INNOVATEBIO
National Biotechnology Education Center

Our Food Future: How Biotechnology Students Can Combat the Climate Crisis

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The Good Food Institute

NSF

Meat Demand is Growing Globally

In 25 years, how much is meat demand expected to grow globally?

- 15%

- 55%

- 100%

- 117%

How will we feed 10 billion people by 2050?

Sustainably

Efficiently

Safely

What we will cover today

Brief introduction to GFI

- GFI's theory of change
- Actions GFI takes

What we will cover today

- Why alternative proteins are essential for our food future

- How you can be confident that millions of jobs are coming in food Biotech

- What resources GFI has in place to help you get quickly going in the classroom

What we will cover today

- Some quiz questions throughout

- Leave ten minutes at the end to answer questions you'd like to ask

Take aways for you today

Knowledge base for the intersection of

Alternative proteins
Food cellular technologies
Biotechnology
Environmental impacts

Knowledge you can share with your students and mentees

The Good Food Institute

GFI is a 501(c)(3)nonprofit developing the roadmap for a sustainable, secure, and just protein supply. We focus on three key areas of work:

Science and Technology
Advancing foundational, open-access research in alternative proteins and creating a thriving research and training ecosystem around these game-changing fields.

Corporate Engagement
Partnering with companies and investors across the globe to drive investment, accelerate innovation, and scale the supply chain—all faster than market forces alone would allow.

Policy
Advocating for fair policy and public research funding for alternative proteins.

GFI officially earned GuideStar's 2019 - 2022 Platinum Seal of Transparency—obtained by less than 1% of nonprofits—reflecting our commitment to maximum impact, efficiency, and inclusion.

We work as a force multiplier, bringing the expertise of our departments to the rest of the world.

United States
Brazil
India

Europe
Asia Pacific
Israel

180+ staff in 6 regions

Our unique role

GFI plays a unique role in the alternative protein ecosystem.
As a non-profit organization, we maximize our impact by:

Sharing knowledge freely. In a field where many innovators seek novel solutions to the same set of problems, GFI's research, data, and insights are open-access and support the progress of every innovator in this space.

Focusing on the white space. GFI advances high-impact, tractable solutions in areas where too few people are working

Taking a big-picture perspective. GFI works across the plant-based and cultivated industries, the public and private sectors, and international borders, as well as into future decades. We spot and address today's industry-wide challenges, and we forecast and avert obstacles.

Cultivated Meat Reduced CO_2

GFI's Solution: Accelerating alternative proteins

We can create meat, eggs, and dairy more sustainably and efficiently by making them from plants, cultivating them directly from cells, or producing them by fermentation.

Instead of asking consumers to give up the foods they love, GFI is accelerating the transition to alternative proteins by helping companies make products that are **delicious**, **affordable** and **accessible**.
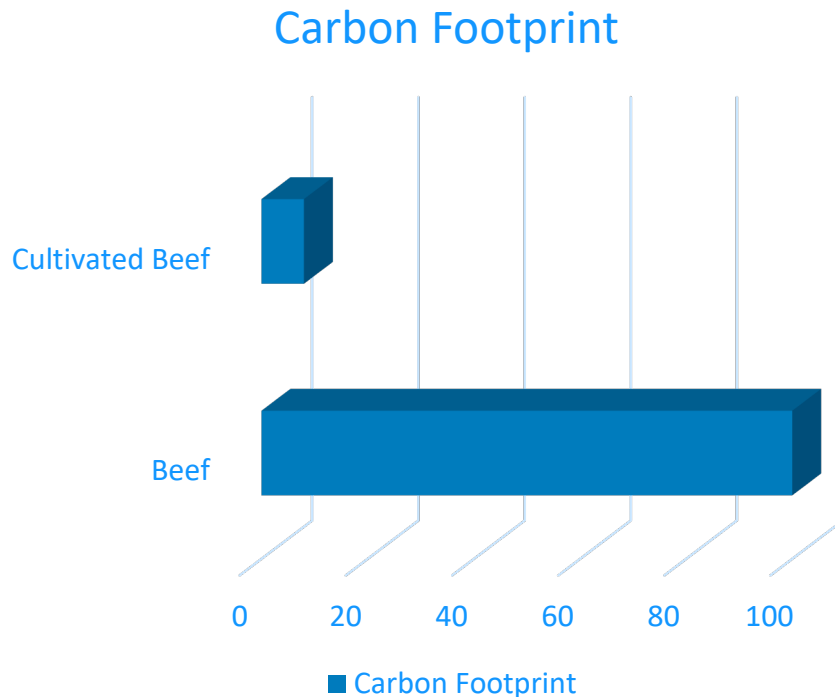
https://link.springer.com/article/10.1007/s11367-022-02128-8

