The SynBio Sleuths

ANSWER SET

A Treasure Hunt for the ever curious

Q1

An ode to… umm to….

Let’s gather around and let’s sit down
Have a talk about X, how does that sound
Technology used to multiple nucleotides like rabbits
You’ve become one of a molecular biologists most oldest habits

A template, a primer, to bind to the other side,
dNTPs, enzyme & buffer to make sure everything sits tight
A handful of ingredients and a few easy steps
Cleave it, and cleave it and hope it extends

X , oh X what a beautiful technique,
Gave each and every biologist a new and awesome feat
You can use it to amplify, magnify, detect and identify
If you want something more maybe go for a mutation

A medical tool doing wonders beyond you’ve seen
All started with a few water baths which ever so keen
As Y, tweaked his setup to make sure it all worked fine
Little did he know he was creating something so divine

As your friend on stage recites his poem, an ode to his beloved, he decided to change the name of his muse. However you are far too clever for all that.
You’ve figured out what the poem is dedicated to havent you? Give me X and Y

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Answer for Question 1

Reasoning:
Google search based on keywords in the poem

Answer:
X- Polymerase Chain Reaction/ PCR
Y- Kary Mullis

Q2

> One of the persons in the image below shared a Nobel Prize in Physiology/Medicine with an Indian-American for a discovery that has now become textbook material.
> What does reading the ‘concept’ section of this Indian-American’s search result on website-x tell you about ‘stop signals’ (exact sentence).
> Find website-x hidden on this slide

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Answer for Question 2

Reasoning:
Searching for this image on google, you can identify this to be Robert Holley who shared the 1968 Nobel Prize with Har Gobind Khorana.
Dnaftb.org is hidden behind the image

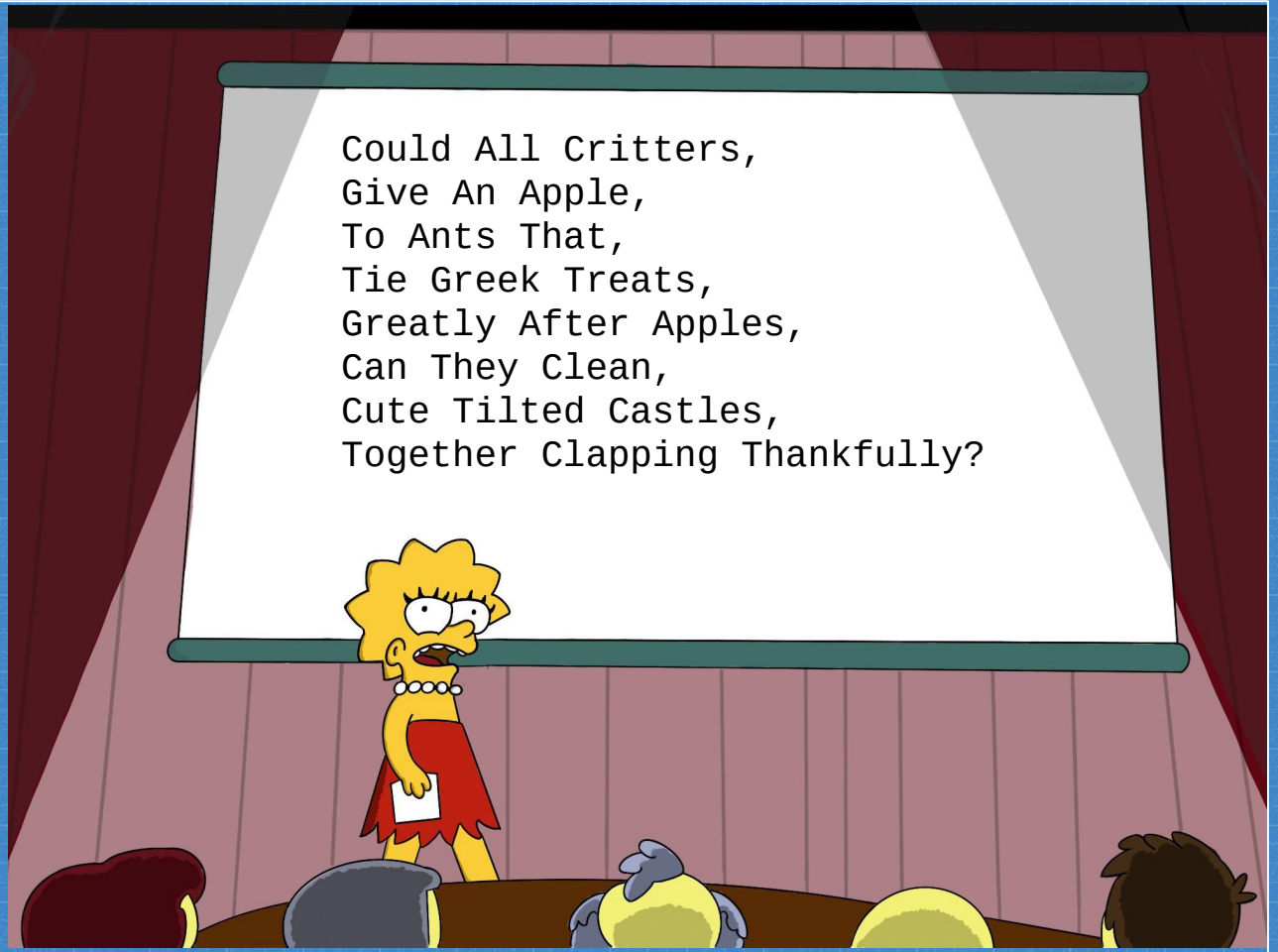
Searching Har Gobind Khorana on dnaftb.org and going to the concept tab in the page, gives you a page titled “DNA words are 3 letters long”. Look at the last line

