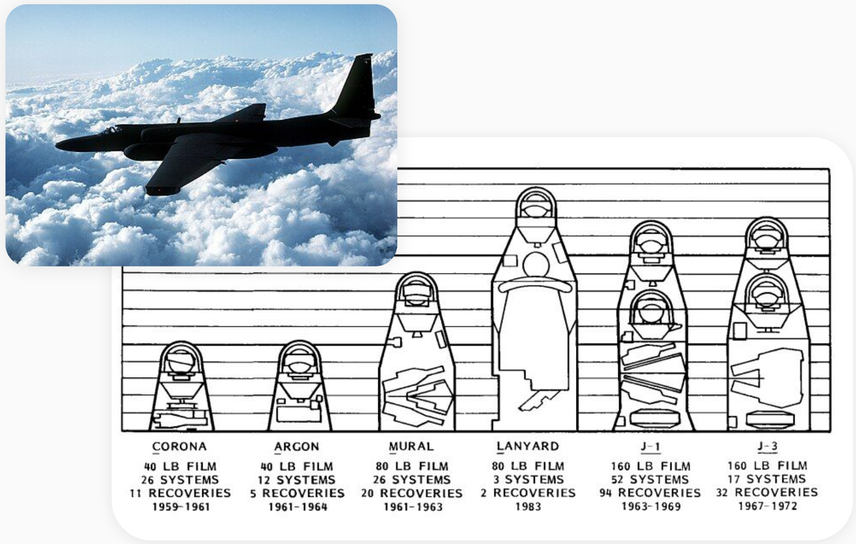
Concentric By Ginkgo and Texas A&M University Awarded USDA NIFA AFRI Grant to Conduct Genomic Animal Research to Prevent Zoonotic Disease Spillover

Property of Ginkgo Bioworks

In order to fill the early warning gap, we need to develop the high-fidelity data asset that generates biological intelligence (BIOINT)

Parallel to Geospatial Intelligence (GEOINT): At the dawn of the Cold War, the **CEO of Polaroid** (Dr. Edwin Land) identified aerial photography as **"a unique opportunity for comprehensive intelligence,"** anticipating nearly unlimited military, civilian, and peacetime uses

High-altitude photography unlocked national security applications of imaging just like genomic sequencing can unlock the biosecurity technology stack



The modern GEOINT industry advances security, economic, and environmental well-being through public and private partnerships – similarly, a market is expected to form around biological intelligence (BIOINT)

Satellite launch / data collection → **Data processing & analysis** → **Data reselling**

$4.6B
Earth observation market (comprising imaging & analysis)

$300M
Illustrative annual IC contract size for market leader (Maxar)

125+
Customers (~70/30 split of public/private, spanning defense, intel, & civilian)

Sources: Euroconsult report, Airbus annual report, Maxar 10-K, Planet Labs 10-K, GEOINT 2023 symposium prospectus

The “bioradar” product we are deploying is an end-to-end system that leverages sequencing to generate BIOINT

COLLECTION PLATFORM

- **Multi-modal surveillance techniques** generate data that form the foundation of an early warning system
- **Flexible platform** allows us to upgrade our offering for different / new pathogens while maintaining surveillance infrastructure
- **End-to-end capabilities** make this program easy to deploy (lab network, logistics, reporting, etc.)

ANALYSIS & DECISION SUPPORT

Pathogen Identification and Characterization

Sequencing and bioinformatics capabilities allow us to **identify and characterize new variants**

The New York Times

A C.D.C. airport surveillance program found the earliest known U.S. cases of Omicron subvariants.

Source: The New York Times, March 24, 2022, link

Genetic Engineering Alerts

ENDAR, developed for the IARPA/FELIX program, leverages AI/ML approaches to **detect genetic engineering** in surveillance samples

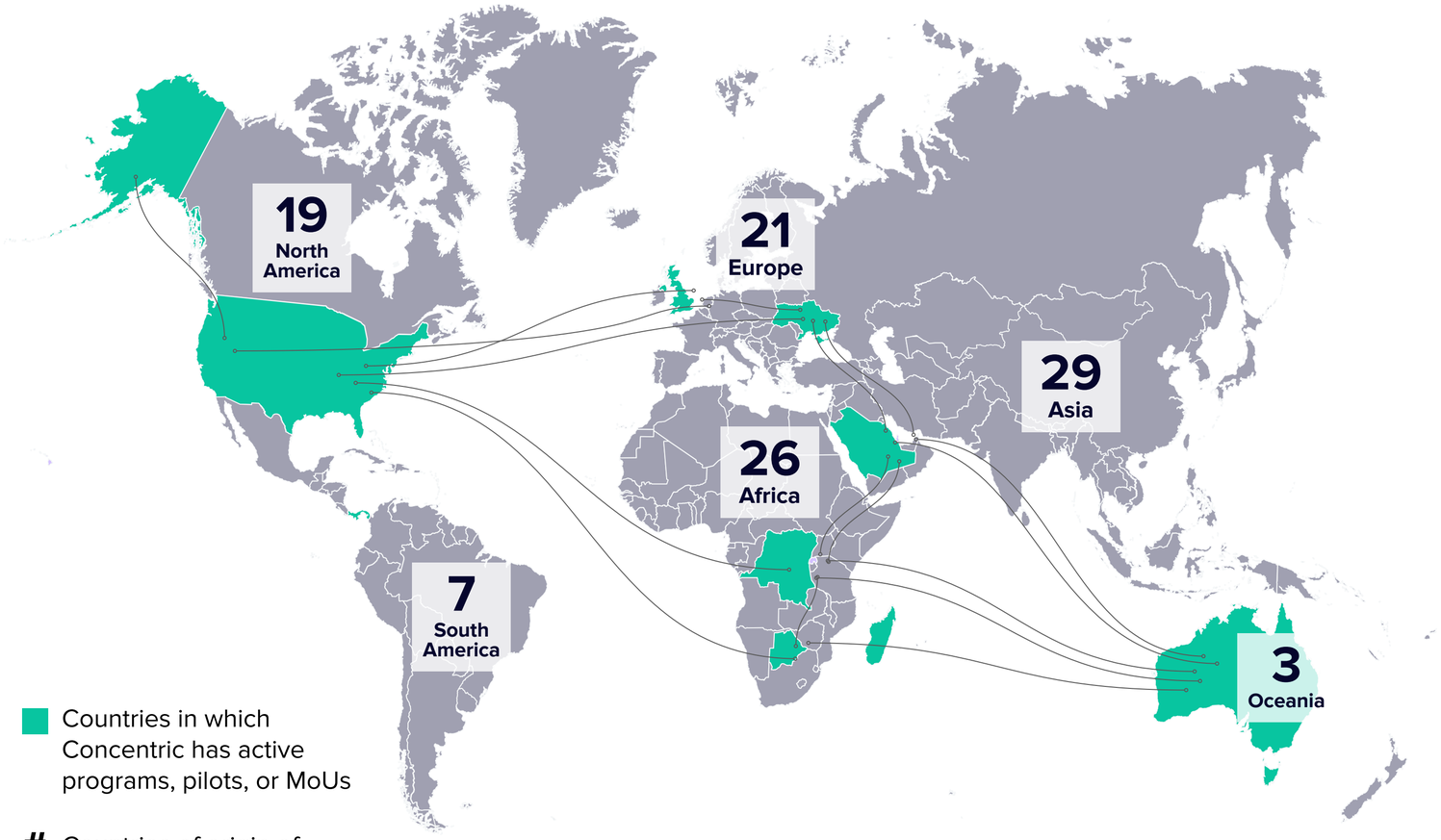
FELIX

Biothreat Modeling & Prediction

Global epidemic tracker could be enhanced to overlay program-specific surveillance data



Effective early warning requires a global network of bioradar stations, we are beginning with international airports



Countries in which Concentric has active programs, pilots, or MoUs

\# Countries of origin of flights sampled by Concentric, by continent
(as defined by Dept. of Homeland Security)

Data updated 08/01/23

12.5M+
Samples to date

65,000+
Viral samples sequenced to date

8
Key international airports (incl. 2 outside US)

11
Countries with active programs, pilots, or MoUs

105
Countries of origin of flights sampled

Our approach to expansion is focused on partnering with countries to develop comprehensive biosecurity programs

MOU / Strategic Partnership → **Program Design** → **Operational Programs**

We typically align on our objectives with partners through a memorandum of understanding or strategic relationship

Ginkgo Bioworks and the Government of the **Republic of Madagascar** Announce Plans to Develop New Biosecurity Capabilities
Sep 25, 2023

Ginkgo Bioworks and the Government of the **Republic of Panama** Announce Plans to Establish New Biosecurity Capabilities
Aug 3, 2023

We work closely with international partners to design biosecurity programs that meet their needs

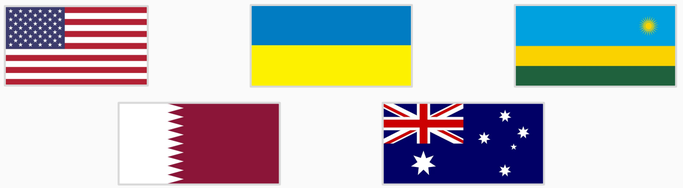
Ginkgo Bioworks and the Ministry of Health of the **Republic of Botswana** Announce Plans to Develop and Implement New Biosecurity Capabilities in Botswana
Dec 20, 2022

Ginkgo Bioworks and the Ministry of Health of the **Republic of Botswana** Announce Pathogen Monitoring Program at Key Ports of Entry
Jul 17, 2023

We deploy biosecurity programs, such as airport bioradar stations, working with local partners