Animal Agriculture is Wasteful

How many calories do you need to feed a cow to be able to create one calorie of beef?
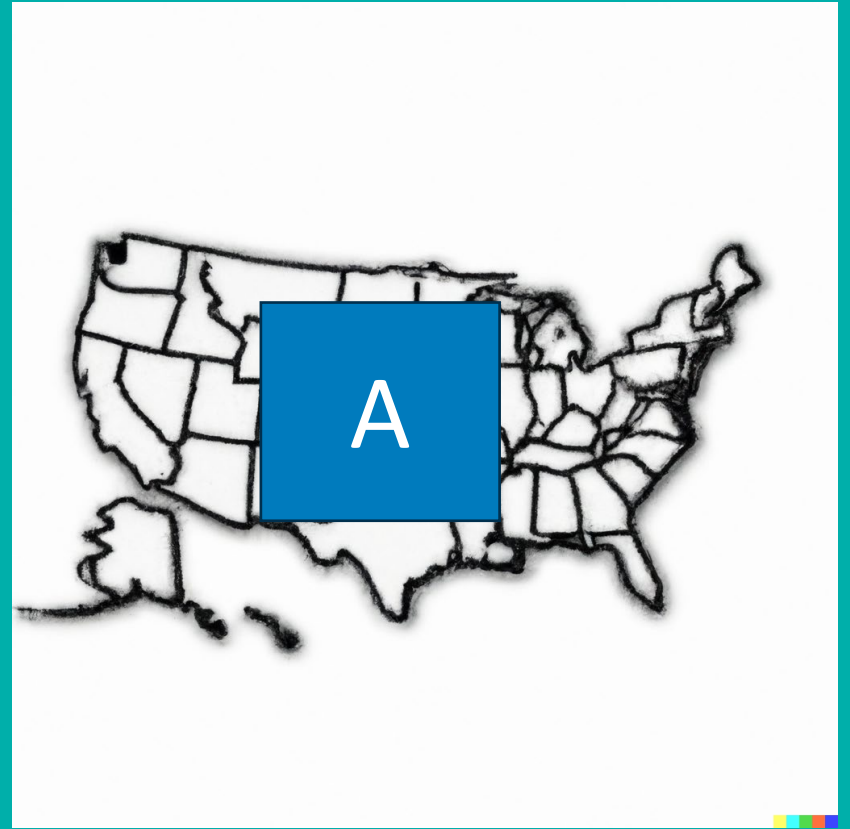
- 8
- 15
- 25
- 34

