

GENETIC ENGINEERING WORKSHOP



Geering Up 2017

BIO SHOCK

ULTIMATE COLLECTION







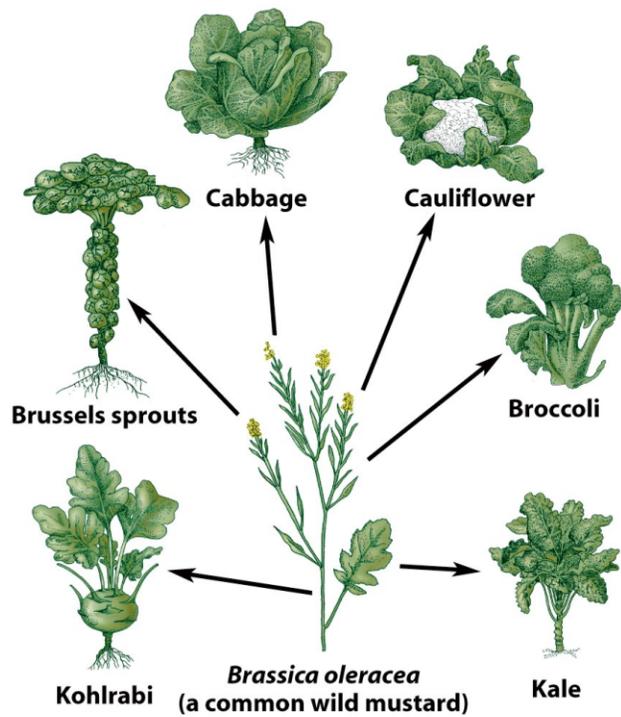


Figure 16-9 Discover Biology 3/e
© 2006 W. W. Norton & Company, Inc.



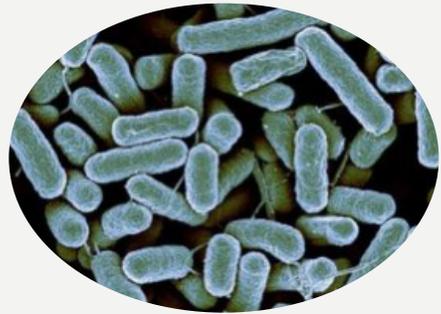
UNDERSTANDING GENETIC ENGINEERING...

...Begins by understanding DNA
People have been trying to alter genetics for a long time before DNA discovery

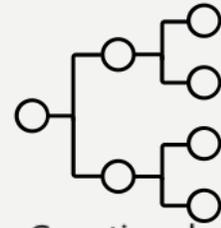
Process is tedious (generations!)

Unexpected results can occur
No guarantee that breeding is the solution

What if you wanted a completely new characteristic?



First description
of a living cell



Genetic rules
discovered,
"Heredity"



Students (us) can
engineer life to
perform desired
functions



DNA structure
proposed,
"Double Helix"



DNA discovered





DNA DISCOVERY

Johann Miescher (1860's)

Discovered an unexpected substance during white blood cell research – 'nuclein'

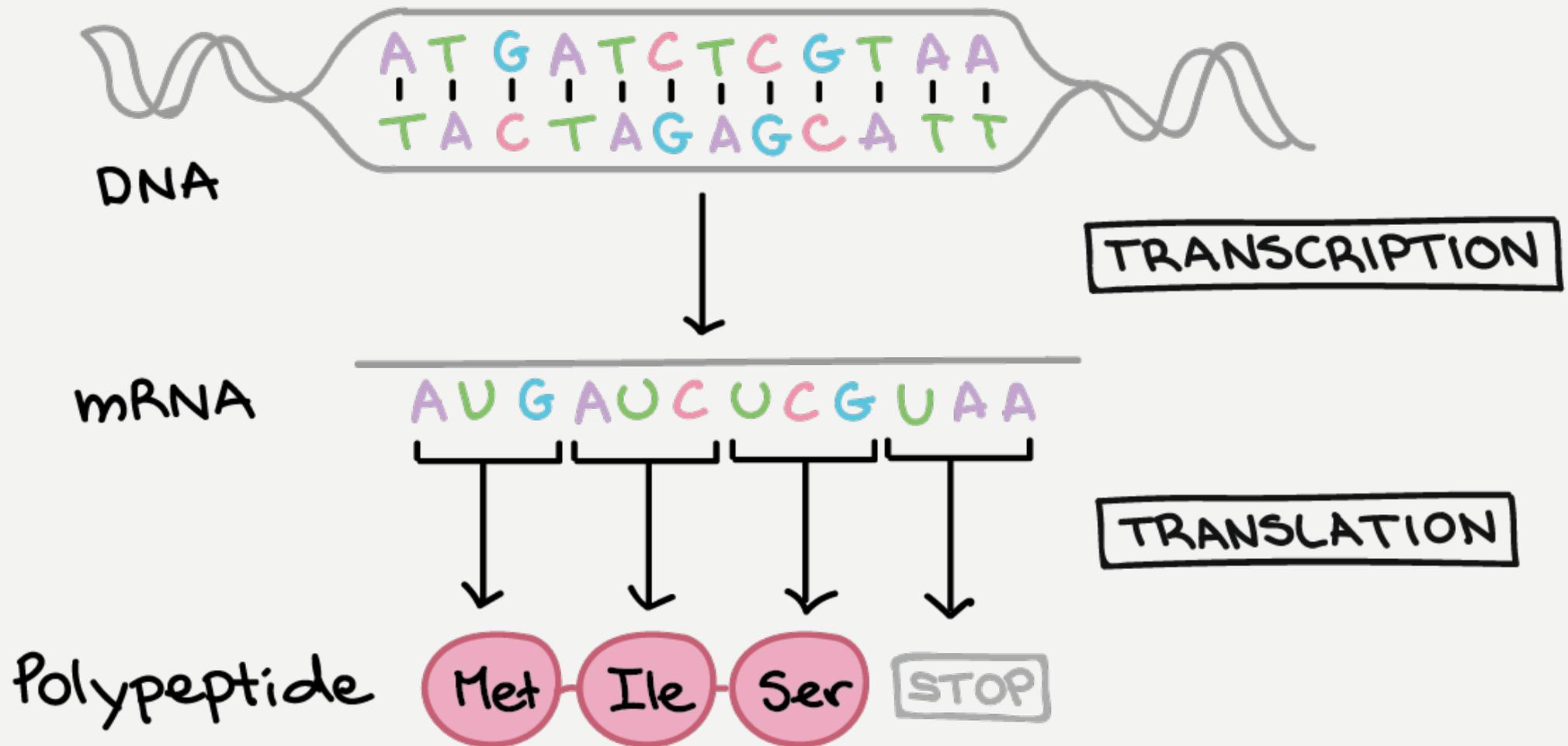
Gregor Mendel (1860's)

Discovers that there are rules to traits (genetics)

For a long time people didn't connect the dots... 'useless molecule'

Rosalind Franklin, Maurice Wilkins, James Watson, and Francis Crick determined helical structure

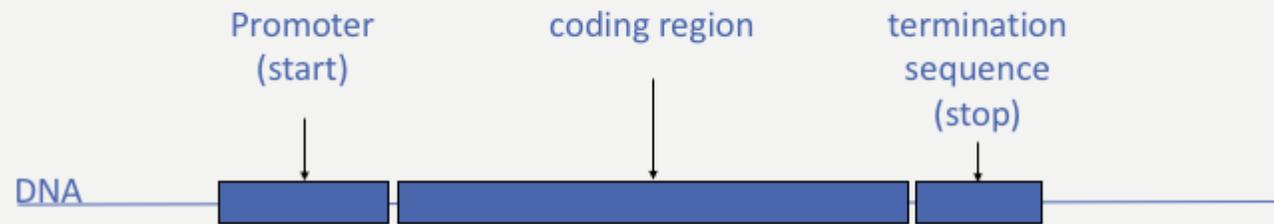
Remember this?