Example engagements demonstrate how biosecurity programs are shaped and deployed with partner countries

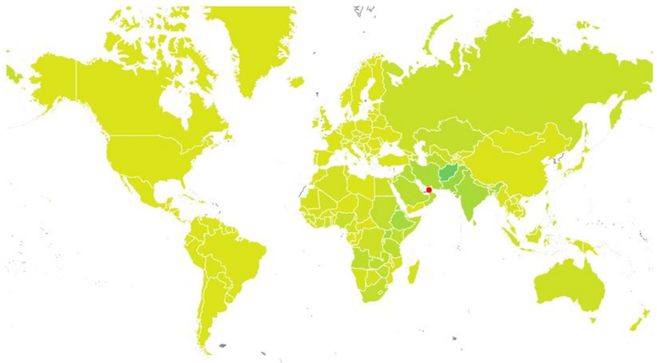
Effective national security solutions for biological threats will leverage the full breadth of Ginkgo's capabilities

DETECT | **DECIDE** | **RESPOND**

concentric by GINKGO

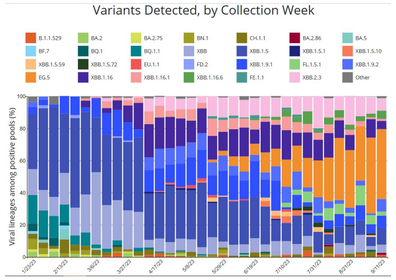
GINKGO BIOWORKS

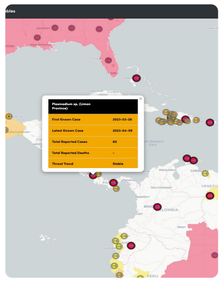
Our growing global bioradar network turns the biological environment into **valuable data**



Illustrative future state of the network; not all red dots represent active partnerships and nodes

State-of-the-art, AI-enabled tools are designed to generate **actionable biological intelligence** about threats





Expert bioinformatic & epidemiological analysis

Office of the Director of Nat
IARPA
BE THE FUTURE

FELIX and B24IC programs create tools to support identification and attribution of engineered threats

Rapid discovery and manufacturing infrastructure could enable next-generation **medical countermeasures**

novo nordisk® · Boehringer Ingelheim · MERCK · Lilly · GSK · Biogen · moderna · DARPA · Roche · aldevron · Pfizer

Property of Ginkgo Bioworks

Lunch / Breakout Sessions

12:15 - 1:15

SWITCH BETWEEN ROOMS

Session 1
12:15 - 12:45

BIOPHARMA
Jen Wipf | Head of Commercial, Cell Engineering

FINANCE / OPERATIONS
Mark Dmytruk | CFO
Jason Berndt | Head of Operations

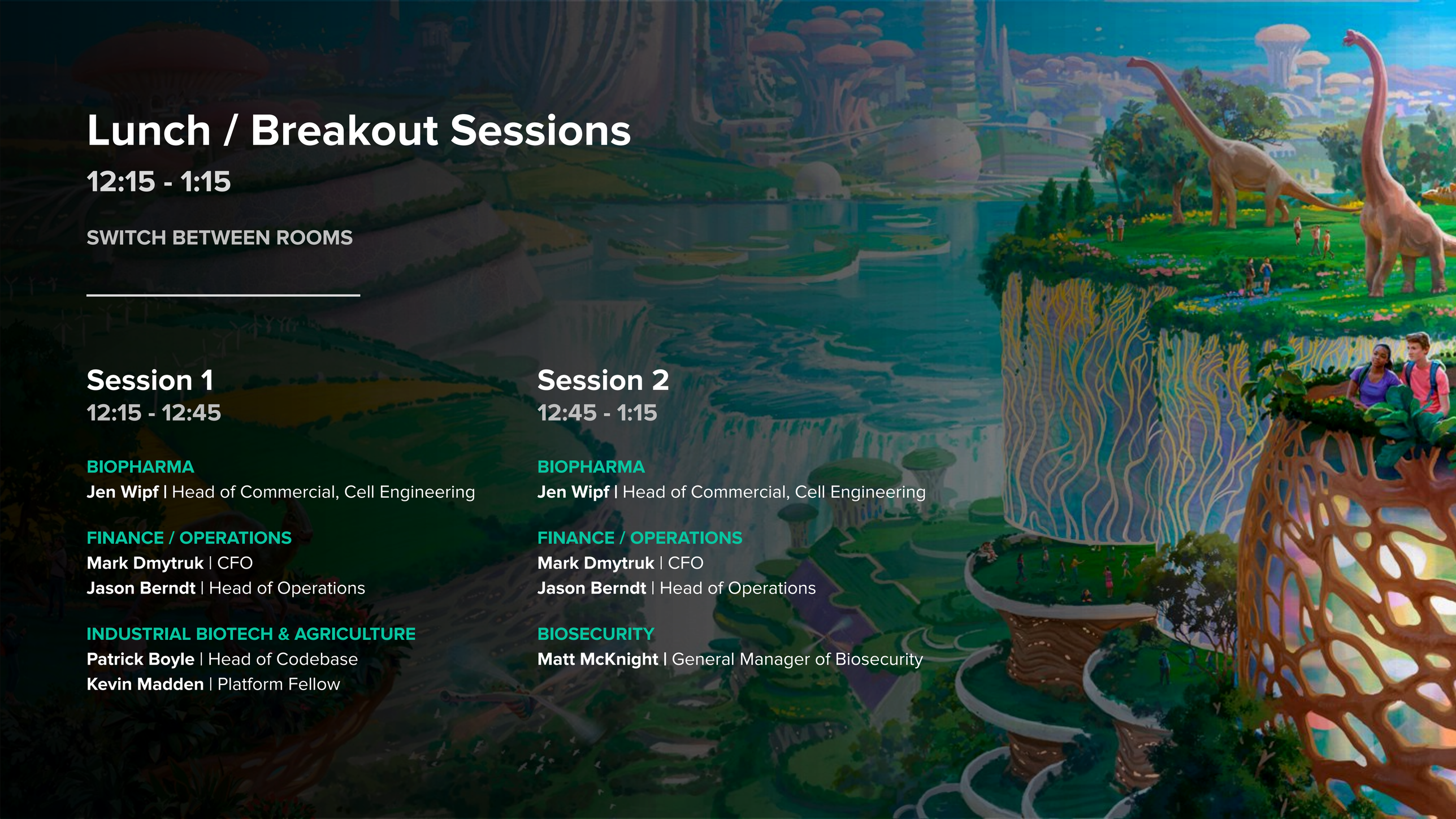
INDUSTRIAL BIOTECH & AGRICULTURE
Patrick Boyle | Head of Codebase
Kevin Madden | Platform Fellow