Cultivated Meat Reduced CO_2

- ## Cultivated Meat Reduces Carbon Footprint by 92%

- ## Recent LCA with CE Delft and GFI

https://link.springer.com/article/10.1007/s11367-022-02128-8

Carbon Footprint

Cultivated Beef

Beef

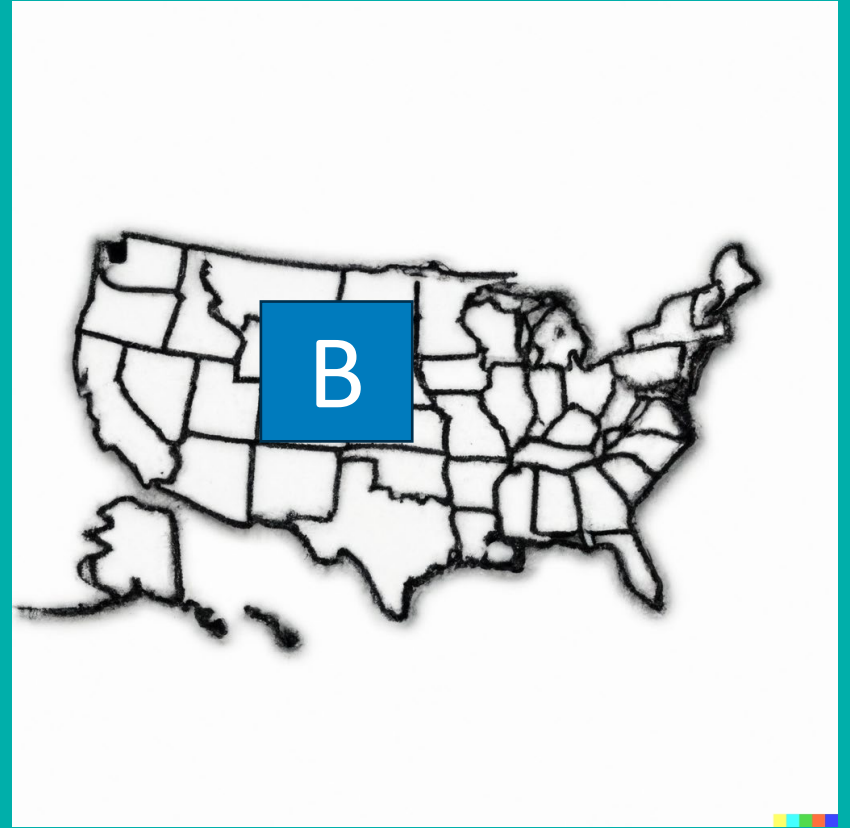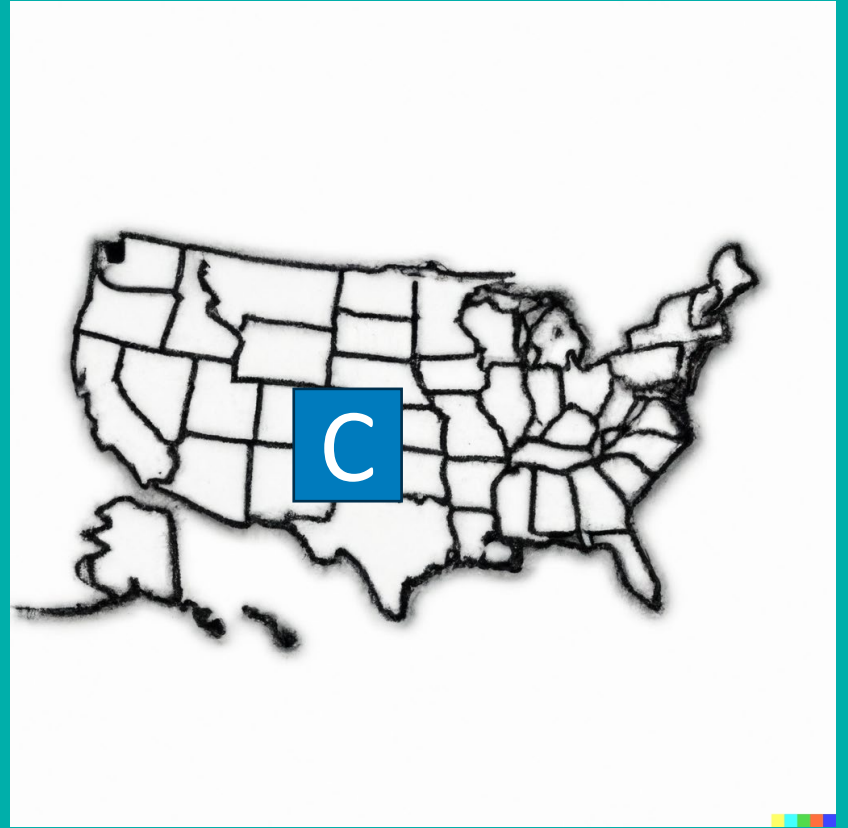0   20   40   60   80   100

■ Carbon Footprint

Which of these maps is the correct representation of the amount of U.S. land that it takes to raise beef cattle?

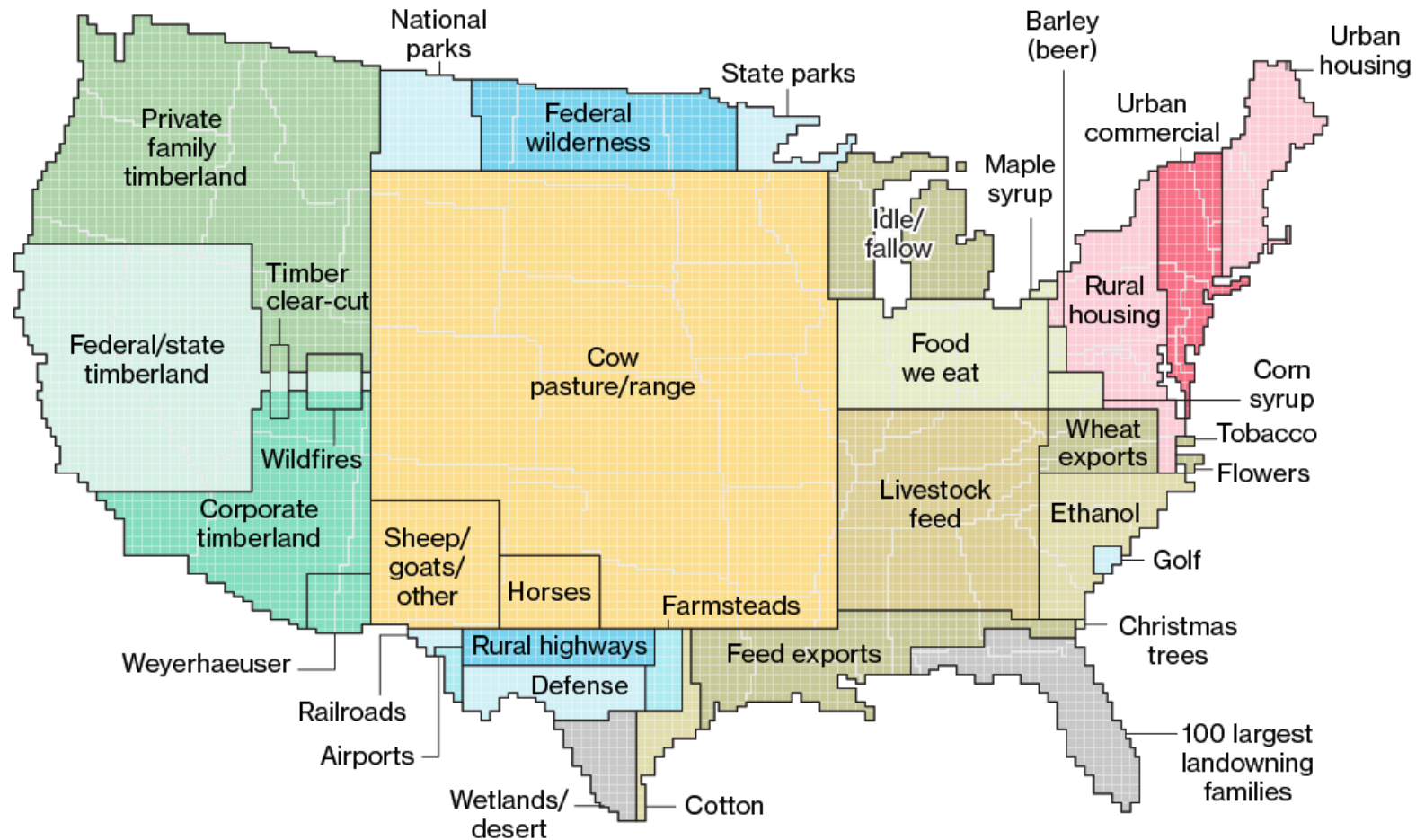Which of these maps is the correct representation of the amount of U.S. land that it takes to raise beef cattle?