Q3

What is Lisa talking about? What is she saying you think to yourself. You seem confused and look around. All your fellow humans are confused.

You start to notice that your epithelial cells and the bacteria (maybe others too but it's difficult to tell) almost replying to Lisa. They seemed to have figured it out.

Can you?
Answer: 8 characters long



All hints are on these webpages, no need to click any links on the webpages.

Hint 1
Hint 2

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Answer for Question 3

Reasoning:
If you notice, all the words start with either A,T,G or C.
Taking the first letter of each word gives you:
CAC
GAA
TAT and so on. This is a DNA sequence where each line is a codon.

One of the images gives the clue for converting A,T,G,C of DNA to letter code for proteins.

Using the link given in the hint, you can translate this to proteins. Using the single letter convention for amino acids (mentioned in the link), you get:
“HEYCELLS”

Q4

As your teacher was explaining how restriction enzymes cut at DNA, you seemed to have decided to take an afternoon siesta. You wake up just in time as your teacher calls out your name and says, “Now it's your turn to solve the problem”. The question written on the blackboard reads:

> How many combinations of completely paired double stranded DNA do you when you add EcoRI to sequences 1 and 2 and mix them together?
>
> Sequence 1:
> AGAAAGCAATAGGAATTCGCCACTTCTTTATGAGATCGAATTCCTTTCATTAGGAGCCCCGC
> TCTTTCGTTATCCTTAAGCGGTGAAGAAATACTCTAGCTTAAGGAAAGTAATCCTCGGGGCG
>
> Sequence 2:
> GAATTCCTTATGTCGTGAATTC
> CTTAAGGAATACAGCACTTAAG

Luckily enough, you managed to scribble something down before your untimely nap:

1. A restriction enzyme is an enzyme that cleaves DNA into fragments at or near specific recognition sites within molecules known as restriction sites.
   Ex: EcoRI, BamHI, etc.
2. Remembering that in nucleic acids, Adenine and Thymine always pair up and Cytosine and Guanine always pair up, answer the following question.
   You also remember that, single strands of DNA are always desperately in search of their partners and will go for the closest match
3. EcoRI Cuts at the recognition site “GAATTC” in the following pattern:

Hint 1: Main image

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Answer for Question 4

Reasoning:

By cutting the sequences according to the diagram shown below you get:

Sequence 1:
Let’s name them A, B, C respectively

```
AGAAAGCAATAGG          AATTCGCCACTTCTTTATGAGATCG          AATTCCTTTCATTAGGAGCCCCGC
TCTTTCGTTATCCTTAA          GCGGTGAAGAAATACTCTAGCTTAA          GGAAAGTAATCCTCGGGGCG
```

Sequence 2:
Let’s name them X, Y, Z respectively

```
G        AATTCCTTATGTCGTG        AATTC
CTTAA        GGAATACAGCACTTAA        G
```

Since DNA pairs such that A,T pair up and C,G. The following combinations are possible:

(A,C),(A,B,C),(A,Z),(A,B,Z),
(X,C),(X,B,C),(X,Z),(X,Y,Z),
(A,B,Y,C),(A,B,Y,Z),
(A,Y,B,C),(A,Y,B,Z),
(X,Y,B,C),(X,Y,B,Z),
(X,B,Y,C),(X,B,Y,Z)
(A,A),(C,C),(X,X),(Z,Z)

NOTE:

1. Combinations such as (A,B) is not the final product as there is a region of DNA that is not paired
2. B and Y can be present multiple times in each combination.

Q5

You come across a sheet of paper that looks like it has been ripped out of a newspaper. It reads as below.
What is the question? What is the answer?

Best Environmental iGEM Project 2018 - NCKU Tainan

2018 NCKU Tainan team strives to reduce the concentration of carbon dioxide (CO2) with the approach of synthetic biology.