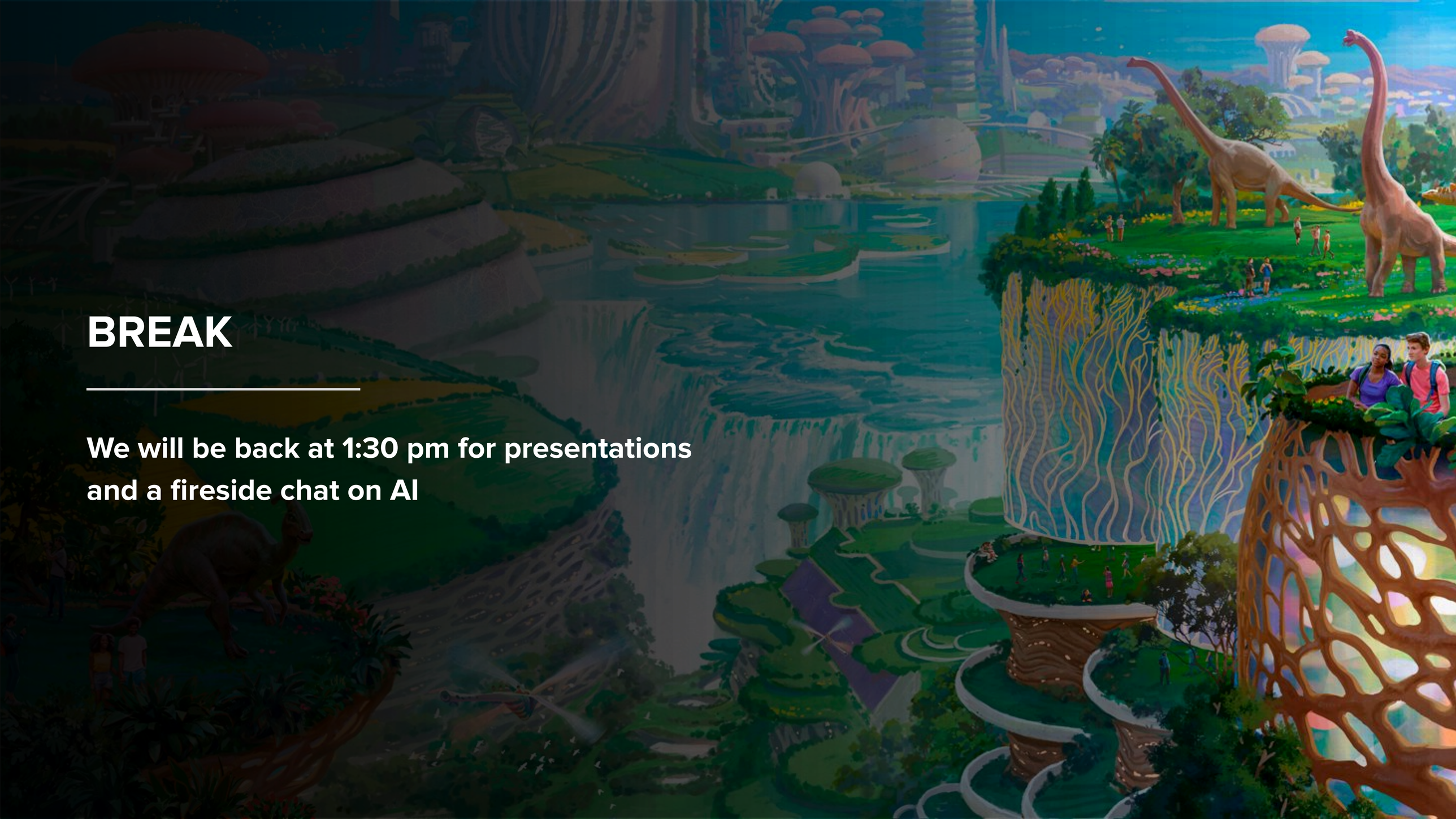
Session 2
12:45 - 1:15

BIOPHARMA
Jen Wipf | Head of Commercial, Cell Engineering

FINANCE / OPERATIONS
Mark Dmytruk | CFO
Jason Berndt | Head of Operations

BIOSECURITY
Matt McKnight | General Manager of Biosecurity





BREAK

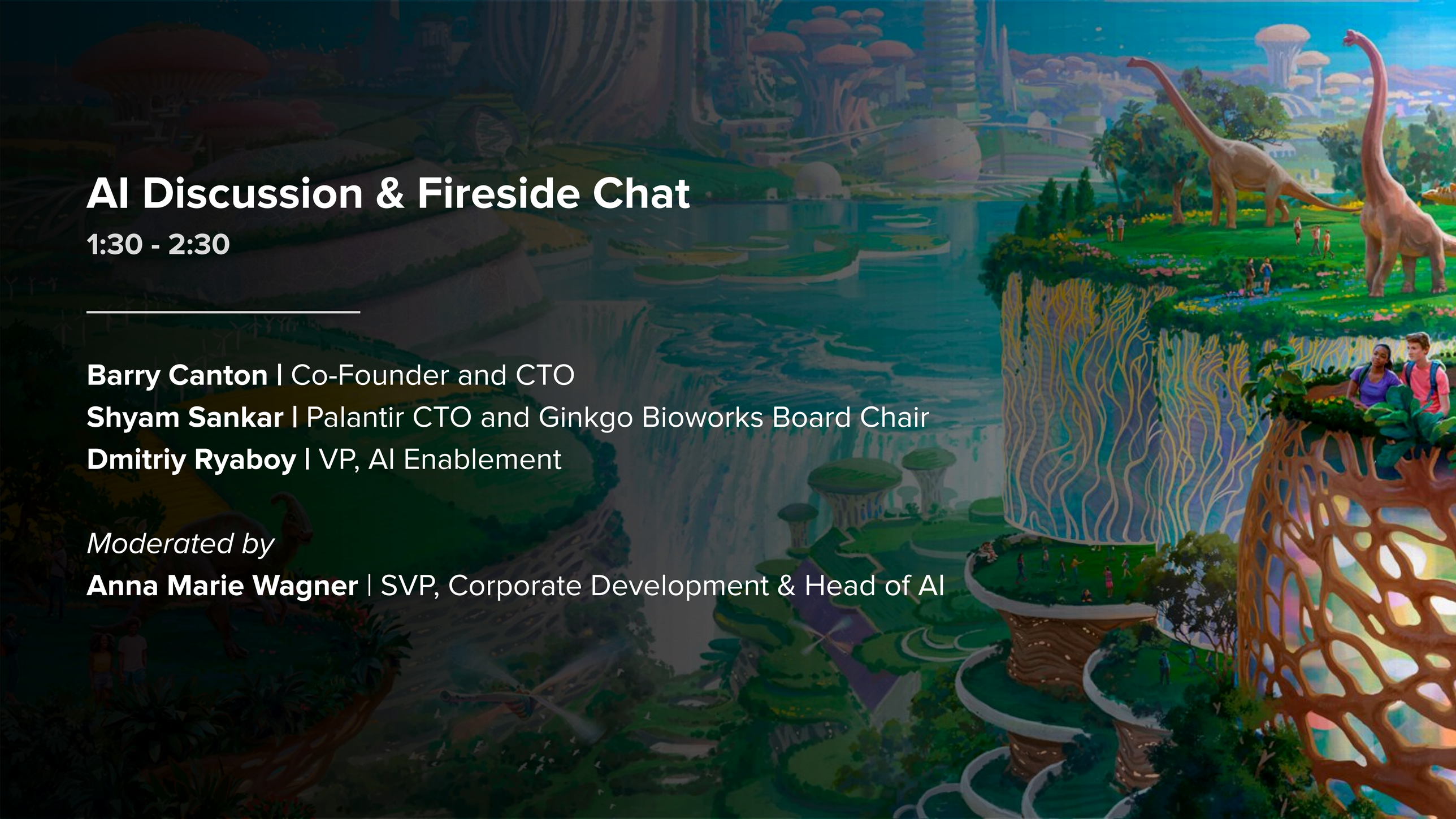
We will be back at 1:30 pm for presentations and a fireside chat on AI

AI Discussion & Fireside Chat

1:30 - 2:30

Barry Canton | Co-Founder and CTO
Shyam Sankar | Palantir CTO and Ginkgo Bioworks Board Chair
Dmitriy Ryaboy | VP, AI Enablement

Moderated by
Anna Marie Wagner | SVP, Corporate Development & Head of AI

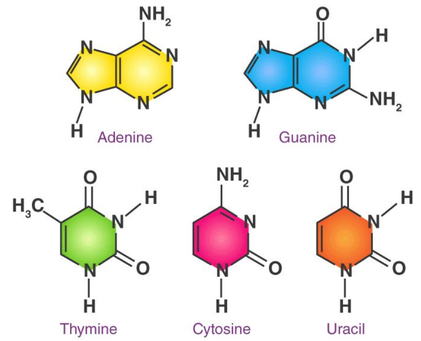


Biology represents another natural language; built on just a few letters but vastly more complex and powerful when assembled

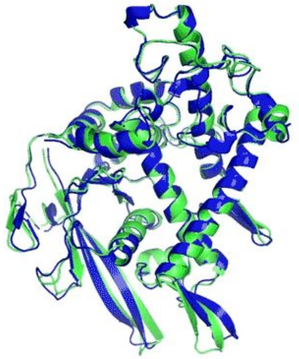


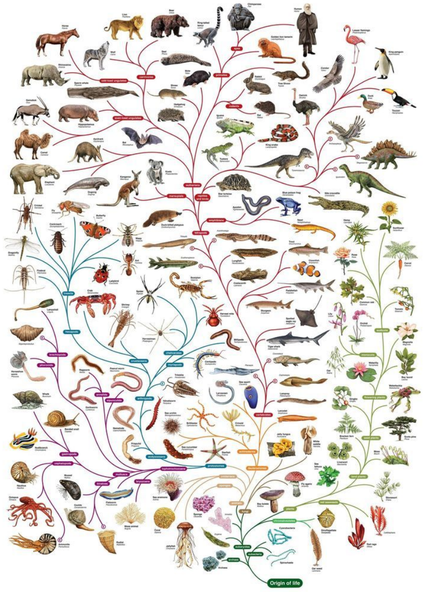
1. the	26. had	51. no
2. of	27. his	52. said
3. and	28. they	53. who
4. to	29. from	54. more
5. a	30. she	55. about
6. in	31. which	56. up
7. that	32. or	57. them
8. it	33. we	58. some

The quick brown fox jumps over a lazy dog.



1st base	2nd base T		2nd base C		2nd base A		2nd base G		3rd base
T	TTT	Phe (F)	TCT	Ser (S)	TAT	Tyr (Y)	TGT	Cys (C)	T
	TTC		TCC		TAC		TGC		C
	TTA		TCA		TAA	STOP	TGA	STOP	A
	TTG		TCG		TAG		TGG	Trp (W)	G
C	CTT	Leu (L)	CCT	Pro (P)	CAT	His (H)	CGT	Arg (R)	T
	CTC		CCC		CAC		CGC		C
	CTA		CCA		CAA	Gln (Q)	CGA		A
	CTG		CCG		CAG		CGG		G
A	ATT	Ile (I)	ACT	Thr (T)	AAT	Asn (N)	AGT	Ser (S)	T
	ATC		ACC		AAC		AGC		C
	ATA		ACA		AAA	Lys (K)	AGA	Arg (R)	A
	ATG	Met (M)	ACG		AAG		AGG		G
G	GTT	Val (V)	GCT	Ala (A)	GAT	Asp (D)	GGT	Gly (G)	T
	GTC		GCC		GAC		GGC		C
	GTA		GCA		GAA	Glu (E)	GGA		A
	GTG		GCG		GAG		GGG		G





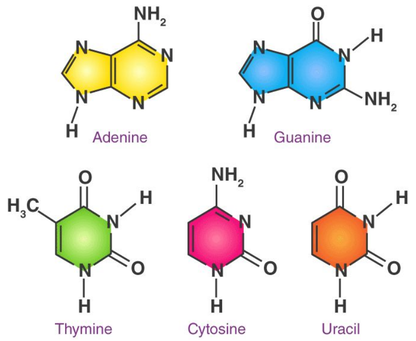
Biology represents another natural language; built on just a few letters but vastly more complex and powerful when assembled



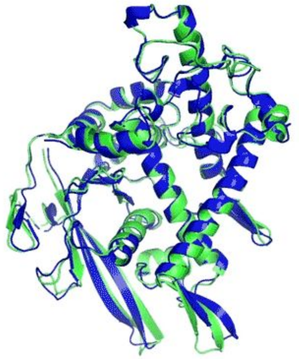
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5. a	30. she	55. about
6. in	31. which	56. up
7. that	32. or	57. them
8. it	33. we	58. some

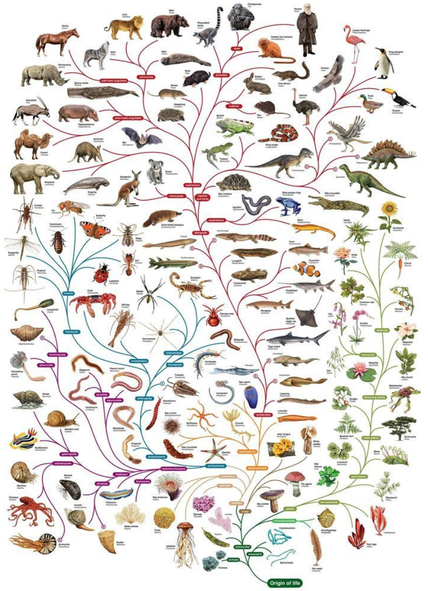
The quick brown fox jumps over a lazy dog.