Which of these maps is the correct representation of the amount of U.S. land that it takes to raise beef cattle?

Cultivated Meat Uses Less Land

- Cultivated Meat Reduces Land Footprint by 90%

- Recent LCA with CE Delft and GFI

https://link.springer.com/article/10.1007/s11367-022-02128-8

Likely drivers of the next pandemic

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#1. Increasing human demand for animal protein.

#2. Unsustainable agricultural intensification.

#3. Increased use and exploitation of wildlife.

#4. Unsustainable use of natural resources accelerated by urbanization, land use change, and extractive industries

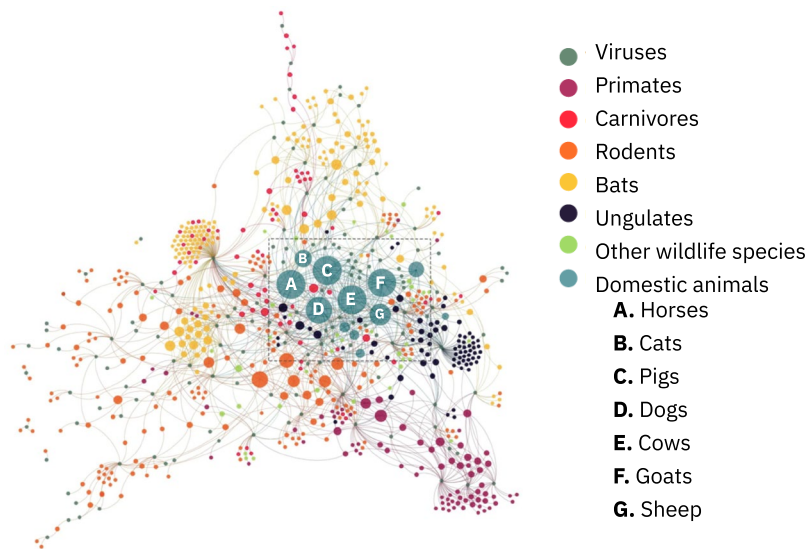**#5.** Increased travel and transportation

#6. Changes in food supply

#7. Climate change

Source: UN Environment Programme, *Preventing the next pandemic*

The network of zoonotic viruses shared among domestic/farmed mammals, wild mammals, and humans

- ● Viruses
- ● Primates
- ● Carnivores
- ● Rodents
- ● Bats
- ● Ungulates
- ● Other wildlife species
- ● Domestic animals
  - **A.** Horses
  - **B.** Cats
  - **C.** Pigs
  - **D.** Dogs
  - **E.** Cows
  - **F.** Goats
  - **G.** Sheep

Spillover risk
Virus transmission risk is highest from animal species that have increased in abundance—domesticated species, primates, and bats were identified as having more zoonotic viruses than other species.

