99¢

99¢
12.49

AMPABEE
Tec-Chihuahua
Mexico

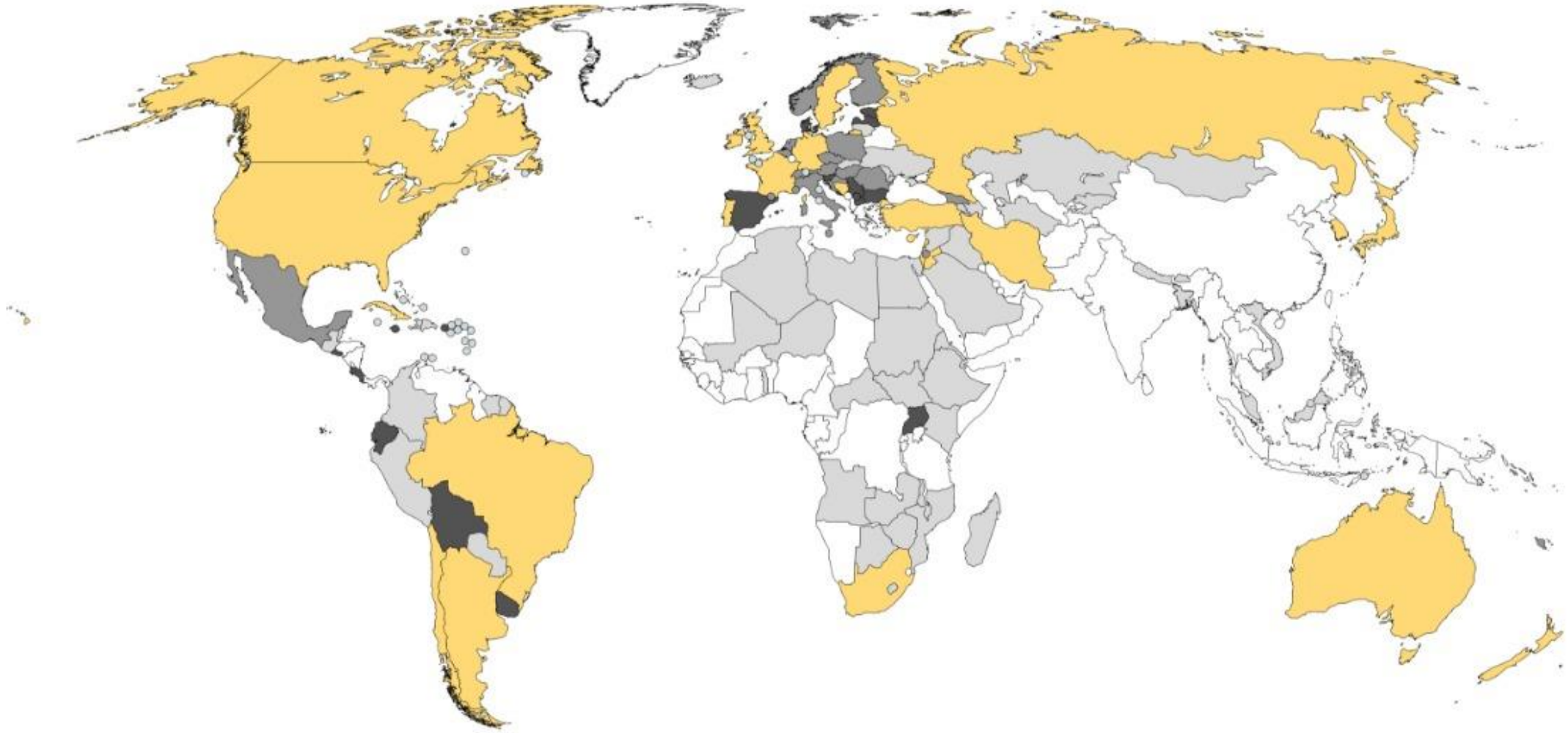
US $577 BILLION

87% OF FOOD

$2.3 BILLION
DOLLARS

-30%

COLONY COLLAPSE DISORDER



BOTH

AMERICAN FOULBROOD