1st base	2nd base T		2nd base C		2nd base A		2nd base G		3rd base
T	TTT	Phe (F)	TCT	Ser (S)	TAT	Tyr (Y)	TGT	Cys (C)	T
	TTC		TCC		TAC		TGC		C
	TTA		TCA		TAA	STOP	TGA	STOP	A
	TTG		TCG		TAG		TGG	Trp (W)	G
C	CTT	Leu (L)	CCT	Pro (P)	CAT	His (H)	CGT	Arg (R)	T
	CTC		CCC		CAC		CGC		C
	CTA		CCA		CAA	Gln (Q)	CGA		A
	CTG		CCG		CAG		CGG		G
A	ATT	Ile (I)	ACT	Thr (T)	AAT	Asn (N)	AGT	Ser (S)	T
	ATC		ACC		AAC		AGC		C
	ATA		ACA		AAA	Lys (K)	AGA	Arg (R)	A
	ATG	Met (M)	ACG		AAG		AGG		G
G	GTT	Val (V)	GCT	Ala (A)	GAT	Asp (D)	GGT	Gly (G)	T
	GTC		GCC		GAC		GGC		C
	GTA		GCA		GAA	Glu (E)	GGA		A
	GTG		GCG		GAG		GGG		G

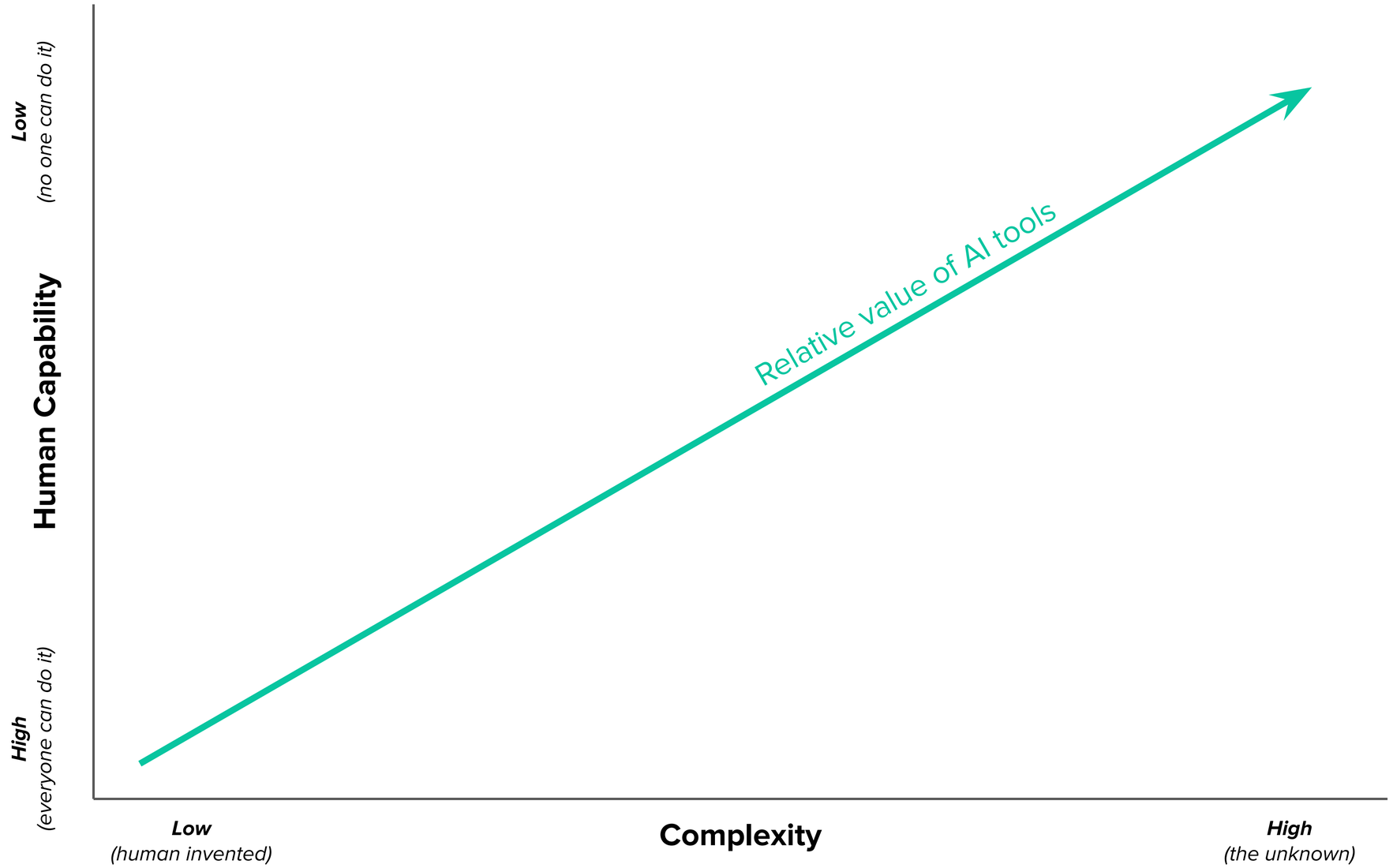




ONE BIG DIFFERENCE:

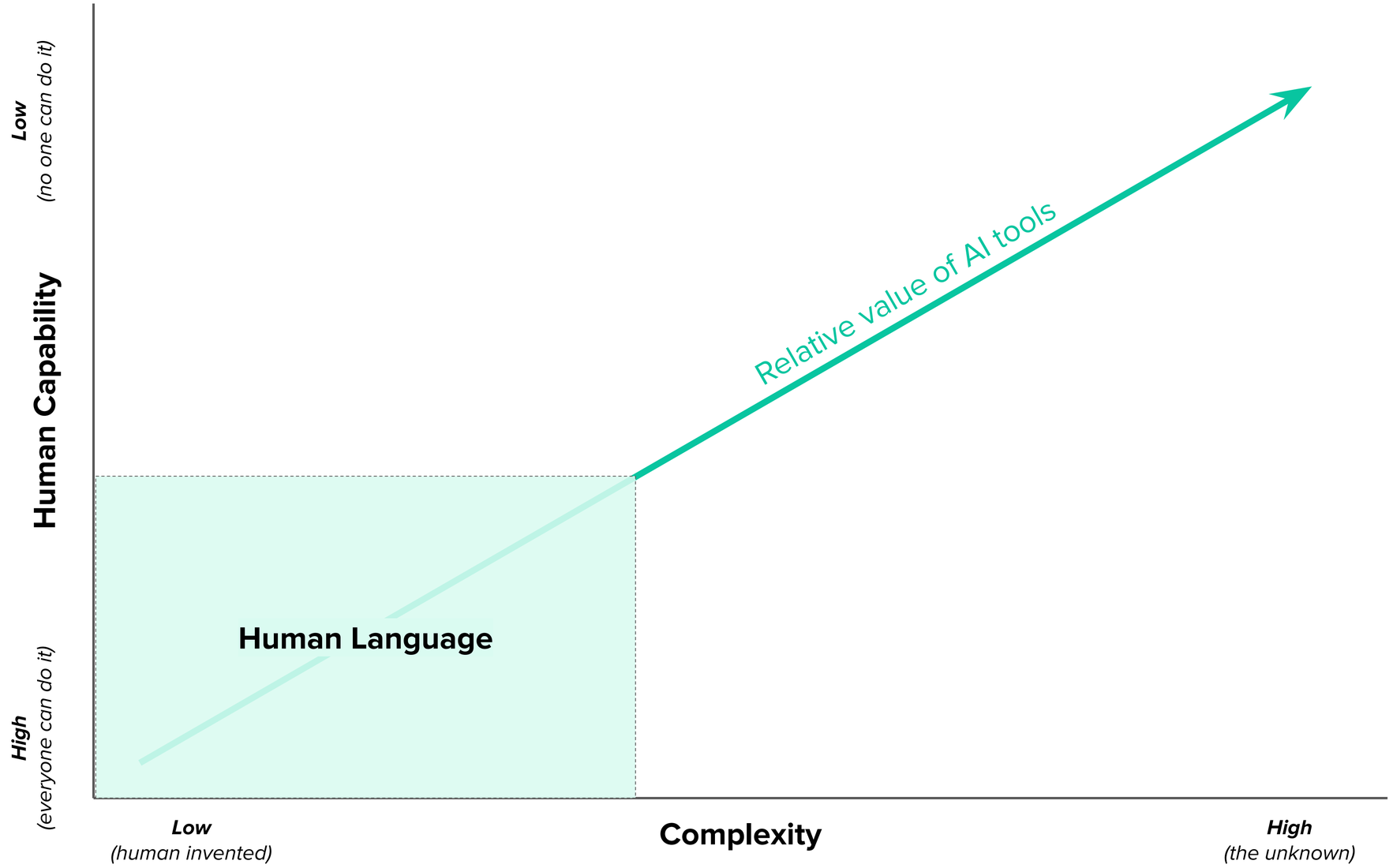
we invented language……biology invented us.