Source: UN Environment Programme, *Preventing the next pandemic.* Johnson, et al. 2020, Global shifts in mammalian population trends reveal key predictors of virus spillover risk
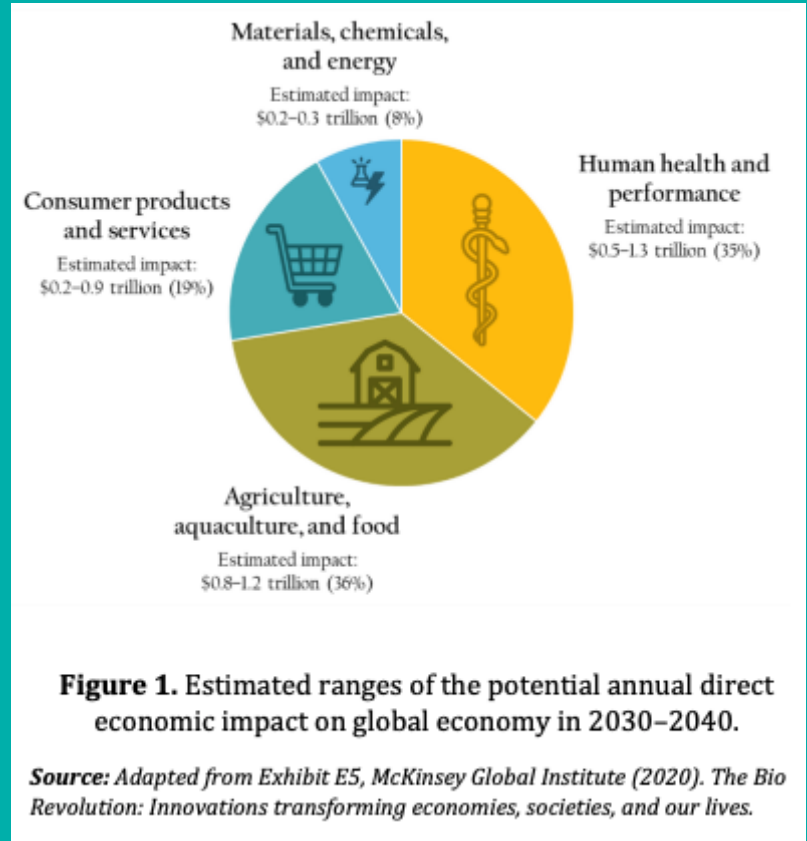
New BioTech Jobs Coming Soon

How many jobs could be created worldwide through a diet shift away from ruminant livestock and to alternative proteins?

A. 44 million
B. 57 million
C. 70 million
D. 83 million

Reducing Methane Emissions in the Global Food System - ClimateWorks Foundation

Biomanufacturing to Advance the Bioeconomy – December 2022

Food Technologies largest impact on the economy

Figure 1. Estimated ranges of the potential annual direct economic impact on global economy in 2030–2040.

Source: Adapted from Exhibit E5, McKinsey Global Institute (2020). The Bio Revolution: Innovations transforming economies, societies, and our lives.

What is Cultivated Meat?

- Meat grown from cells in a bioreactor without the animal involved

- Possible to grow all types of meat: beef, chicken, pork, fish
  - cells can be grown and integrated into a hybrid product
  - cells can also be grown into a tissue product that is like a breast or a steak

Image Credit: BluNalu

Cultivated Meat and Regenerative Medicine

Which one of the following qualities <u>does not</u> apply to both regenerative medicine and cultivated meat technologies?

A. Requires the use of pharmaceutical-grade media
B. Uses somatic stem cells
C. An aseptic environment must be maintained
D. An initial cell culture must be done

Replacing diseased tissues and organs in the body by growing them in the lab.
- Using stem cells (pluripotent) to generate more than 200 types of cells found in the body
- Use high precision to grow an organ
- Pharmaceutical grade process (much higher purity media)
- Must be kept sterile

Growing meat without the animal.
- ✓ Somatic stem cells
- ✓ Lab-cultured
- **Food grade media**
- **Cells proliferated in bioreactors/cultivators**
- **Differentiation based on the end product needed**
- ✓ Scaffolding can be utilized
- Form factor less precise
- ✓ Must be kept sterile

Cultivated Meat Production

SAMPLE

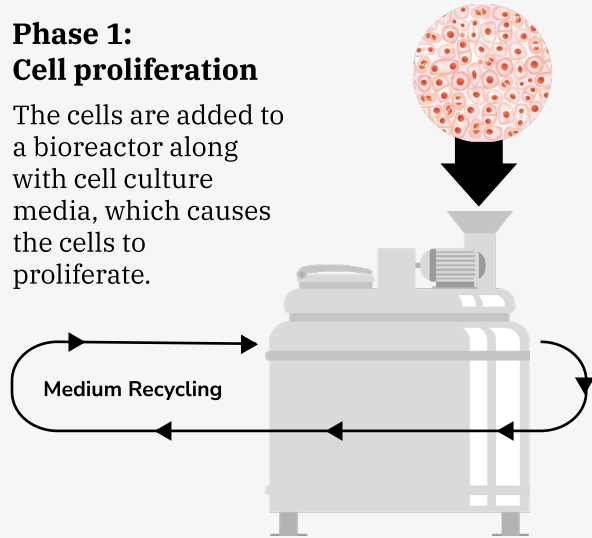A small sample of cells is obtained from an animal.
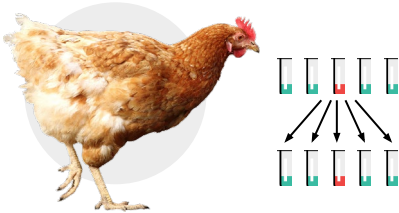
CELL STARTER CULTURE

**Phase 1:
Cell proliferation**

The cells are added to a bioreactor along with cell culture media, which causes the cells to proliferate.