EUROPEAN FOULBROOD

NO INFECTION REGISTERED

NO DATA

AFB

AMERICAN FOULBROOD

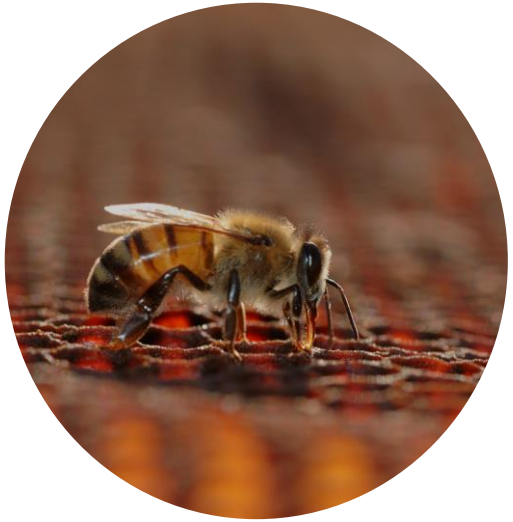
Paenibacillus larvae

HEALTHY LARVAE

EFB

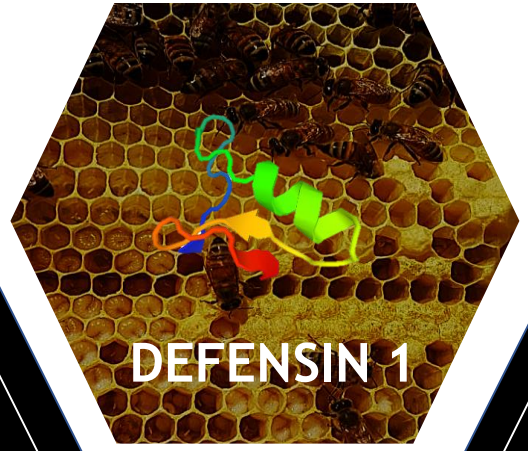