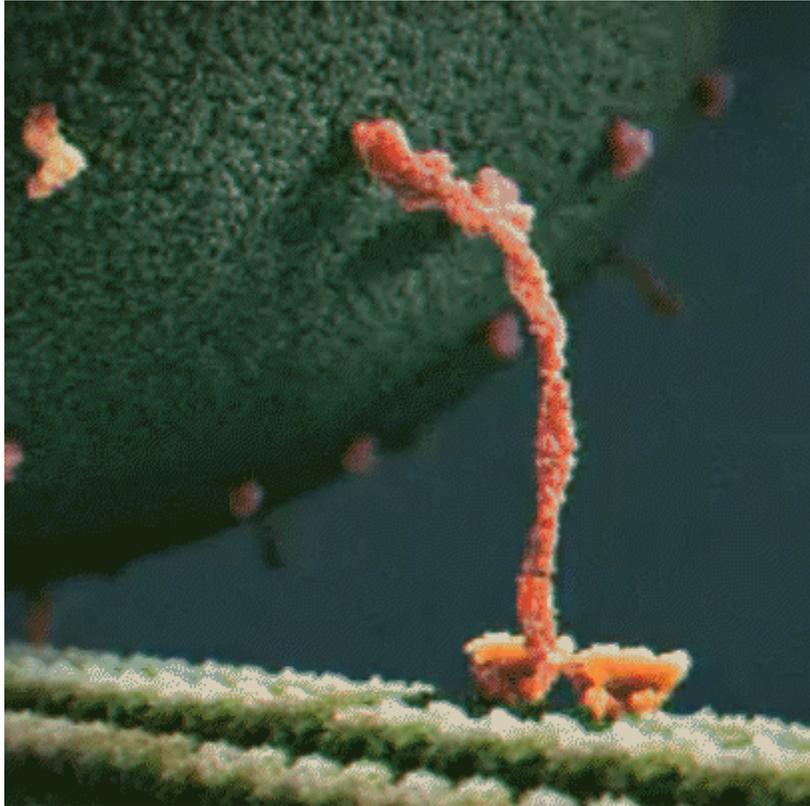


DNA is universal



DNA has order





Proteins

- **Hemoglobin** is essential for moving oxygen through your body
- **Insulin** allows your body to use sugar from the food you eat
- **Rubisco** breaks up carbon dioxide for use in plants



Human Genome Project

An international effort to sequence the entire human genome, completed in 2003.

Anonymous volunteers donated blood samples.

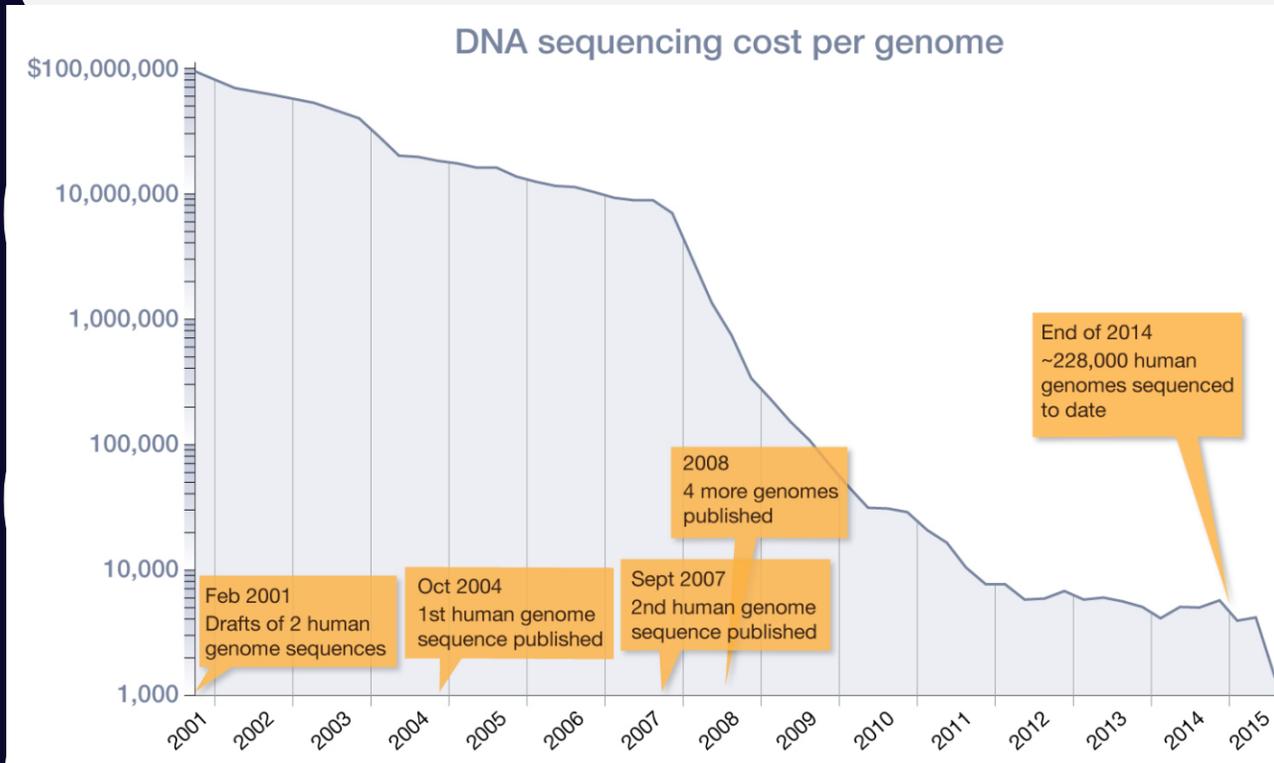
Total cost of \$2.7 BILLION dollars to complete.

Why is this exciting?

Sequencing the full human genome was a major step in understanding our own existence.

The cost of sequencing is going down. That's a BIG deal!

Looking forward. What's next?





What is genetic engineering?

Changing an organism's characteristics by modifying its genetic material - DNA!
What does it mean to modify DNA?



Genetically Modified Organisms



Why genetic engineering?

To understand, we need to look at the first instance of genetic engineering: Insulin

Insulin injections is required for diabetes.

Initial proteins developed from natural sources

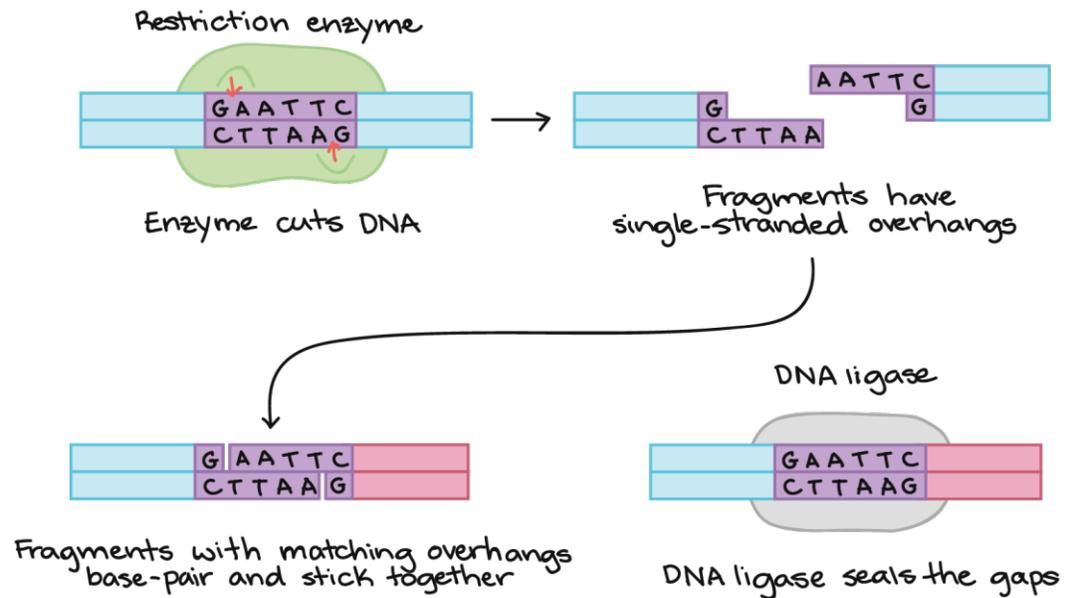
- Where?
- How?
- What are the issues?