Medium Recycling

**Phase 2:
Tissue Maturation**

A change in culture conditions pushes the cells to differentiate into muscle, fat, and connective tissue.

Scaffolding

Final Product
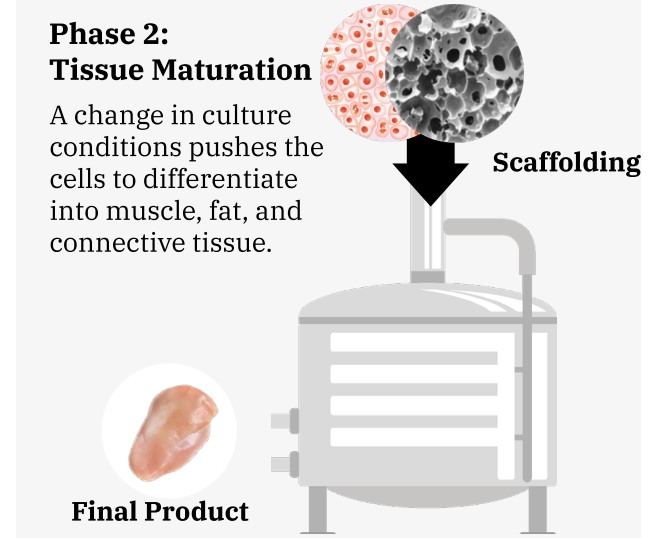
CELLS AT MATURATION
Primarily muscle, fat, and connective tissue.

Fat Cell

Muscle Cell

Fibroblast Cell

Technical Talent Bottlenecks

Difficulty hiring technical talent

48% No
52% Yes
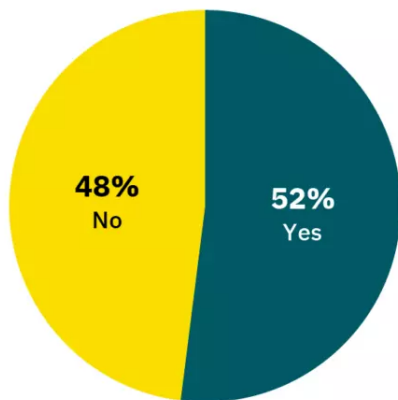
Severity of talent bottleneck

Very severe — 17%
Moderately severe — 77%
Not severe — 6%

Difficulty hiring technical talent

Research & development — 79%
Manufacturing — 35%
Quality assurance and control — 22%
Other — 5%
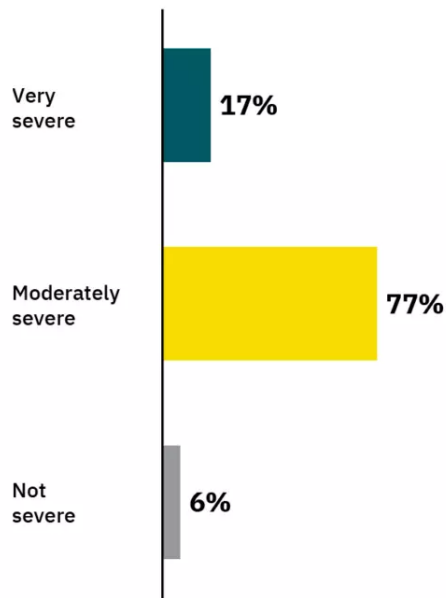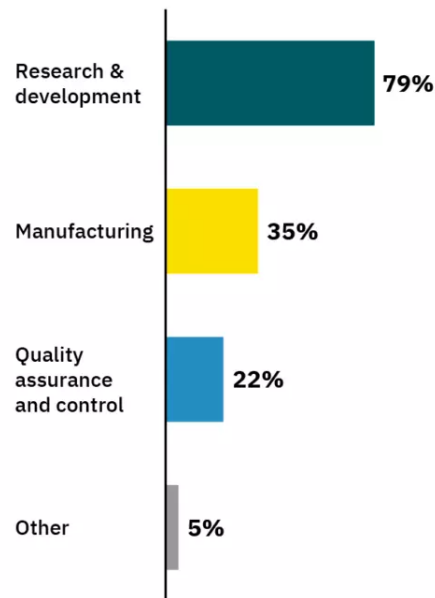
Source: GFI startup survey. As of October 2022. Note that not all 130 participants in this section of the survey answered every question in the section.

https://gfi.org/blog/alternative-protein-startups-underscore-the-need-for-scientific-and-engineering-talent/