EUROPEAN FOULBROOD

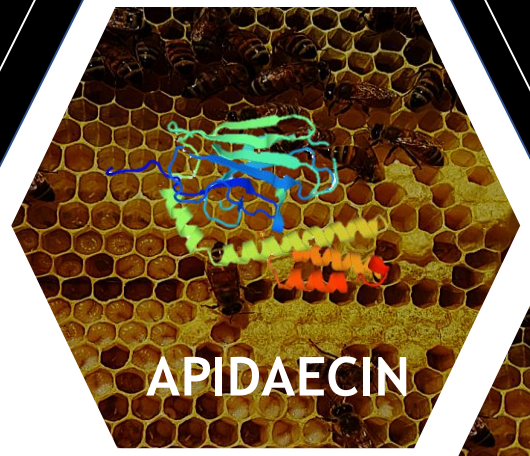
Melissococcus plutonius



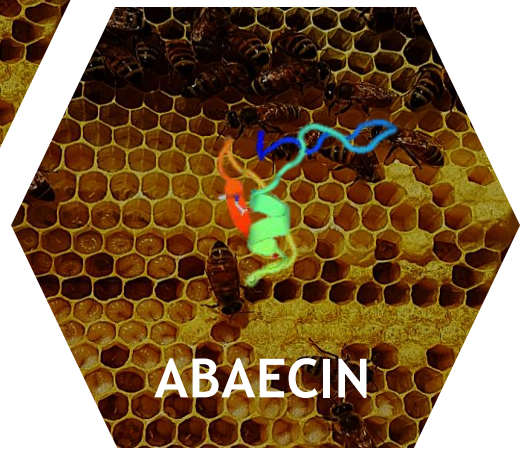
ANTIMICROBIAL PEPTIDES MECHANISMS OF ACTION