Now, insulin is developed, along with most pharmaceuticals from genetically engineered strains.

New Discovery

Paul Berg discovered two essential technologies for the development of genetic engineering:

- Restriction Enzymes
(Molecular tools to cut DNA at a specific location)

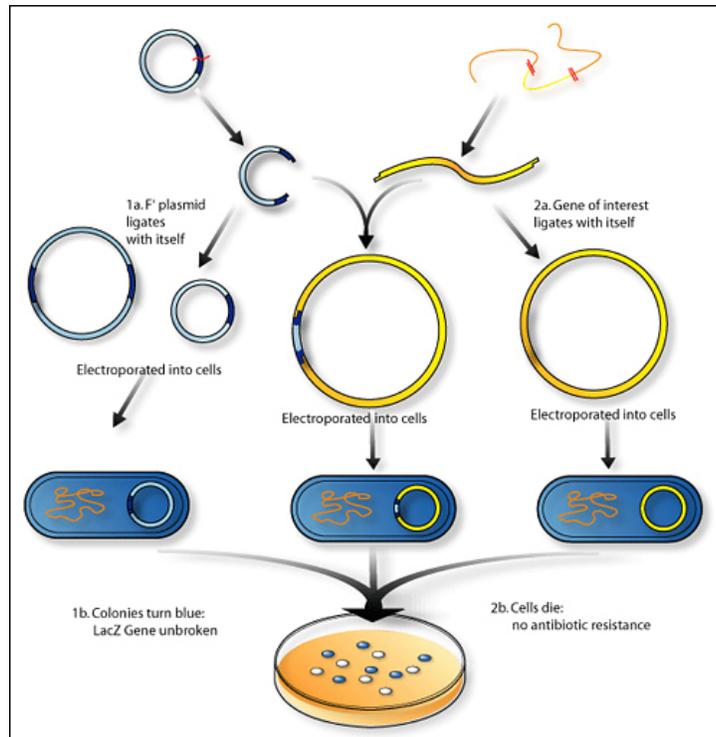


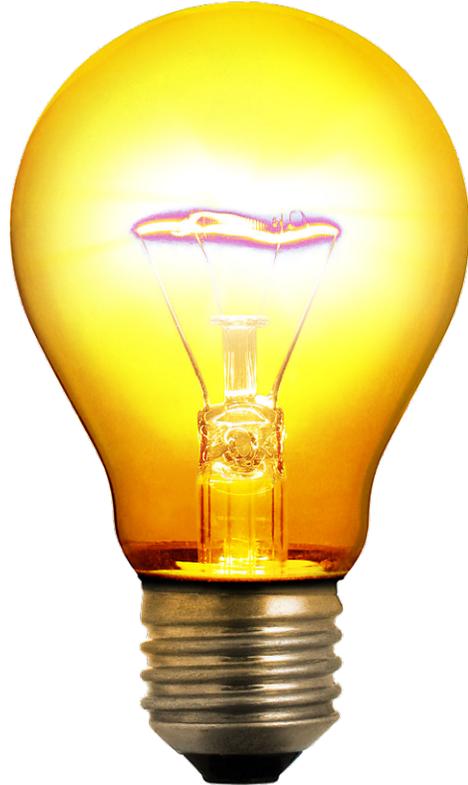
New Discovery

Paul Berg discovered two essential technologies for the development of genetic engineering:

- Restriction Enzymes
(Molecular tools to cut DNA at a specific location)
- Cloning (allows foreign DNA insertion into a host cell and replication)

With both these tools Genetic Engineering is possible.





New Discovery Leads to a New Application

Stanley Cohen and Herbert Boyer realise the potential of these technologies (1978):

Think:

- Insulin is just a protein
- Bacteria synthesize protein all the time
- Why can't we just insert the gene for this protein with these new tools?

It works! Genius!

WHY GENETIC ENGINEERING?



WHY GENETIC ENGINEERING?



WHY GENETIC ENGINEERING?

cattatttagatgagattattgagcaaatcagtgaattttctaagcgtgttatttttagcagatgccaattagataaagttcttagtgcata
gtaataaatctactctaataactcgtttagtcacttaaagattcgcacaataaaatcgtctacggttaaatctatttcaagaatcacgta

1265 1270 1275 1280 1285 1290
His Tyr Leu Asp Glu Ile Ile Glu Gln Ile Ser Glu Phe Ser Lys Arg Val Ile Leu Ala Asp Ala Asn Leu Asp Lys Val Leu Ser Ala
Cas9

gaacaagcagaaaatattattcatttatttacgttgacgaatcttgagactcccgctgcttttaaatattttgatacaacaattgatcgta
cttgttcgtcttttataataagtaataaatgcaactgcttagaacctcgagggcgacgaaaattataaaactatggtgtaactagcat

1305 1310 1315 1320 1325 1330
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Cas9

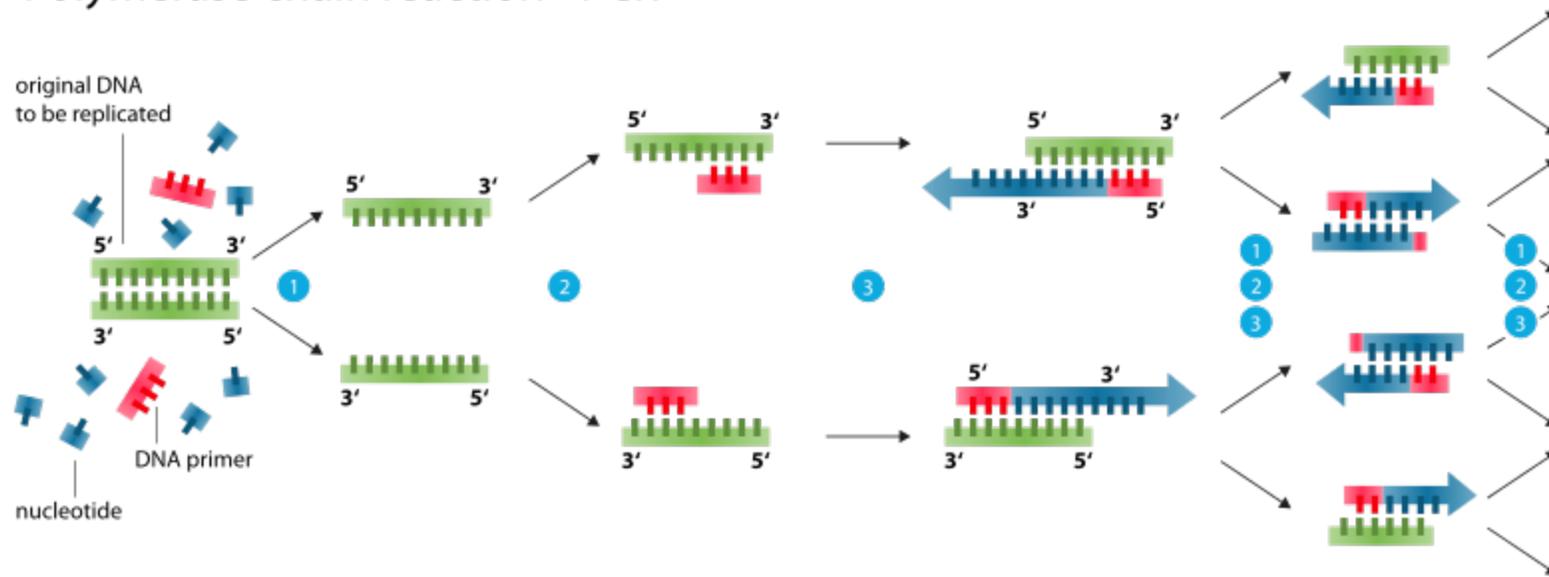
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1345 1350 1355 1360 1365
Asp Ala Thr Leu Ile His Gln Ser Ile Thr Gly Leu Tyr Glu Thr Arg Ile Asp Leu Ser Gln Leu Gly Gly Asp Ala Ala Asn Asp Glu /
Cas9 (in fram