Current vs. Future Skills Needs

Top 15 overall skills needed today

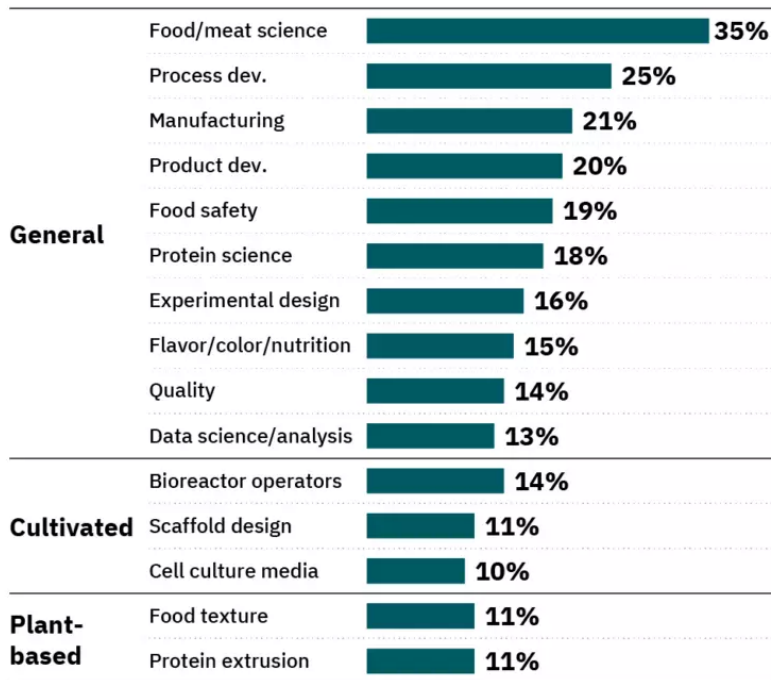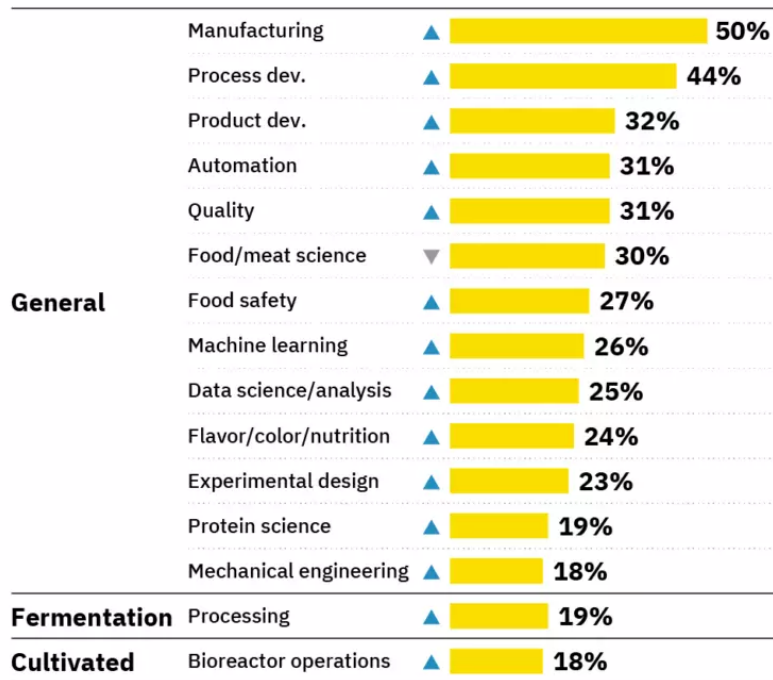|		
General	Food/meat science	35%
	Process dev.	25%
	Manufacturing	21%
	Product dev.	20%
	Food safety	19%
	Protein science	18%
	Experimental design	16%
	Flavor/color/nutrition	15%
	Quality	14%
	Data science/analysis	13%
Cultivated	Bioreactor operators	14%
	Scaffold design	11%
	Cell culture media	10%
Plant-based	Food texture	11%
	Protein extrusion	11%

Top 15 overall skills needed in 5 years

General	Manufacturing ▲	50%
	Process dev. ▲	44%
	Product dev. ▲	32%
	Automation ▲	31%
	Quality ▲	31%
	Food/meat science ▼	30%
	Food safety ▲	27%
	Machine learning ▲	26%
	Data science/analysis ▲	25%
	Flavor/color/nutrition ▲	24%
	Experimental design ▲	23%
	Protein science ▲	19%
	Mechanical engineering ▲	18%
Fermentation	Processing ▲	19%
Cultivated	Bioreactor operations ▲	18%