With enough compute, AI can take on extremely hard problems

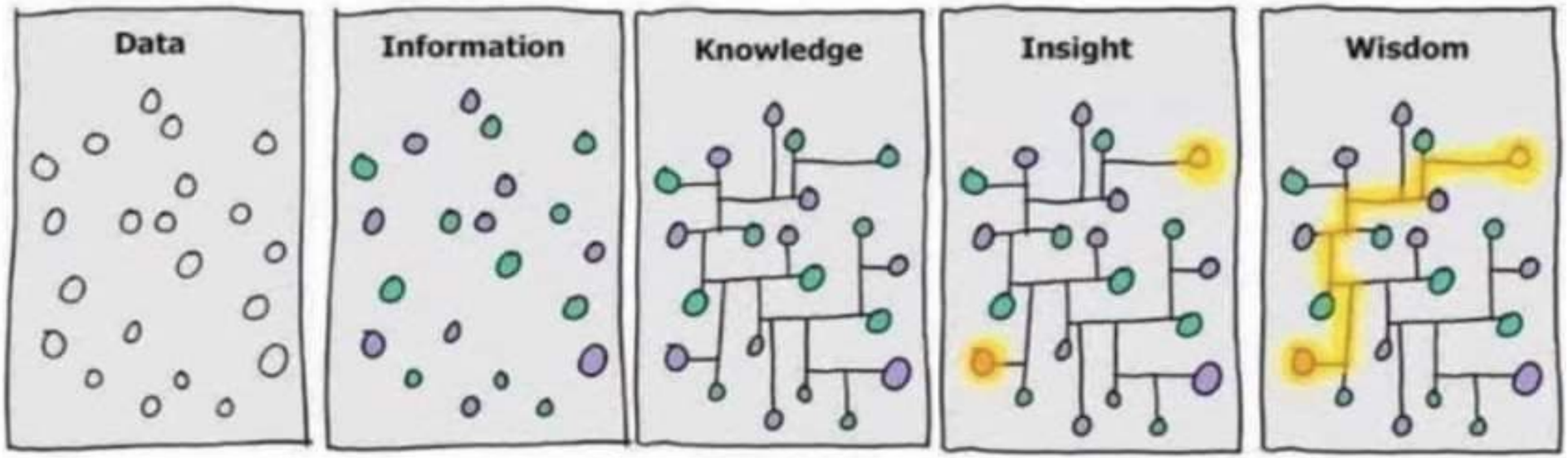


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Arguably, the bar was high for AI in human language because we're so good at it... it's easy for us to recognize a bad answer



The current generation of LLMs can approximate wisdom (or at least knowledge) with enough training data



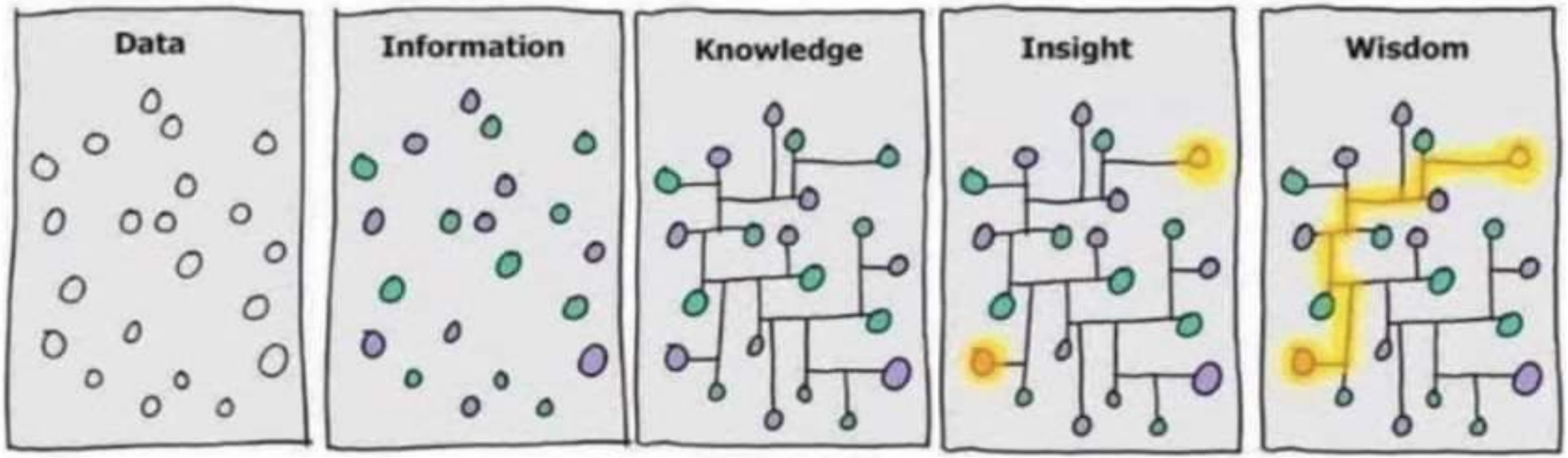
Lex Fridman: "[GPT4 is] compressing all of the web…into one organized black box that is human wisdom. What is that?"

Sam Altman: "Human knowledge, let's say."

Lex Fridman Podcast #367

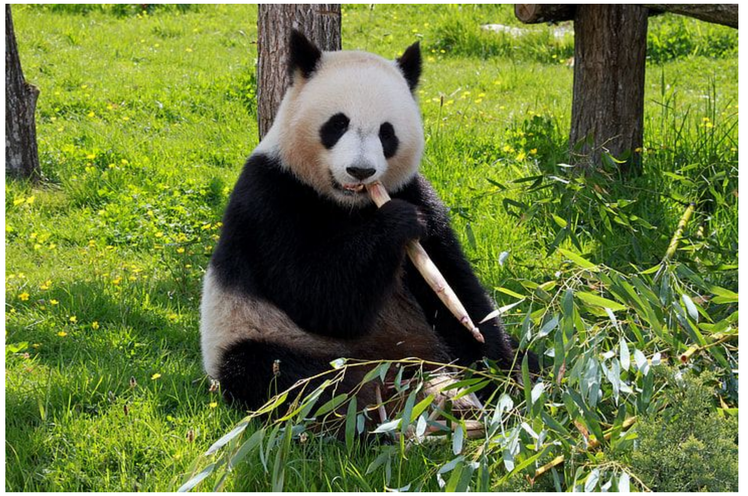
Property of Ginkgo Bioworks — 36

The current generation of LLMs can approximate wisdom (or at least knowledge) with enough training data

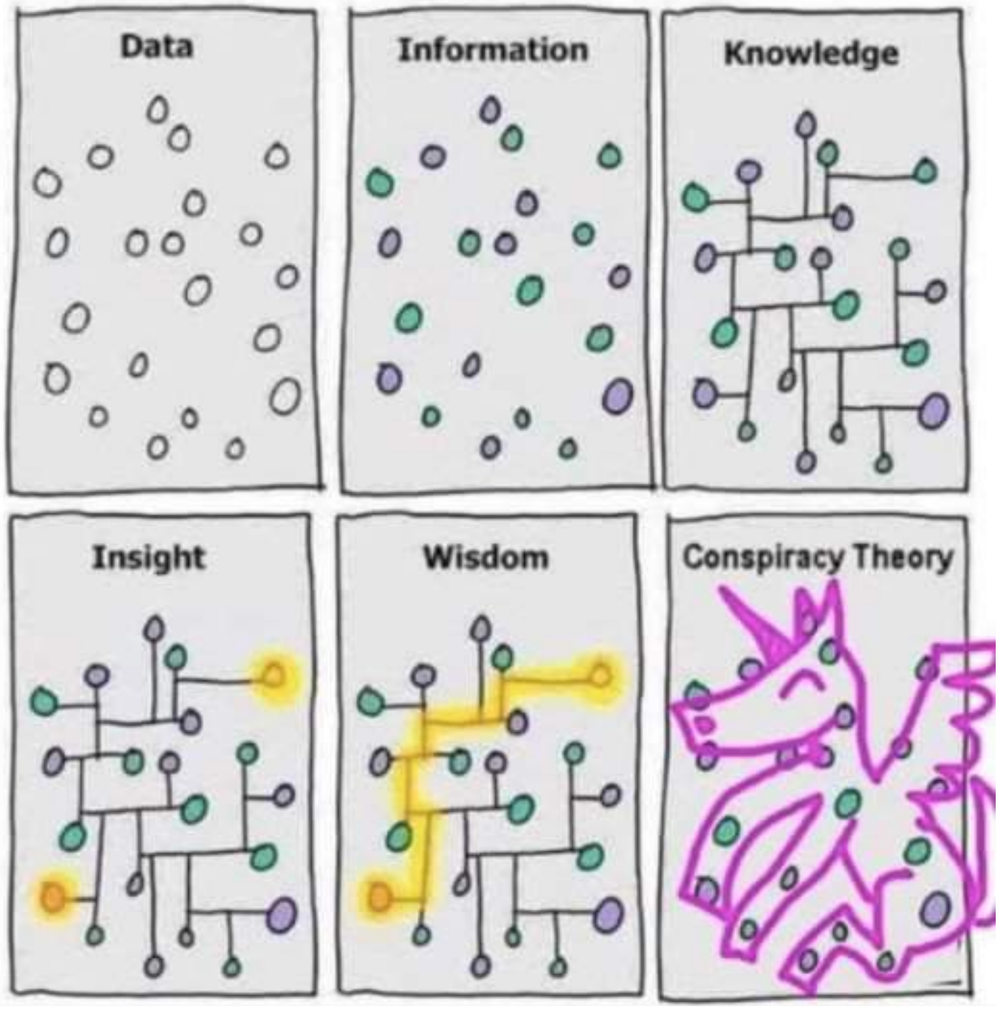


Panda. Large black-and-white bear-like mammal, native to China. Eats shoots and leaves.