gtaactaaactcagtcgatcctccactgTGA
Primer 2 TCA

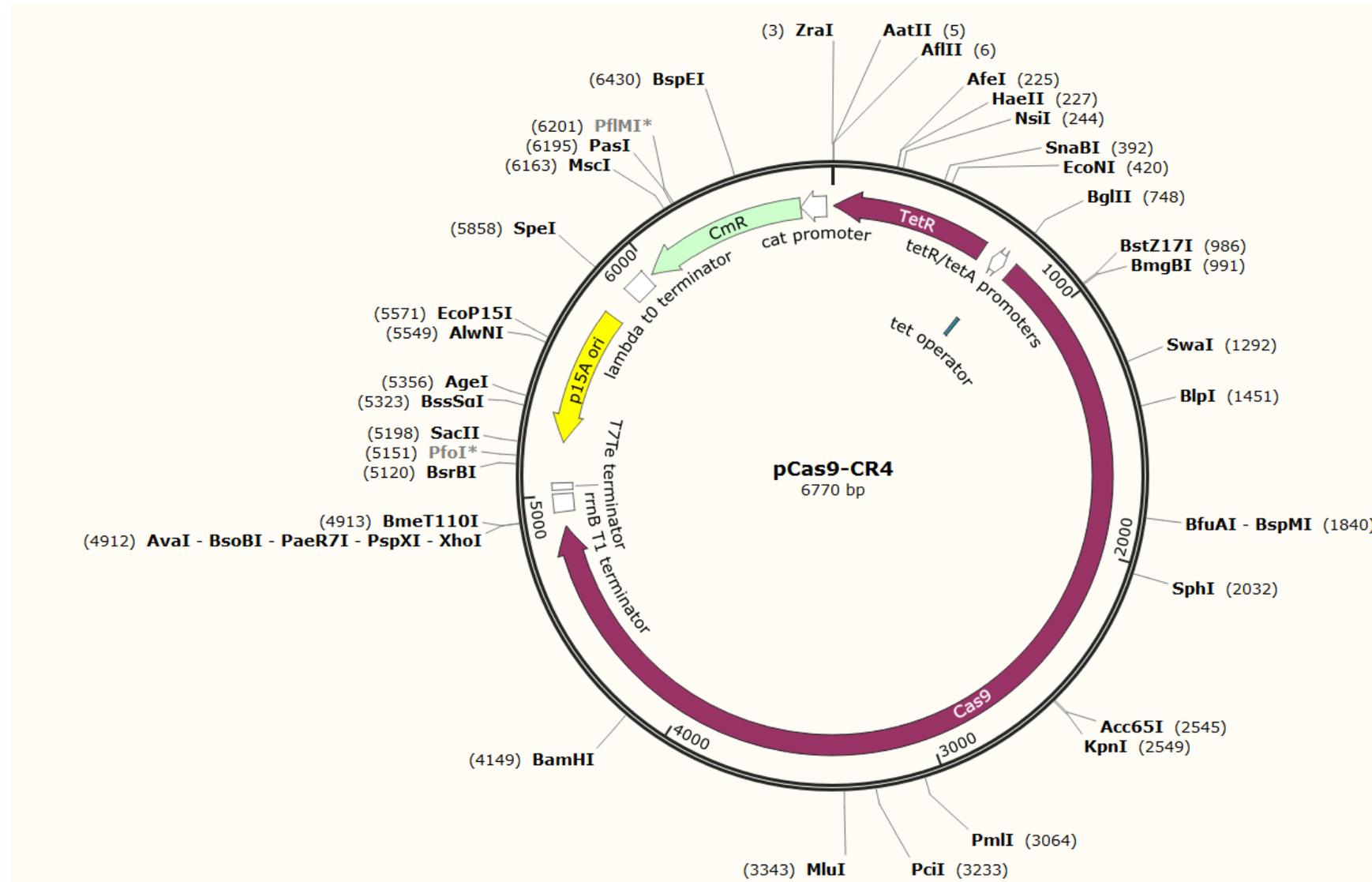
WHY GENETIC ENGINEERING?

Polymerase chain reaction - PCR



- 1 **Denaturation** at 94-96°C
- 2 **Annealing** at ~68°C
- 3 **Elongation** at ca. 72 °C

WHY GENETIC ENGINEERING?



WHY GENETIC ENGINEERING?

The image illustrates the application of restriction enzymes in genetic engineering. On the left, a circular plasmid map shows various restriction sites and features. On the right, a software window provides detailed information for the SpeI enzyme.

Plasmid Map Features:

- (6430) SpeI
- (6201) PflMII
- (6195) PstI
- (6163) MscI
- (5858) SpeI
- (5571) EcoP15I
- (5549) AlwNI
- (5356) AgeI
- (5323) BssSai
- (5198) SacII
- (5151) PfoI*
- (5120) BsrBI
- (4913) BmeT110I
- (4912) AvaI - BsoBI - PaeR7I - PspXI - XhoI
- (4149) BamHI
- (3343) MluI
- (3064) PmlI
- (3233) PciI

Restriction Enzyme: SpeI Software Window:

SpeI

DNA Letter Codes

653 enzymes

5' ...ACTAGT ...3'
3' ...TGATCA ...5'

Overhang Type: 5' Palindromic Recognition Sequence: 6 bp

New England Biolabs

SpeI Buffer: CutSmart Buffer

Buffer:	NEB 1.1	NEB 2.1	NEB 3.1	CutSmart
Activity:	75%	100%	25%	100%

Incubation Temperature: 37°C [Enzyme Website](#)

Methylation Sensitivity

- Dam: No Effect
- Dcm: No Effect
- EcoKI: Sometimes Blocked

Same Recognition Sequence: -- 2 Enzymes --

Compatible Sticky Ends: -- 14 Enzymes --

Search

WHY GENETIC ENGINEERING?

The image displays a circular plasmid map with various restriction enzyme sites and a software window for BamHI enzyme details.

Plasmid Map Labels:

- (6430) **BspEI**
- (6201) **PfIMI***
- (6195) **PasI**
- (6163) **MscI**
- (5858) **SpeI**
- (5571) **EcoP15I**
- (5549) **AlwNI**
- (5356) **AgeI**
- (5323) **BssSaI**
- (5198) **SacII**
- (5151) **PfoI***
- (5120) **BsrBI**
- (4913) **BmeT110I**
- (4912) **AvaI - BsoBI - PaeR7I - PspXI - XhoI**
- (4149) **BamHI**
- (3343) **MluI**
- (3064) **PmlI**
- (3233) **PciI**
- (225) **AfeI**
- (227) **HaeII**
- (244) **NotI**
- (5) **AatII**
- (6) **AflIII**
- (3) **ZraI**

Plasmid Features:

- CmR** (Chloramphenicol resistance gene)
- lambda t0 terminator**
- p15A ori** (p15A origin of replication)
- T7Te terminator**
- rrnB T1 terminator**

Software Window: Restriction Enzymes: BamHI

BamHI

653 enzymes

DNA Letter Codes

5' ... GGATCC ... 3'

3' ... CCTAGG ... 5'

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Buffer	NEB 1.1	NEB 2.1	NEB 3.1	CutSmart
Activity	75%	100%	100%	100%

Incubation Temperature: 37°C [Enzyme Website](#)