https://gfi.org/blog/alternative-protein-startups-underscore-the-need-for-scientific-and-engineering-talent/
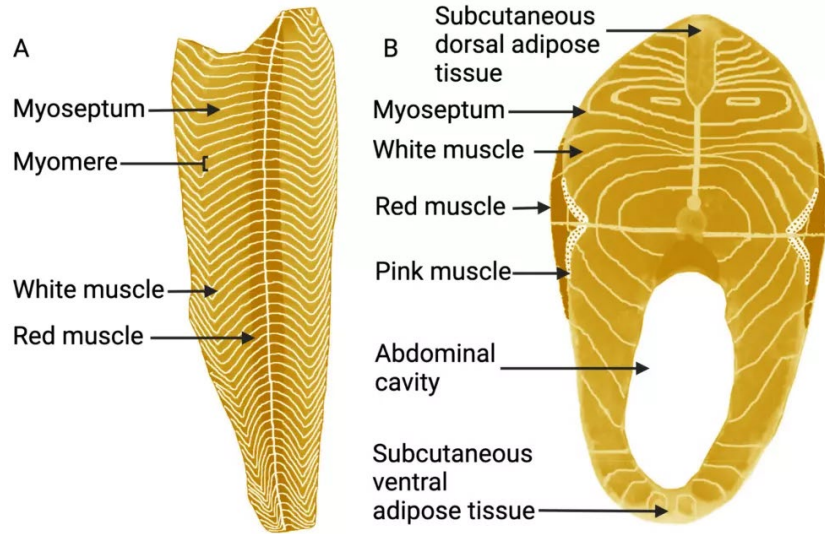
Sign up for GFI's MOOC today

Syllabus

Module 1: Reimagining the protein supply to feed 10 billion

In the first module, you'll learn about the sustainability and public health challenges associated with conventional meat production. This lecture will also provide a brief introduction to plant-based, fermentation-derived, and cultivated meat.

Module 2: What is meat?

In module two, we'll cover the nutritional properties of meat, including the properties of meat-derived proteins and fats. Then we'll discuss some of the qualities that contribute to the experience of eating meat, including texture, color, and flavor.

A

Myoseptum
Myomere
White muscle
Red muscle

B

Subcutaneous dorsal adipose tissue
Myoseptum
White muscle
Red muscle
Pink muscle
Abdominal cavity
Subcutaneous ventral adipose tissue

Cultivated Meat Deep Dive

Free and Open Access

https://gfi.org/science/the-science-of-cultivated-meat/deep-dive-cultivated-meat-end-products/

Cultivated Meat Approval

Which agency(s) have already issued a no-questions letter (e.g., green light) to produce cultivated meat in the United States?

A. USDA
B. FDA
C. NIST
D. USDA and FDA

More Workforce and Curriculum Resources

- ## Opportunities for Workforce Development
- ## Curriculum Repository

https://gfi.org/solutions/?_value_chain_segment=workforce

https://gfi.org/resource/alt-protein-curriculum-development-and-support/

Request access to our curriculum repository

Educators don't always need to create curricula from scratch. Find the building blocks of alternative protein courses using our curriculum repository. This exclusive resource includes syllabi, slide decks, recommended readings, and assessment tools from existing alternative protein curricula. All featured resources are open-access, ready for educators to adapt them as needed.
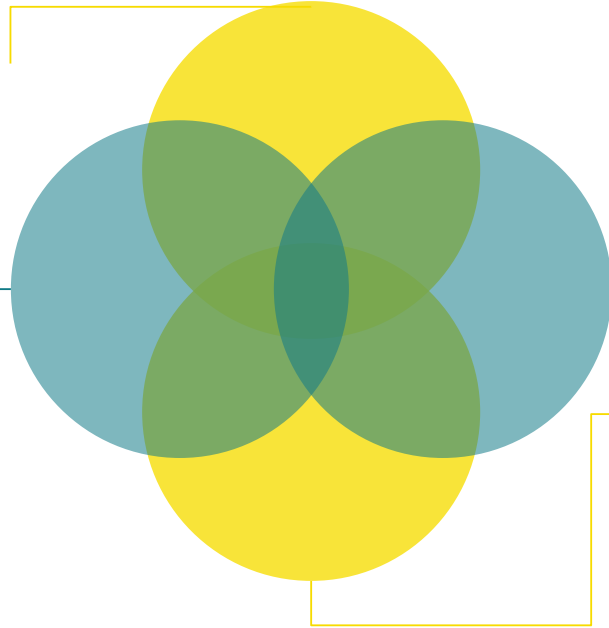
Industrial animal agriculture sits at the intersection of the most pressing issues we face today

ENVIRONMENTAL DEVASTATION

- Accounts for 14-51% of global greenhouse emissions
- Land use, water use, nutrient runoff
- Loss of biodiversity

GLOBAL FOOD INSECURITY

- Tremendous inefficiency in the face of resource scarcity

THE NEXT GLOBAL PANDEMIC

- 75% of emerging human pathogens are zoonotic in origin
- 10 million annual deaths from antimicrobial resistance in 2050

ANIMAL SUFFERING

- 3 trillion animals a year, and growing

Thank you!

Disclaimer

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