Property of Ginkgo Bioworks — 37



GPT-3.5 | GPT-4 | Advanced Data Analysis

The image is not self-explanatory without context, so I will describe its components as accurately as possible.

The image appears to be a meme or humorous image. It contains three panels arranged vertically, with each panel featuring a different scene. This structure is typical of multi-panel memes where each panel contributes to the overall joke or message.

1. **Top Panel**: The top panel contains a character who seems to be in distress, with sweat dropping from their face. The character is looking at a computer screen, which is emitting light. The background is dark, emphasizing the brightness of the screen. This panel might represent a person who is stressed or anxious while using a computer.
2. **Middle Panel**: The middle panel shows a group of four characters with musical instruments, performing in a band. The character from the top panel is also present in this scene, playing the drums with a focused expression. This panel might symbolize joy, passion, or relief through engaging in music or other creative activities.
3. **Bottom Panel**: The bottom panel returns to the character from the top panel, who is again in front of the computer screen. However, this time the character appears more relaxed and content, with a smile on their face.

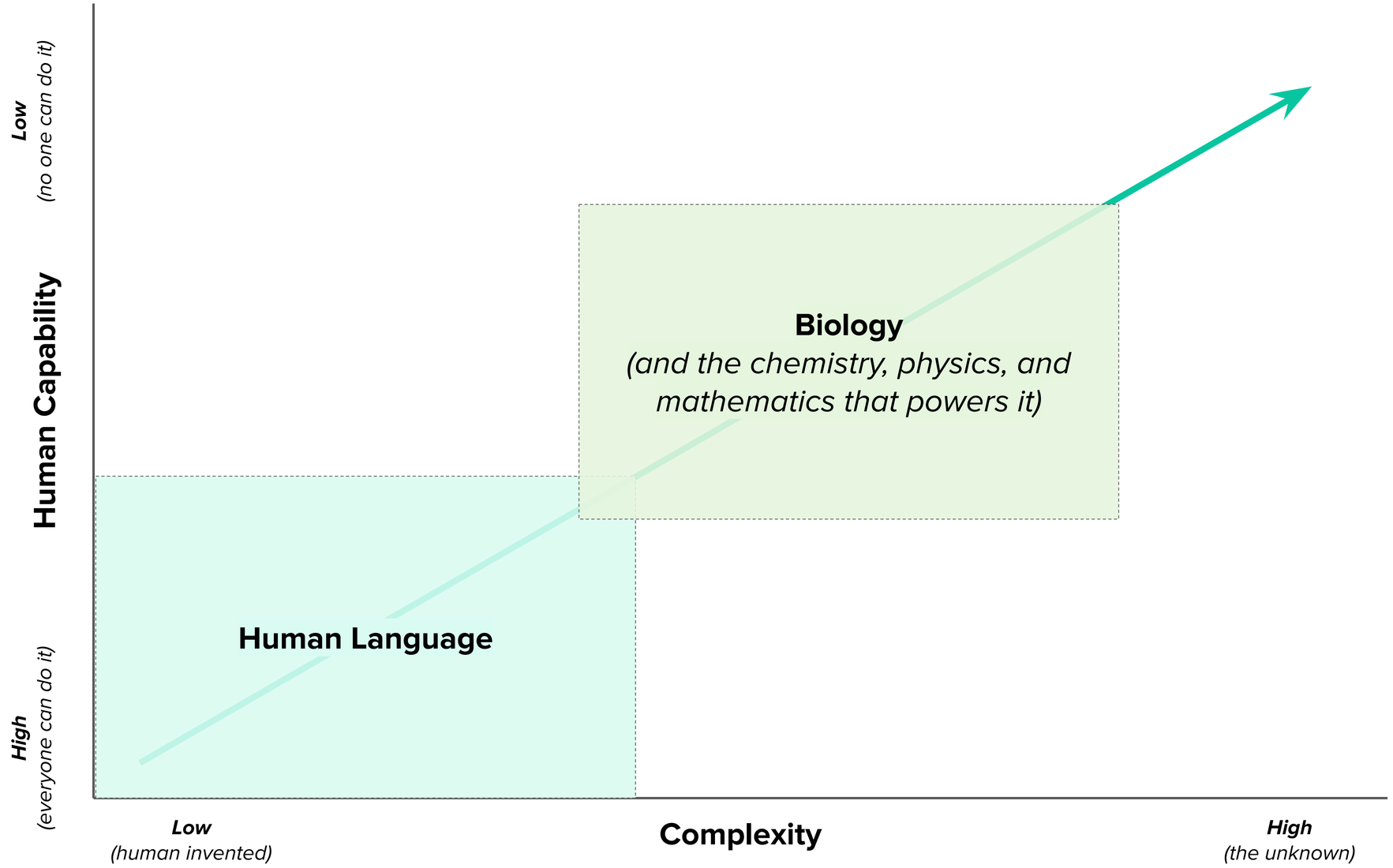
Interpretation:

Without specific context or knowledge of the characters, it's challenging to pinpoint the exact message or joke the image is conveying. However, one possible interpretation could be the therapeutic or stress-relieving effect of music and creative expression. The character might be feeling overwhelmed or stressed (top panel), finds relief and joy in playing music (middle panel), and then returns to their computer work feeling rejuvenated and happy (bottom panel).

Understanding the image's precise meaning might require familiarity with the characters, the source material, or the specific cultural or internet meme context in which the image is used.

Not quite....

In biology, AI has the potential to supercharge human understanding, allowing scientists to build new ideas on top of AI's knowledge



A much smaller fraction of total potential biological information is currently available to us, limiting our knowledge

NGS Sequencing



```
ORIGIN
        1 atgtcgaagg cgcttccgcc catcacgacg gcgtcgcgcg gccgccagtt acagcagccc
       61 accccactct cgcccacgga cgggcagtac cagctcacca cgacaatgaa acagcgctcc
      121 accagccgcc gcgttggcgt ggaggtggag ttctcgctcg gacctgtgca ggagcgctac
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      301 cggcagcggc gtgaagcagc gcggcggagg tttgagcagc gccgccagcg cgagctggag
      361 gaactctctg cgcgcaaggg ctacctcacg cagcgccggg ctgcagagga agaagaggag
      421 gaggacgccc accacacacg ccacactgcg gacggccaac acggcgtgaa gaagcaacat
      481 ccccatccac cgccaagcaa aggtgccgct ggtgaccagc gaaggcggcg gcgctacgag
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      781 aaaccggtgg aaaatatgac agttgcgcag caacagcccg agacgaaggc ggaggcgccg
      841 agcgattcgt cgtctgcggc ttctcgttcc tcatcttcgt cgtcgtcgtc gtcatcatcg
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Sequencing is relatively easy…

Anyone want to guess what this one does? It’s only 613 base pairs short!

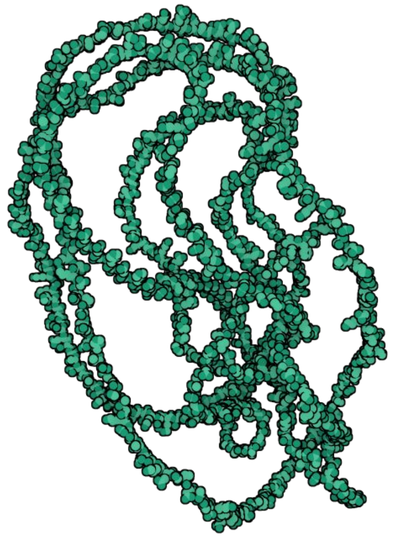
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RNASeq → Amino Acid Sequence

Protein Folding Models

```
ORIGIN
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       61 accccactct cgcccacgga cgggcagtac cagctcacca cgacaatgaa acagcgctcc
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EVANEDDEL
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Source: AlphaFold

We can even predict structure pretty well…

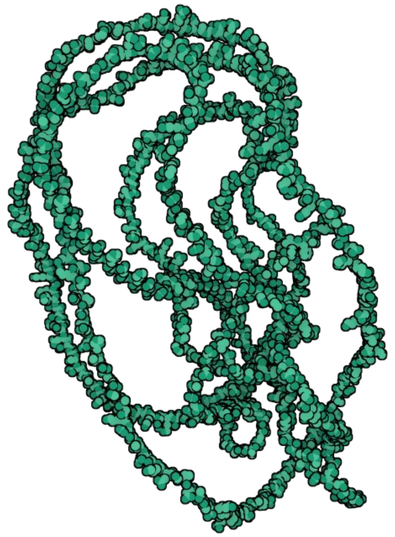
Any guesses now?