Methylation Sensitivity: Dam: No Effect, Dcm: No Effect, EcoKI: No Effect

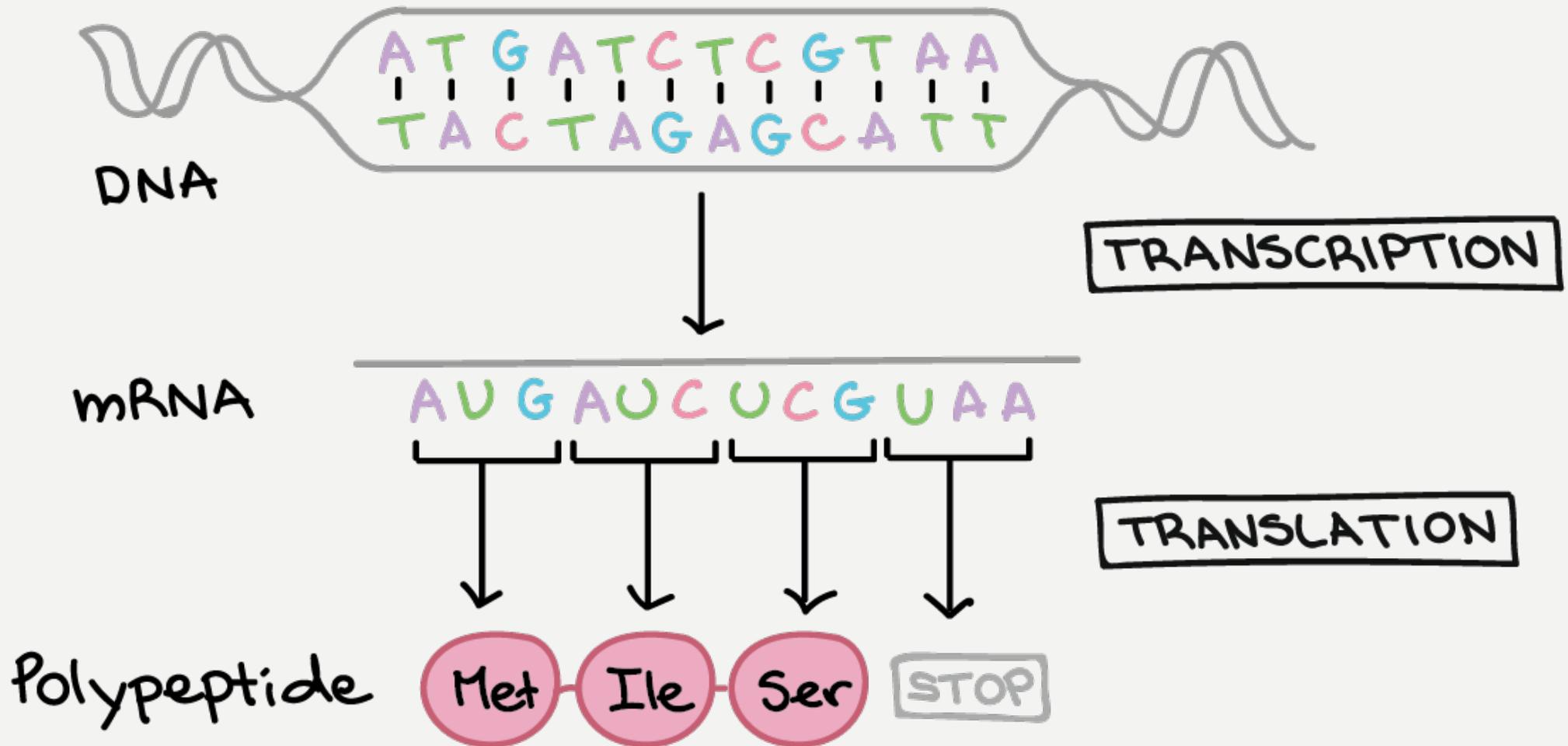
Same Recognition Sequence: -- 0 Enzymes --

Compatible Sticky Ends: -- 18 Enzymes --

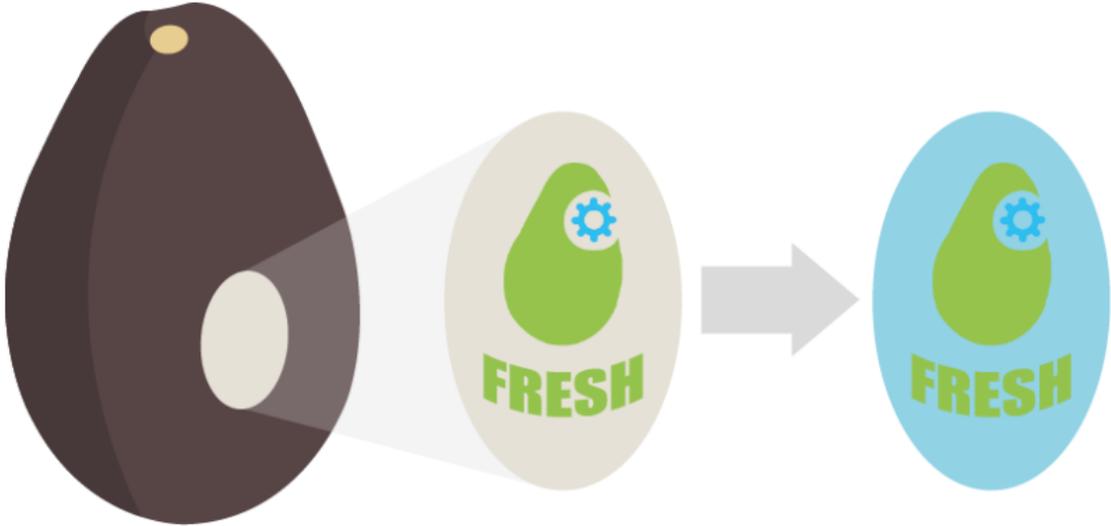
After cleavage, BamHI-HF™ (but not the original BamHI) can remain bound to DNA and alter its electrophoretic mobility.

Search

Remember this?