We constructed a carbon fixing E coli by cloning enzymes from Calvin cycle into it.
We measured the function of each enzyme in the pathway and proved that the engineered pathway can utilize carbon.

Our team has also designed a bioreactor. The bioreactor contains an air valve in which we can pump the CO2.

The bioreactor is also monitored by sensors that will send the data to a cloud database.
Combining IoT and synthetic biology, we believe that our device can be applied to industrial settings.

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Answer for Question 5

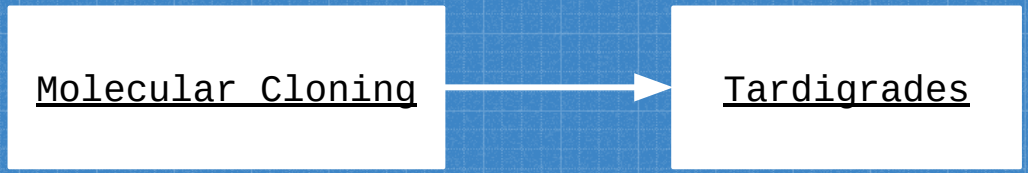
Reasoning:
Underlined letters form a morse code pattern:
1 underline under one character followed by a space= .
3 continuous underlines under 3 characters followed by a space= -
Space refers to a region that is not underlined.

Thus the morse code pattern which can be decoded online reads:
Gfpextractedfromwhat? = Gfp extracted from what?
Which if you google tells you that it is a jellyfish *Aequorea victoria*

Q6

The **Wiki Game**, also known as the Wikipedia race, is a hypertextual game designed to work specifically with Wikipedia. Players start on the same randomly selected article, and must navigate to another pre-selected target article, solely by clicking links within each article. The goal is to arrive at the target article in the fewest clicks (articles), or the least time.

What is the shortest path from site A to site B mentioned below:



Answer should be the path, from A to B.

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Answer for Question 6

Pathway is:

1. Molecular Cloning
2. E coli
3. Prokaryotic
4. Biofilms
5. Desiccation
6. Tardigrades

There can of course be many other paths, and this is one of the shorter ones.

Q7

Identify the speaker if the toast that the speaker raises also happens to be the title of their quite famous speech.

Link for the audio is the image
Hint for the question is the image

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Answer for Question 7

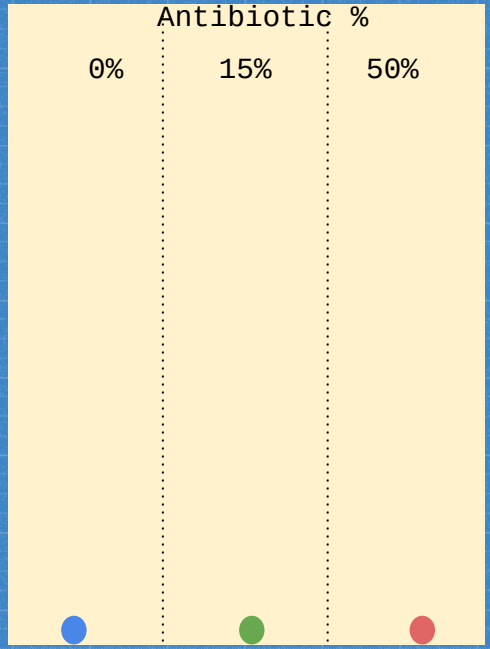
Reasoning:
Download the audio.
Reverse the audio (u-turn get it?) using any software online
Speech is by Frances H Arnold:
https://www.youtube.com/watch?v=EnLdBiu7ci8

Q8

An organism's main goal is to increase the population of the species to propagate it's DNA. Given a limited space, it keeps on reproducing, until it has taken over all space and exhausted all resources. Since it doesn't wish to die, it will try to adapt to survive off of new resources. Once it is able to do that, it has evolved (naturally selected) to survive in places where it couldn't before.

Now, let us do a thought experiment.

1. Consider a swimming pool filled with agar (food for bacteria).
2. Each lane of the swimming pool has agar with different percentages of antibiotic (greater the quantity, more dangerous it is) as shown in the diagram.
3. More antibiotic does not mean less agar.
4. Bacteria can move from one lane to another as there is no physical boundary
5. In each lane, you put bacteria from the same culture. This means that they are all considered identical. However the only difference is that they are all differently coloured.
6. Dead bacteria can be considered to vanish (for the sake of the experiment)



For all this hard work, you give yourself a well earned vacation for a couple of weeks. What would happen in your swimming pool over time, as the bacteria try to grow? Imagine and simulate this experiment in your mind and describe what the outcome will be.

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Answer for Question 8

For this question, don’t worry if your answer isn’t the same as what’s below. What is super important is that you learnt how to do thought experiments.