A much smaller fraction of total potential biological data is currently available to us, limiting our knowledge

Functional data is what you really need... getting that type of data at scale is not trivial.

```
ORIGIN
        1 atgtcgaagg cgcttccgcc catcacgacg gcgtcgcgcg gccgccagtt acagcagccc
       61 accccactct cgcccacgga cgggcagtac cagctcacca cgacaatgaa acagcgctcc
      121 accagccgcc gcgttggcgt ggaggtggag ttctcgctcg gacctgtgca ggagcgctac
      181 ctgccgccgt acaacgacct tgatgacccg cacctcgcgc cgtactgggc gcgccgggag
      241 atgatgatcc gggaggccgc cgagcgccgc cacgagatgc aacgacagcg acggctggag
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      421 gaggacgccc accacacacg ccacactgcg gacggccaac acggcgtgaa gaagcaacat
      481 ccccatccac cgccaagcaa aggtgccgct ggtgaccagc gaaggcggcg gcgctacgag
      541 gcggccgcat ggacatcttc ttcgggctct gctgctgccg ataacggcag gncccgccga
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     1261 gcggaaaagg aggcggagga gtcggagcaa cactctgagg aatccaagaa tgatgaatac
     1321 aaggatgatg actttgaggc atccgagcca tcacccaagg aggaagcagt tgtgaatcct
     1381 ccgaatgcgc aagcagatga gtatgttgat gacttcgagt cacccgcaca agcagcgaag
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     1501 tccactgcag tgaagagtga gacgccggcc tcgacacacg aattggatga ggtgcctgaa
     1561 gtggcaacag gcagccaaaa caataatgct gtggacgacc ttgtgaagac ggcgtcctct
     1621 gcctccagct catcgtcgcc ctcctctgct tccgtgagtg acgcgaagga gctcagcgag
     1681 tctgacgtgg cgaagacaga ggaggtggct aatgaagacg acgagttgta g
```

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GSSKSSRRSSGSSTAVKSETPASTHEL
DEVPEVATGSQNNNAVDDLVKTASS
ASSSSSPSSASVSDAKELSESDVAKTE
EVANEDDEL



Scientific Observation → Is it secreted or not?

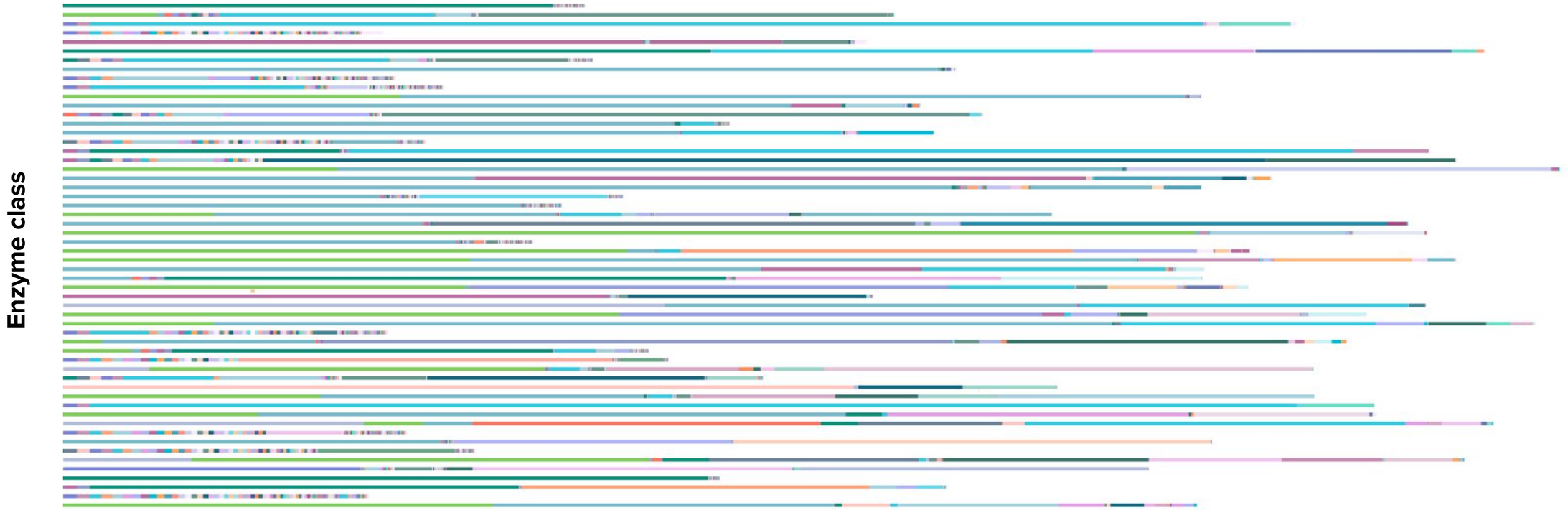
What metabolites are created?

What substrates does it bind to?

Where else have we seen similar structures?

Functional Assays → **Predictive Modeling**

We generate labeled training data in service of our normal business model, working on customer programs



>200
unique customer programs with enzyme campaigns

>5M
total arrayed experimental assay tests

>60M
total multiplexed experimental assay tests

>400
unique enzyme improvement campaigns

Property of Ginkgo Bioworks

We generate labeled training data in service of our normal business model, working on customer programs



>200
unique customer programs with enzyme campaigns

>5M
total arrayed experimental assay tests

>60M
total multiplexed experimental assay tests

>400
unique enzyme improvement campaigns

Ginkgo has been leveraging AI/ML in our engineering programs for years

Machine learning for metabolic engineering: A review

Christopher E. Lawson a b, Jose Manuel Martí a b c, Tijana Radivojevic a b c, Sai Vamshi R. Jonnalagadda a b c, Reinhard Gentz a b i, Nathan J. Hillson a b c, Sean Peisert a i j, Joonhoon Kim b e, Blake A. Simmons a b c, Christopher J. Petzold a b c, Steven W. Singer a b, Aindrila Mukhopadhyay a b g, Deepti Tanjore a f, Joshua G. Dunn h, Hector Garcia Martin a b c d g

Biological Systems and Engineering, Lawrenc
Joint BioEnergy Institute, Emeryville, CA, 946
DOE Agile BioFoundry, Emeryville, CA, 94608
Basque Center for Applied Mathematics, 4800
Pacific Northwest National Laboratory, Richlar
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Ginkgo Bioworks, Boston, MA, 02210, USA
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Received 10 August 2020, Revised 22 October 2020
Available online 19 November 2020, Version of Reco

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ENDAR is like radar for biology

Ginkgo participated in IARPA's "Finding Engineering-Linked Indicators" (FELIX) Program from June 2018 to June 2022

- Goal: Detect genetically engineered DNA in arbitrary samples
- ENDAR: our solution, an AI-driven platform for detection of engineered sequence in NGS data

Hit "moonshot" goal and established state of the art

- Dec 2019: **Demonstrated that *it is possible*** to develop a general-purpose genetic engineering detector
- March 2021: **Hit moonshot goal** (90% sensitivity / 99% sensitivity per locus) on third T&E exercise. IARPA decides continue program and increase difficulty
- March 2022: **Increased automation, sensitivity, & speed**
- May 2022: **Established the state of the art** for detection of engineering in clonal + metagenomic samples

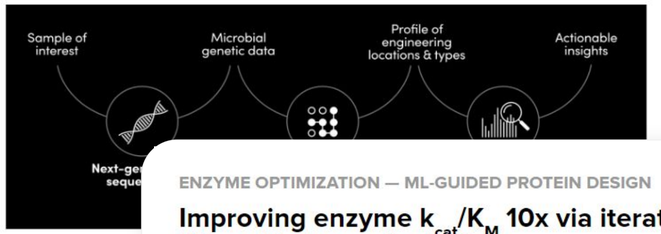
We characterized our system. Given aspects of the sample, we can predict, prior to analysis:

- What types of engineering we'll be able to find (if present)
- How much time this will take us
- How much expertise an analyst will need

Building a global radar for biosecurity, public health, & more

- Productionziation: speed, robustness, & precision
- Integrating into Concentric, our end-to-end biosecurity platform

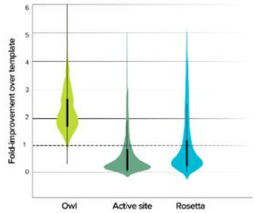
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ENZYME OPTIMIZATION — ML-GUIDED PROTEIN DESIGN

Improving enzyme k_{cat}/K_M 10x via iterative ML-guided protein design

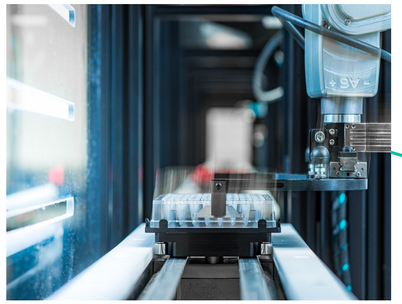


Large experimental datasets coupled with Owl ML-guided design yield more variants with improved performance as compared to traditional methods.

	Gen 1	Gen 2	Gen 3	Gen 4
Library Size (unique enzymes)	2,000	2,000	4,000	100 ← Smaller batch size sufficient due to Owl training from prior rounds
Design Approach	• **Sequence-based (self-supervised) model predictions** • Active site mutagenesis • Rosetta docking and design	• Hit recombination • **Sequence-based (self-supervised) model predictions** • Rosetta docking and design	• **Owl AI-guided design** • Active site mutagenesis • Molecular dynamics • Rosetta docking and design	• **Owl AI-guided design**
Experimental Screening Methods	• Arrayed activity testing	• Arrayed activity assay • uHTP pooled abundance screening on comprehensive site-saturation libraries	• Arrayed activity assay • uHTP pooled abundance and activity screening on large (>10^6) combinatorial libraries	• Arrayed activity assay
Fold Improvement over Wild Type	1.5X	3.9X	4.5X	10X

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Ginkgo takes an integrated approach to data generation and modeling



Our Foundry is a state of the art “label maker”

Large database of experimental results and metagenomic data



Task-specific models

Trained with datasets of inputs and outputs to answer related questions, e.g.
Question → Answer
Enzyme Sequence → Activity

Foundation Model

Trained with large datasets, (traditionally public databases with few “labels”)

Learns general features of language, such as what it means to be “protein-like”

Today, state of the art performance results from fine-tuning a Foundation Model with “labeled data” to generate a task-specific model

Ginkgo takes an integrated approach to data generation and modeling

MODELS

Protein Foundation Model & Application Suite

Protein Foundation Model plus suite of apps to improve recurring protein engineering tasks (e.g. improving catalysis, thermostability, etc.)