Influential iGEM Projects



Influential iGEM Projects



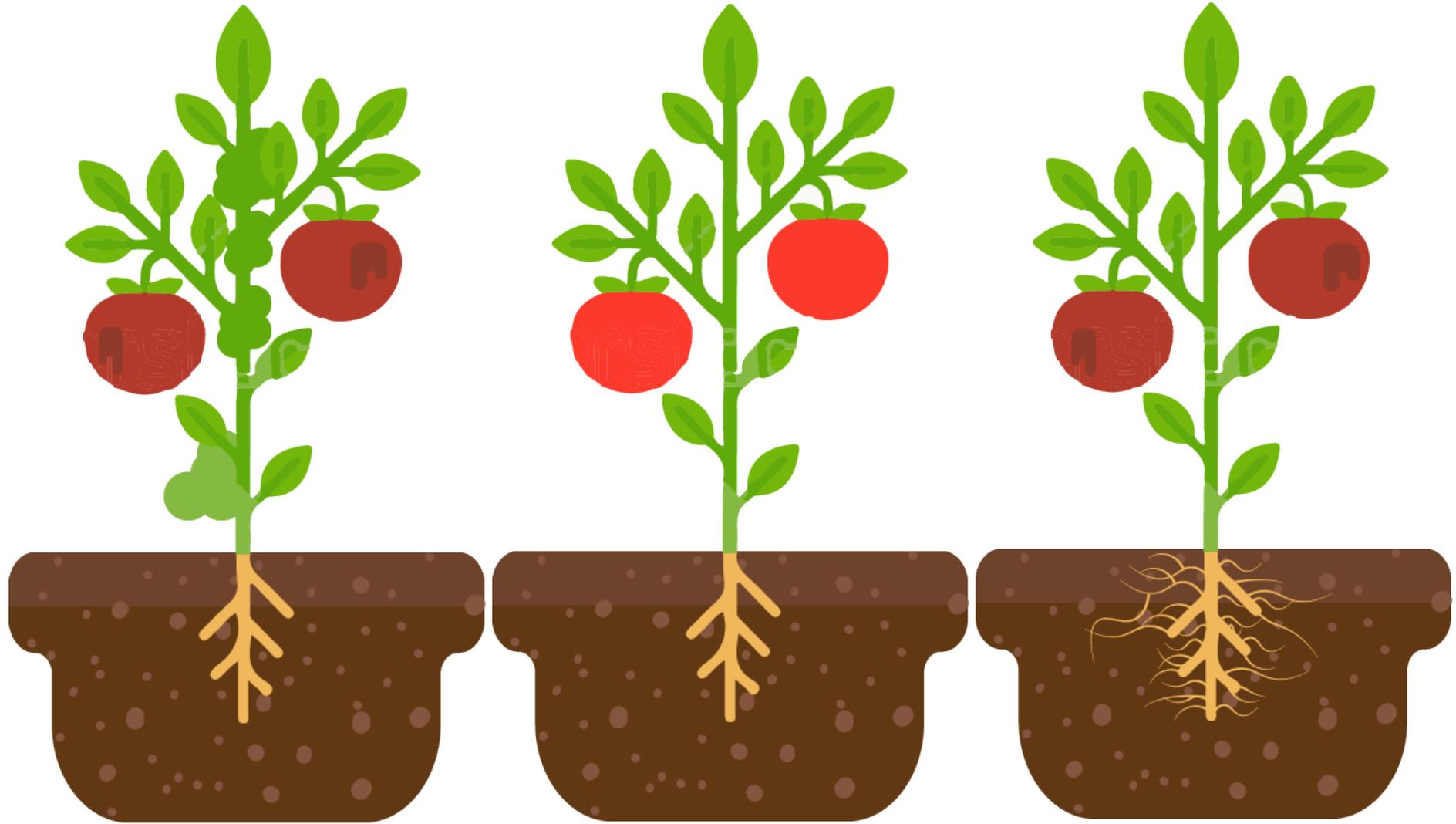
Influential iGEM Projects



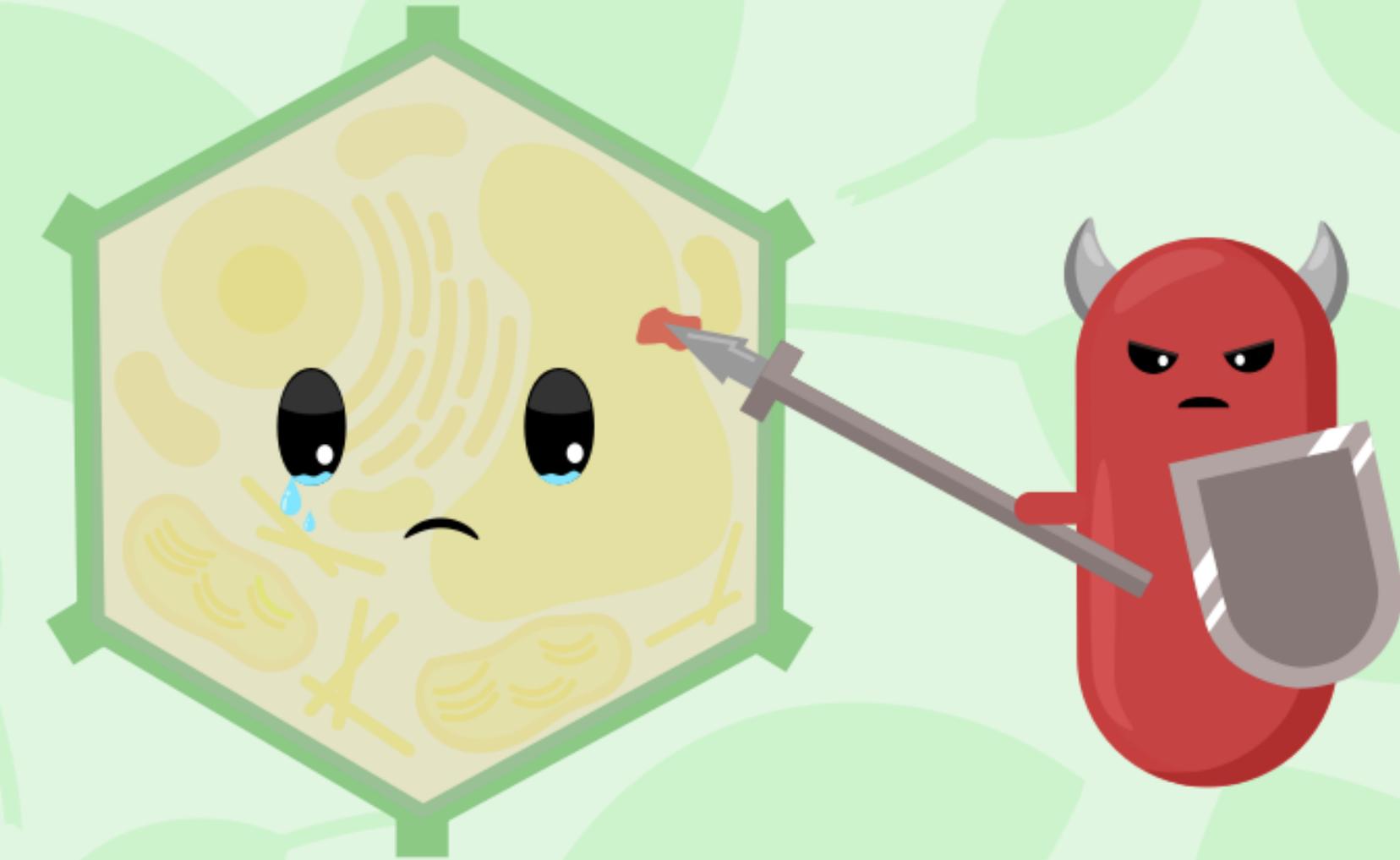
UBC iGEM Projects



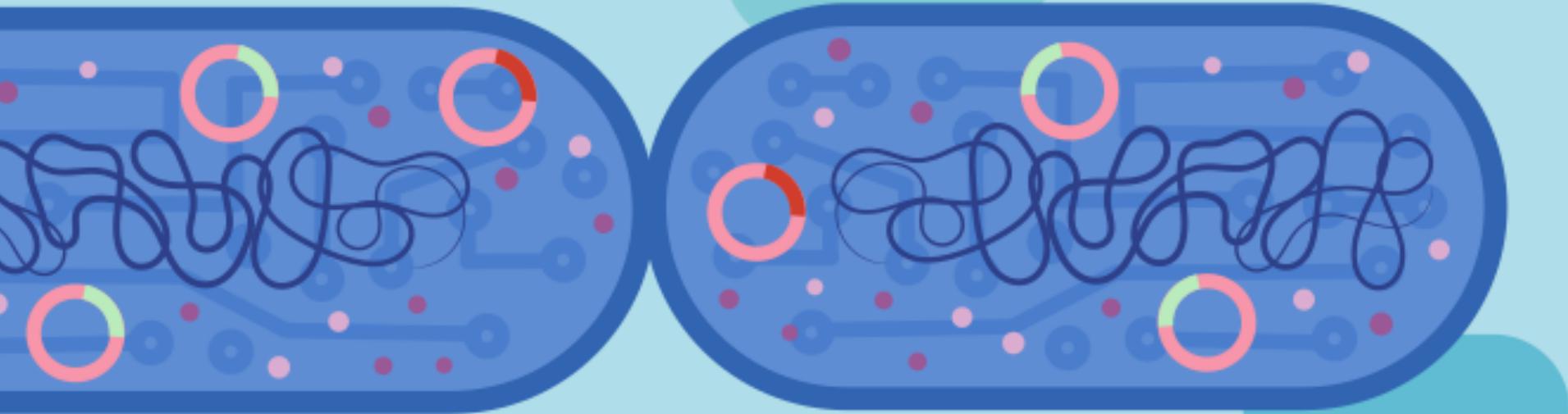
THIS YEARS
PROJECT



THIS YEAR'S PROJECT



THIS YEAR'S PROJECT

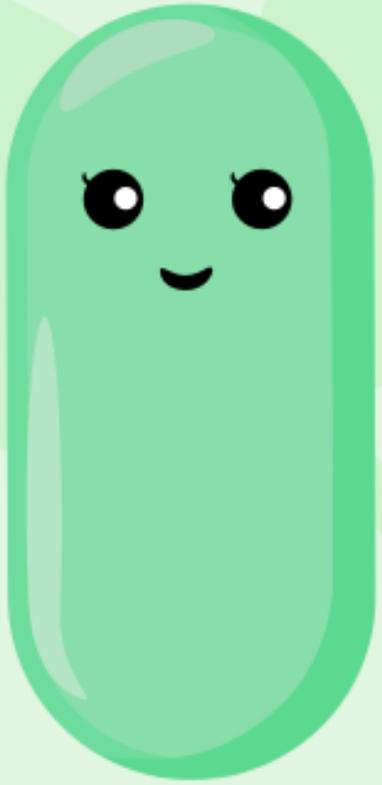


Cas9



THIS YEAR'S
PROJECT

THIS YEAR'S PROJECT



aGROW

THIS YEAR'S PROJECT





WHAT DO YOU ACTUALLY MAKE?