Reasoning:
The red and green bacteria die out because they cannot survive in strong antibiotic conditions. The chance of one of them evolving to get adapted to the antibiotic is not likely as they are killed before getting the chance to adjust to the new environment and evolve.

The blue bacteria thrives as there is no antibiotic in its lane and covers it up entirely. Once it’s full covered, they have used up all the agar and so they start to die out. However some of the bacteria on the boundary between 0% and 15%, spontaneously evolve to gain some resistance towards the antibiotic and extend and start growing into the 15% lane. This can happen at many points along the boundary as this bacteria which were thriving in their 0% lane and so very at peak fitness. Now these bacteria slowly cover the 15% lane (which you can say becomes its new 0%) and this repeats until the blue colony takes over the entire swimming pool.

This is the basis of how natural selection (evolution) works

Q9

A sequence alignment is basically the process of matching two sequences of DNA/RNA/Protein in order to identify how similar they are to each other.

> When an organism's genome is sequenced for the first time, distinguishing features are identified in the genomes (ex: genes) by comparing it to the known genome of a closely related organism.
> Sequence alignment also tells us how a genome changes over time.

When aligning genomes, an alignment score is generated. Higher the score, better the alignment. Use this link to understand how to align sequences.

1. What is the best way to align the following new sequence against the reference?
2. What does the XYZ Gene look like in Sequence A?

Reference Sequence: ACTCTTTCGTTCCTTAAGCGAACCACTCTAGCTTAAAAAGG
Gene slop3: GAACCACTCTAGCTTA

New Sequence: ACTCGTTCGCTTAAGCAGAAAGGACCTAGCTTCCCAAGG
Gene slop3: ??

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Answer for Question 9

Best alignment:
New: ACTCGTTCG---CTTAAGCAGAAAGGAC-CTAGCTTCCCAAGG
Ref: ACTCTTTCGTTCCTTAAGC--GAACCACTCTAGCTTAAAAAGG

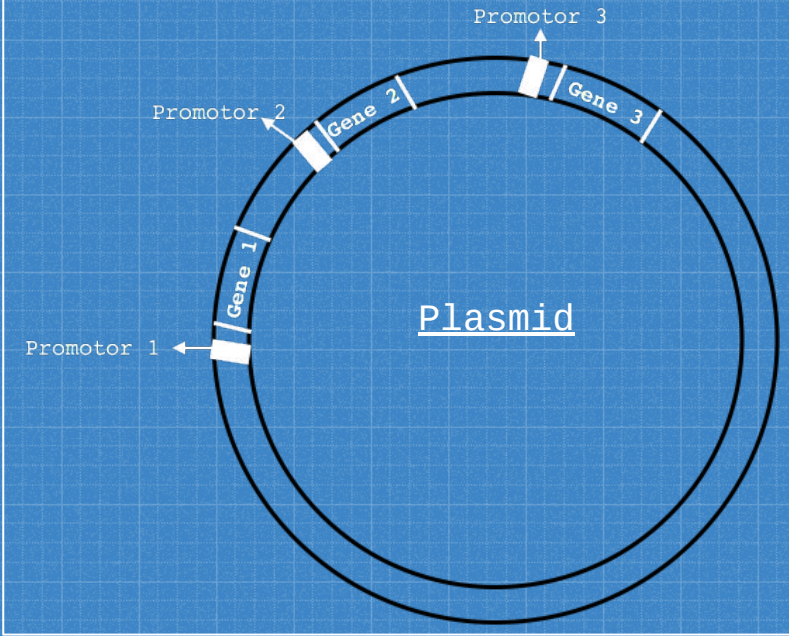
Has a score of: +15
+1+1+1+1-1+1+1+1+1-1-1-1+1+1+1+1+1+1+1-1-1-1+1+1-1-1+1+1-1+1+1+1+1+1+1+1-1-1-1+1+1+1+1

Gene slop3:
New: AAAGGACCTAGCTTC
Ref: GAACCACTCTAGCTTA

Q10

A bacteria can be reprogrammed to help you do what you want it to do by giving it some extra instructions. These are given in the form of genes inserted in a plasmid (plasmid:bacteria::cd:computer). One plasmid can have many different genes.

Using the various genes given in the wordpress link below, construct a bacteria that can solve a problem that is affecting our world.
Ex: plastic eating bacteria to clean up our oceans, making bacteria produce biodegradable silk, etc.



Give us the problem that you want to solve and how your bacteria with its new plasmid, will help solve the problem.

The only thing stopping you is your creativity.

Help 1 ; Help 2

Answer for Question 10

If you have submitted your answer, I have replied personally to it.

There is no right or wrong answer. You just flexed your creative muscle and so very well done for trying to solve a real world problem. This is a very important skill to have, not just to be a scientist.

I’m sure you will come up with something clever to help out society. That is what synthetic biology is really about.

Thank you for participating, we hope you had a good time!
Results will be communicated shortly……