Protein & Genome Annotation

Use genetic context *surrounding* proteins to disambiguate protein function, infer pathway function, and improve multiple biosecurity applications

DNA & RNA Foundation Model

Predict function and expression of engineered sequences *prior to* engaging in lengthy D/B/T/L cycles in the lab

Synbio Foundation Model

Foundation Model of metabolism, enabling downstream applications such as pathway design, genotype recommendation, and, ultimately, a self-driving Foundry

DATA

Naturally-Occurring Sequences Provide Inspiration
We have acquired and continue to build proprietary genomic collections

>2 billion unique proprietary protein sequences

Rational Design Tests Hypotheses
AI/ML-guided approaches
Scientific expertise / insight

Unbiased Design Generates Diversity
Directed evolution, random mutagenesis, etc.

70+ million strain tests conducted annually

Next-Generation Sequencing (NGS): Long- & Short-Read for Standard and Bespoke Workflows
DNA: is the strain correctly constructed? is it mutating?
RNA: is my gene expressed? how is the cell responding?
Other modalities: which mutations are most beneficial? most harmful?

Trillions of base pairs sequenced per day

Arrayed and Multiplexed Assays Enable Multi-modal Measurement
Metabolomics: what biochemical reactions are occuring?
Functions: does the protein function as predicted? is it binding? is it stable?
Phenotypes: is my cell healthy? is it behaving as designed?

Assay throughput of thousands to hundreds of thousands per experiment

Inputs:
DNA Sequence

Measurements:
DNA Sequence
RNA Sequence
Proteins
Metabolites
Functional Assays

We believe our partnership with Google provides the infrastructure we need to scale foundational AI tools for biology

Ginkgo Bioworks and Google Cloud Partner to Build Next Generation AI Platform for Biological Engineering and Biosecurity

GINKGO BIOWORKS

Google Cloud

NEWS PROVIDED BY
Ginkgo Bioworks →
29 Aug, 2023, 08:00 ET

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- *Ginkgo and Google Cloud enter strategic five-year cloud and AI partnership*
- *Ginkgo to pioneer new large language models for biological engineering applications, powered by Google Cloud's Vertex AI platform*
- *Ginkgo intends to make Google its primary cloud services provider, benefiting from access to next-generation computational infrastructure and AI technologies*
- *Partnership to include funding from Google Cloud to enable Ginkgo's development of foundation models and fine-tuned applications*

1 Cloud Computing

Ginkgo is securing the compute capacity we need at attractive prices to train large Foundation Models and run inference on behalf of our customers. As with any of our infrastructure investments, our investments at scale allow us to provide a better customer value proposition, on a variable cost basis

2 Model Development

Google Cloud is supporting Ginkgo's model development efforts, providing up to $56.3 million of non-dilutive cash funding if Ginkgo hits certain technical and scaling milestones (expected over next 3 years)

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These investments generate returns across multiple axes

1

Continue to enhance our core platform offering for customers

We have integrated AI/ML tools into our platform for years and we expect our investments to enhance the tools we use across our programs.

2

Data as a service

Our customers need data and our investments in automation and miniaturization allow us to generate that data faster and at a lower cost. We are discussing several models where we can generate the kind of data our customers need to generate insights, while retaining data with broader platform use.

3

Models as a service

Ginkgo plans to build several models, some of which will stay in-house, but others may be released broadly or generated for specific applications in partnership with collaborators / customers. These models have the potential to dramatically improve the interface between the scientist and the lab.

FIRESIDE CHAT

Teaching AI to Speak DNA



Anna Marie Wagner
SVP, Corporate Development
& Head of AI

Moderator



Shyam Sankar
CTO, Palantir Technologies (NYSE: PLTR)
Ginkgo Board Chair



Barry Canton
Co-Founder & CTO



Dmitriy Ryaboy
VP, AI Enablement



Closing Remarks & Q&A

2:30 - 3:00

Jason Kelly | Co-Founder and CEO

In conclusion, we believe...

1

We continue to build momentum in the biopharma space, allowing us to scale faster than ever before

We are increasing our capacity to bring on new collaborations across markets, particularly in biopharma as our capabilities have expanded. The work we have been doing on product definition and marketing provides clarity to customers on our value-add across markets.

2

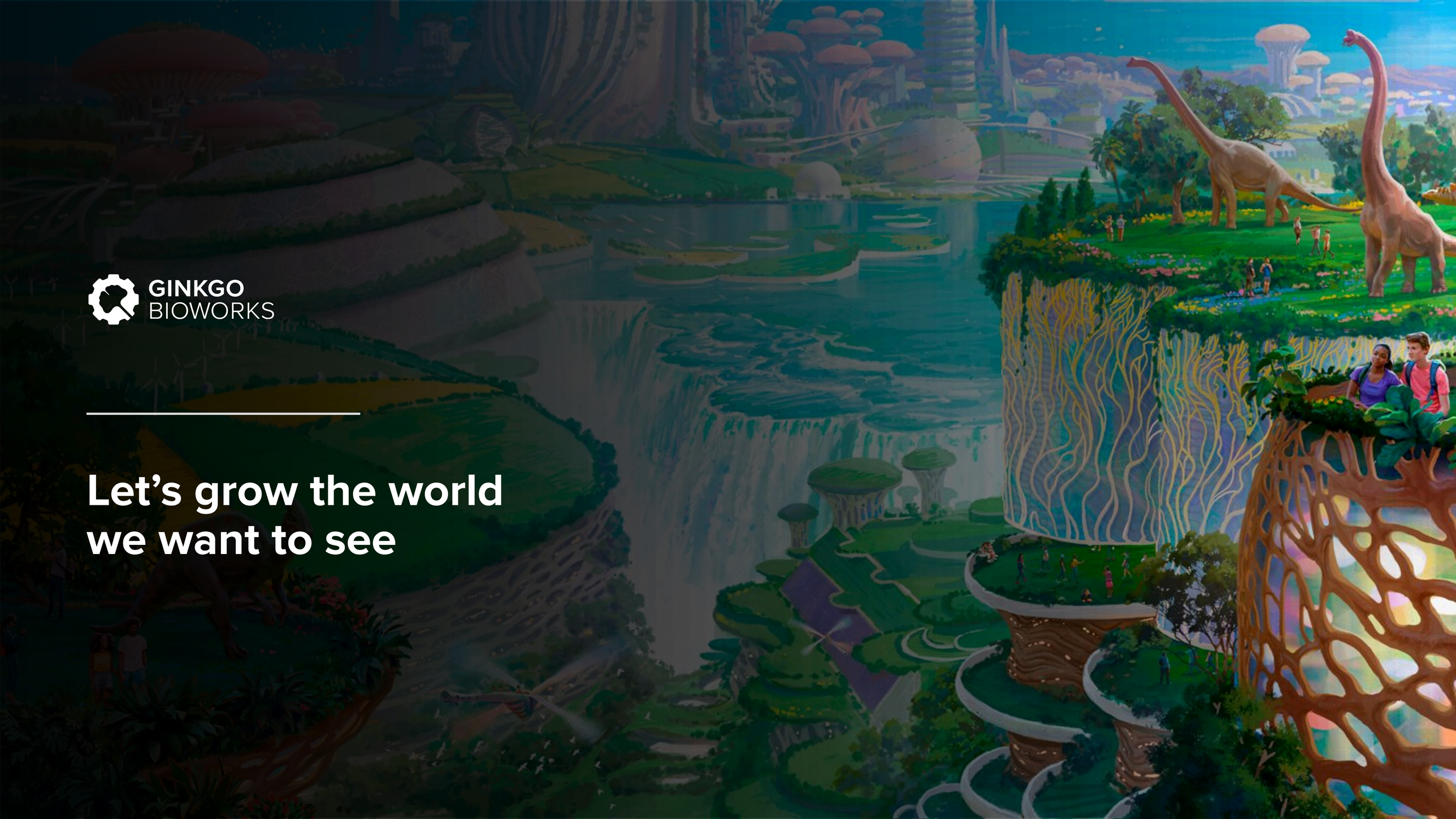
Governments are increasingly recognizing the need for a real-time biological threat warning system

“Bioradar” generates valuable intelligence to support government decision-makers. Our ambition is ultimately to build a system that can not only detect and identify, but also intercept and respond to any biological threat across the world.

3

We’re leveling up our AI and machine learning capabilities to deliver more value to customers

With our Google partnership and proprietary data sets, our goal is to make biology a more predictable engineering discipline, driving an improved customer value proposition and opening up new business opportunities.


GINKGO
BIOWORKS
Let’s grow the world
we want to see

Q&A

2:30 - 3:00

Jason Kelly | Co-Founder and CEO
Barry Canton | Co-Founder and CTO
Mark Dmytruk | CFO
Anna Marie Wagner | SVP, Corporate Development & Head of AI
Jen Wipf | Head of Commercial, Cell Engineering
Matt McKnight | General Manager of Biosecurity