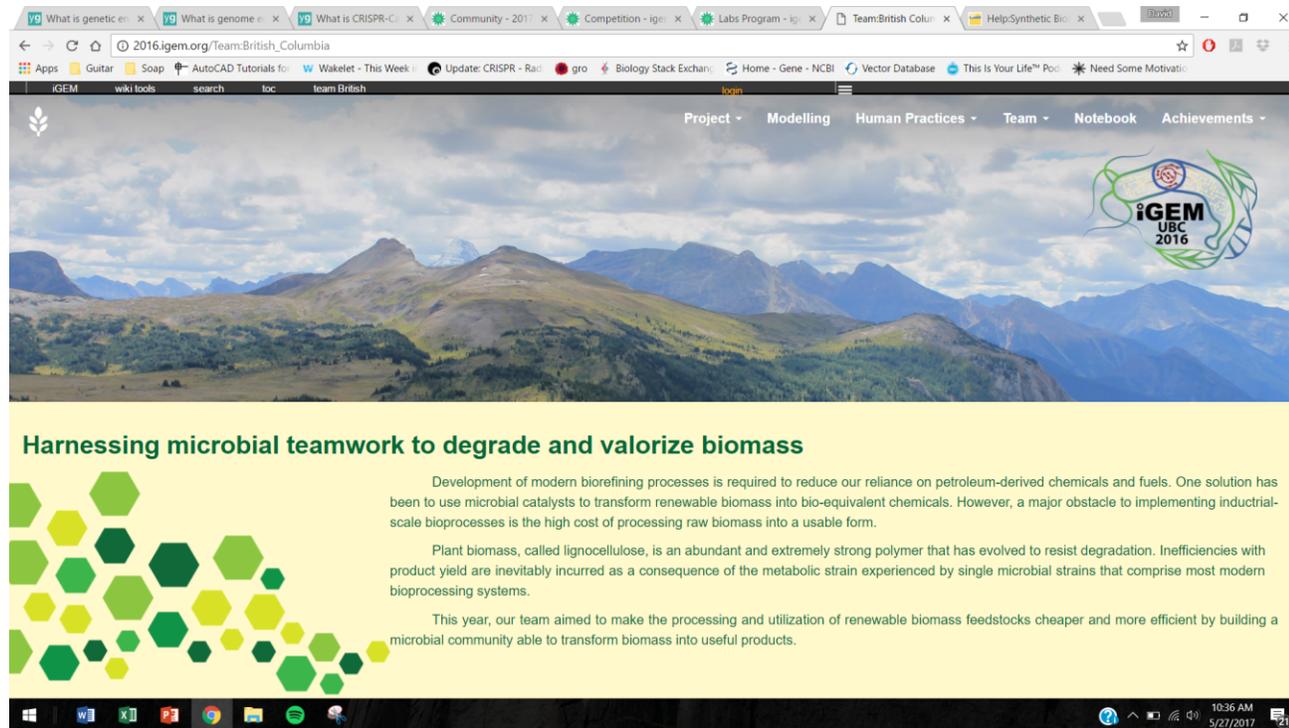
A bacteria (usually) that uses DNA adjustments to do something entirely new!

WHAT DO YOU ACTUALLY MAKE?

A bacteria (usually) that uses DNA adjustments to do something entirely new!

A website detailing our project and our accomplishments

A fundraising package (similar to what is made by start up companies)



The screenshot shows a web browser window displaying the iGEM UBC 2016 website. The browser's address bar shows the URL 2016.igem.org/Team:British_Columbia. The website features a navigation menu with options like Project, Modelling, Human Practices, Team, Notebook, and Achievements. The main content area has a header image of a mountain range and the iGEM UBC 2016 logo. Below the image is a section titled "Harnessing microbial teamwork to degrade and valorize biomass" with a decorative graphic of green hexagons on the left. The text describes the team's goal to develop modern biorefining processes to reduce reliance on petroleum-derived chemicals and fuels, and to utilize plant biomass (lignocellulose) more efficiently.

Harnessing microbial teamwork to degrade and valorize biomass

Development of modern biorefining processes is required to reduce our reliance on petroleum-derived chemicals and fuels. One solution has been to use microbial catalysts to transform renewable biomass into bio-equivalent chemicals. However, a major obstacle to implementing industrial-scale bioprocesses is the high cost of processing raw biomass into a usable form.

Plant biomass, called lignocellulose, is an abundant and extremely strong polymer that has evolved to resist degradation. Inefficiencies with product yield are inevitably incurred as a consequence of the metabolic strain experienced by single microbial strains that comprise most modern bioprocessing systems.

This year, our team aimed to make the processing and utilization of renewable biomass feedstocks cheaper and more efficient by building a microbial community able to transform biomass into useful products.

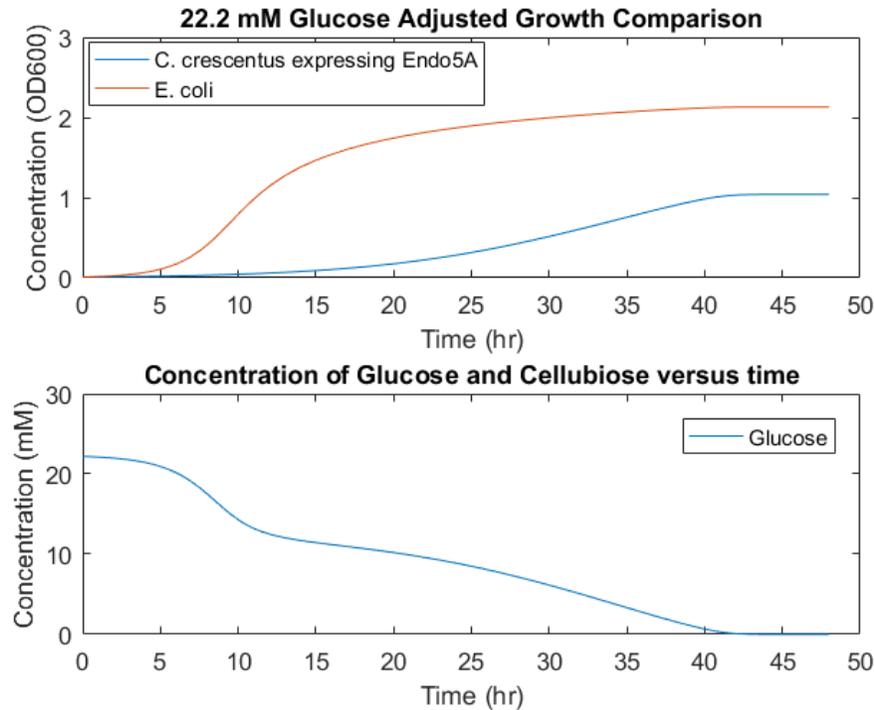
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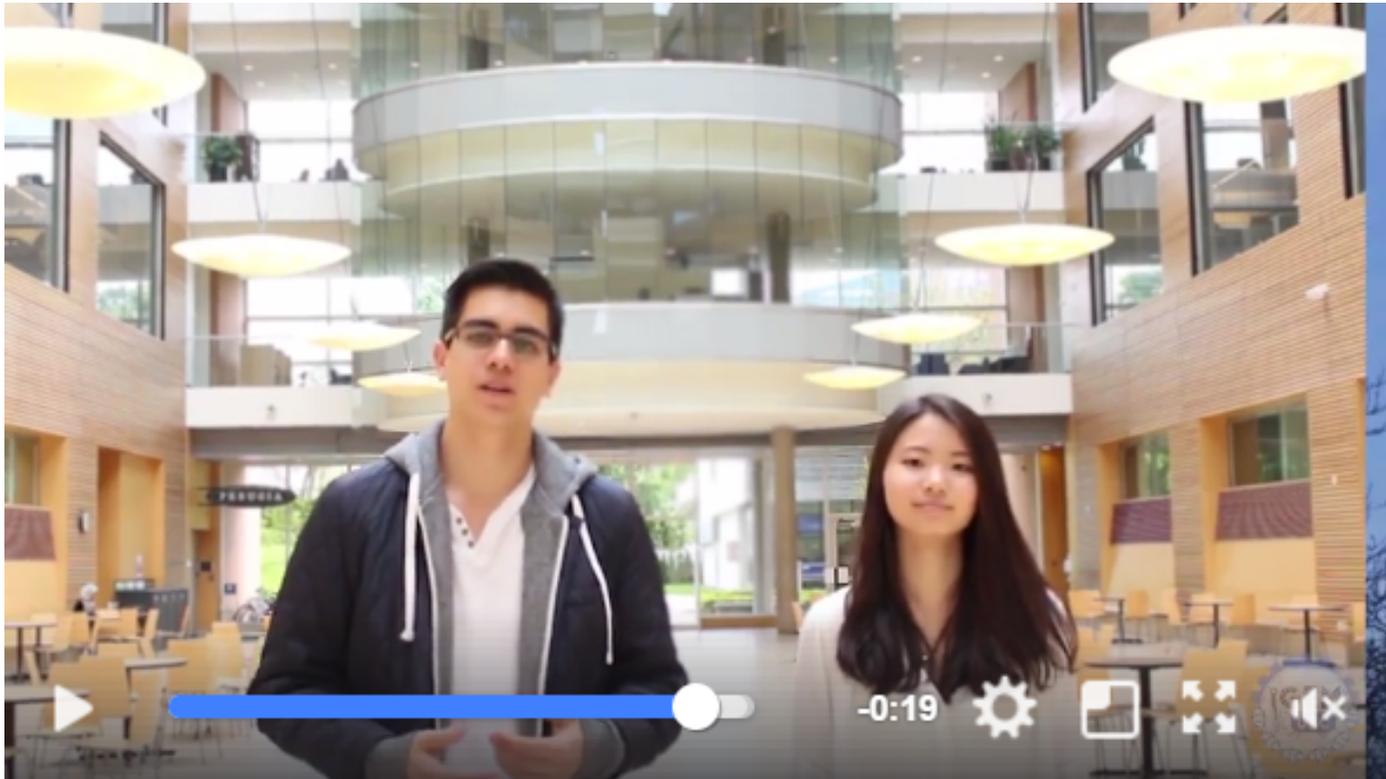
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A 20 minute presentation and a poster

Interactive workshops for students in the community



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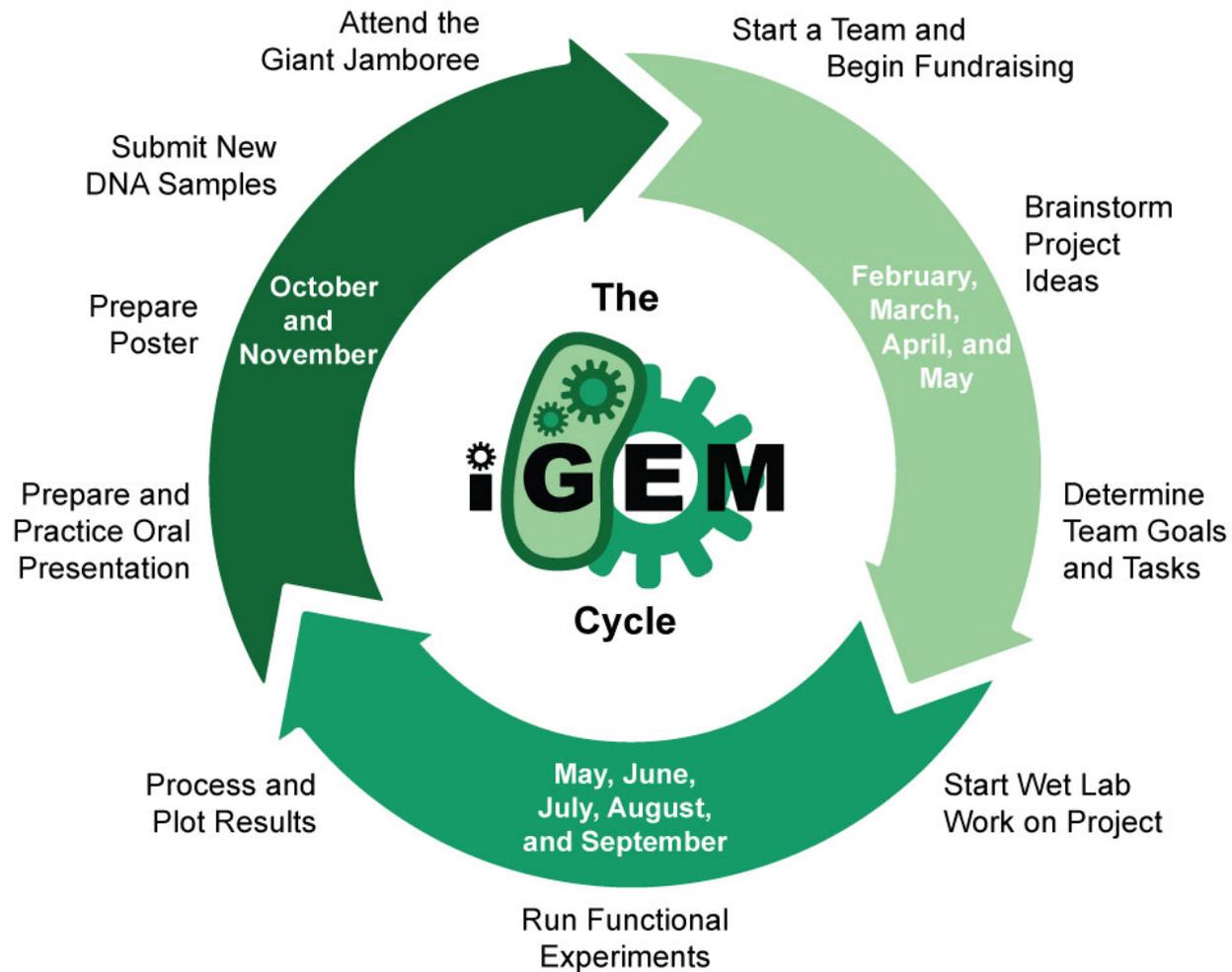
A fundraising package (similar to what is made by start up companies)

A computational model (or software)

A 20 minute presentation and a poster

Interactive workshops for students in the community

Videos detailing our team and our project



TIMELINE

Recruitment begins in the beginning of the year.

Teams not only design a project and do the research, they make the product



AFTER THAT...

The team travels to Boston, USA to present their projects and compete for prizes.

Over 300 teams competed last year!

This year UBC iGEM was nominated for best manufacturing project and won a gold medal!



WHY IGEM?

1

High school students can actually make teams and participate – You don't have to wait

2

Participate in a rapidly growing and important field

- Elon Musk (Tesla, SpaceX, PayPal) said that Artificial Intelligence and Genetic Engineering are the two most important emerging fields right now

3

Meet new people from around the world with similar interests

WHAT NEXT?

1

Follow the UBC iGEM
Facebook Page:
[@UBCIGEM2017](#)

2

Consider joining a team
WHEREVER you go

3

Keep updated with Genetic
Engineering