Humoral Immunity



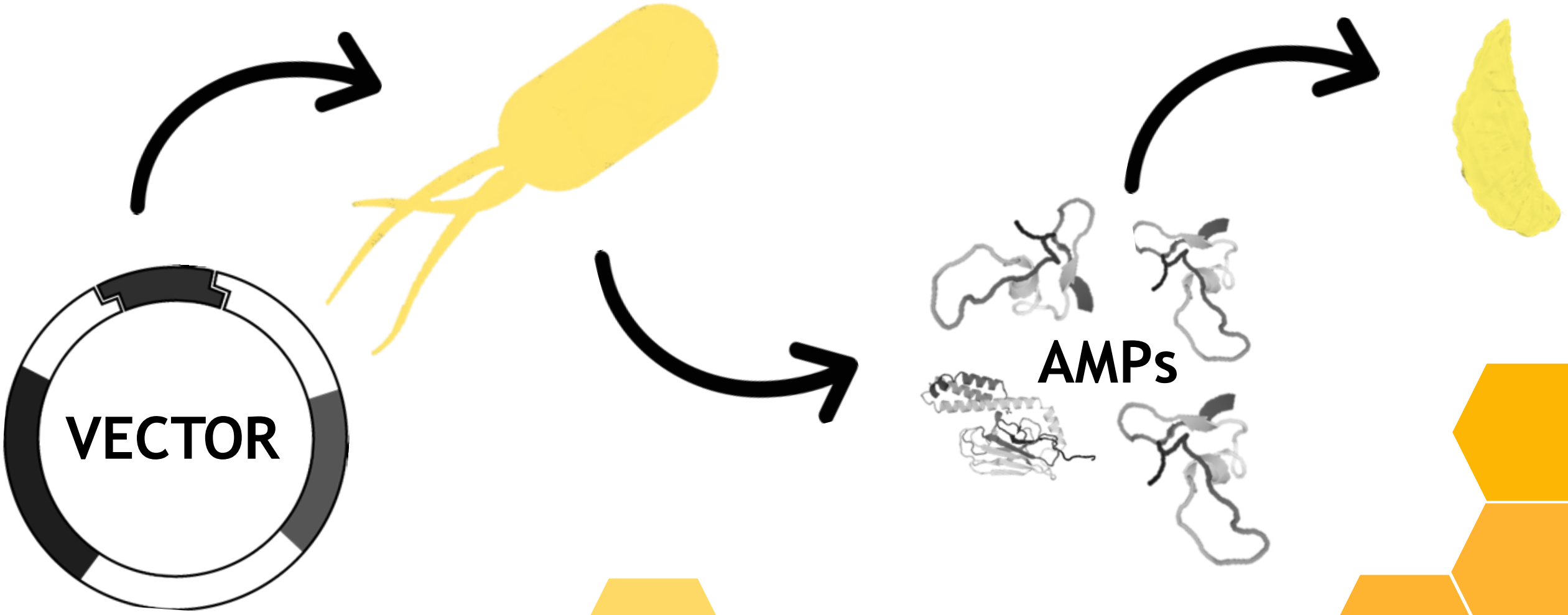


Inhibition of protein synthesis

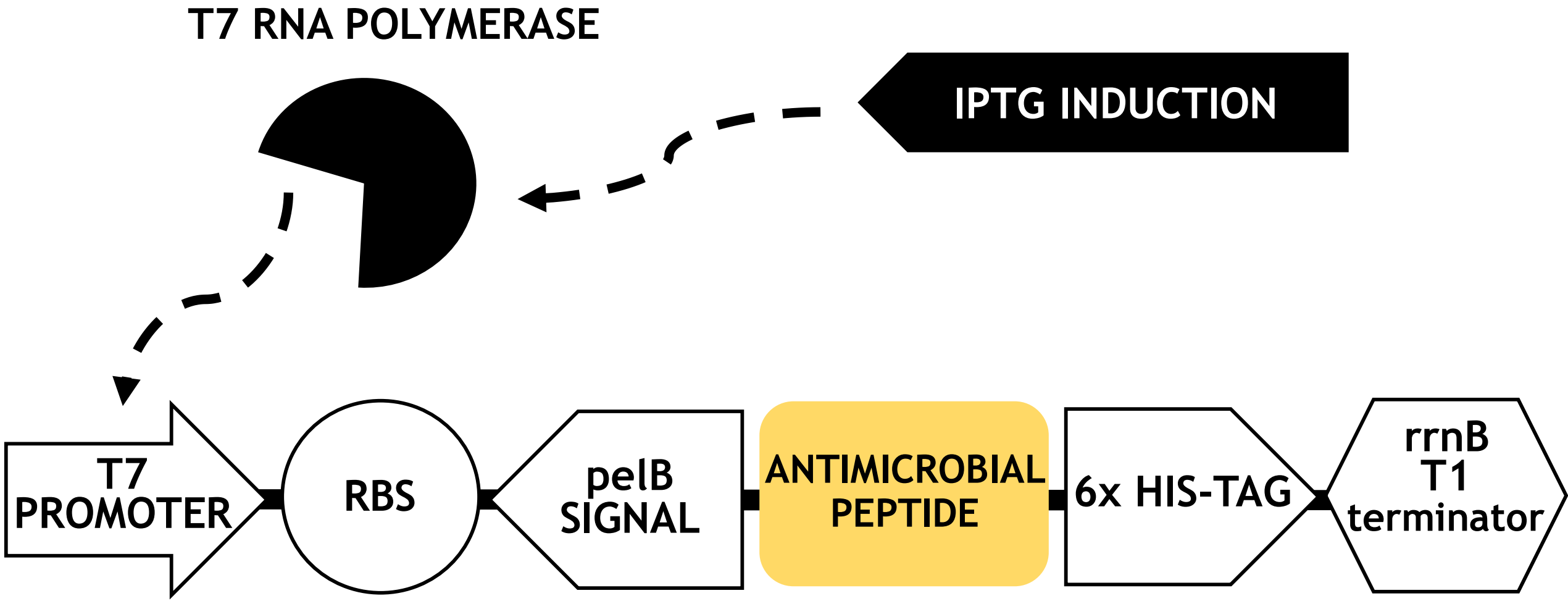


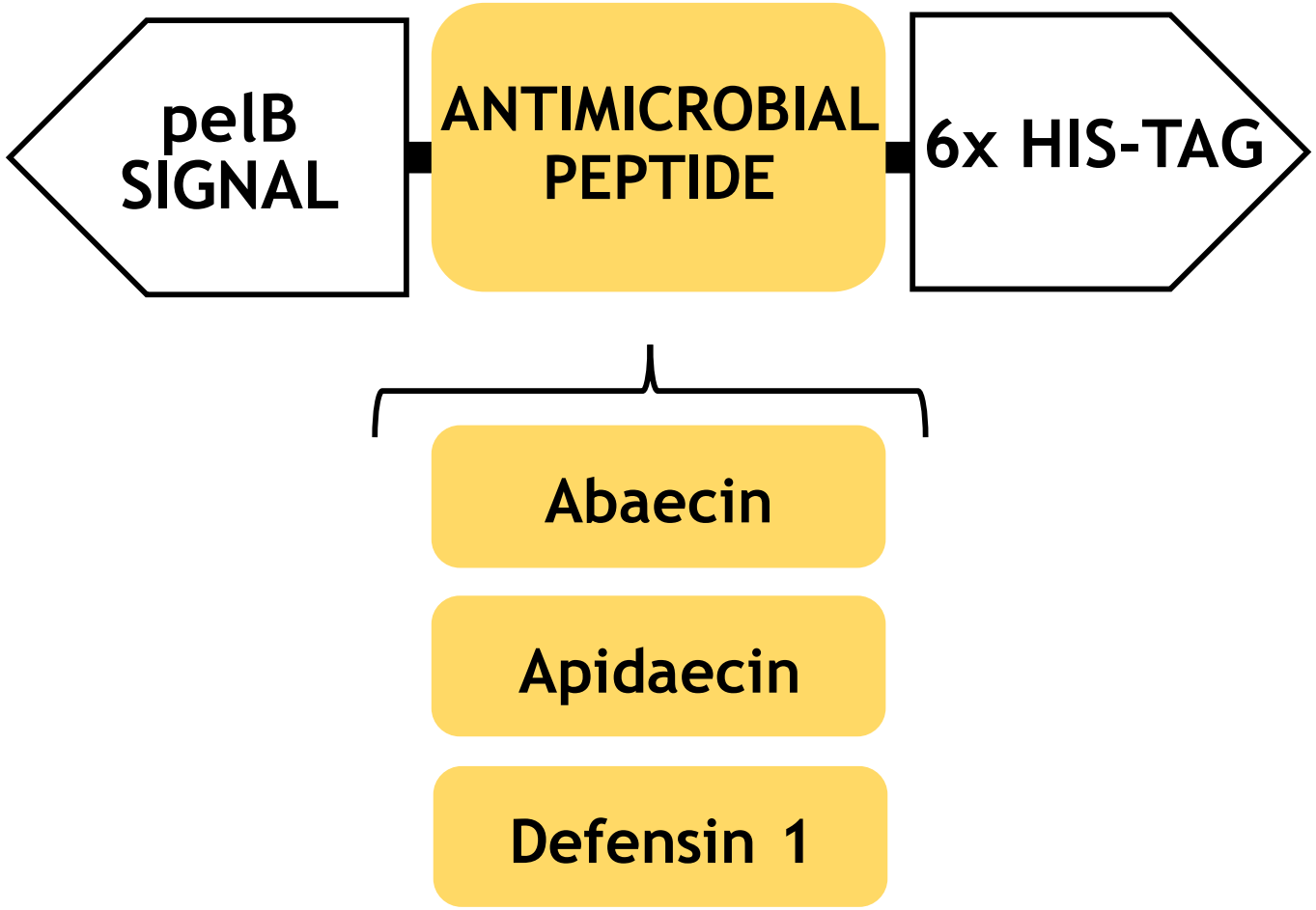
Pore-forming activity

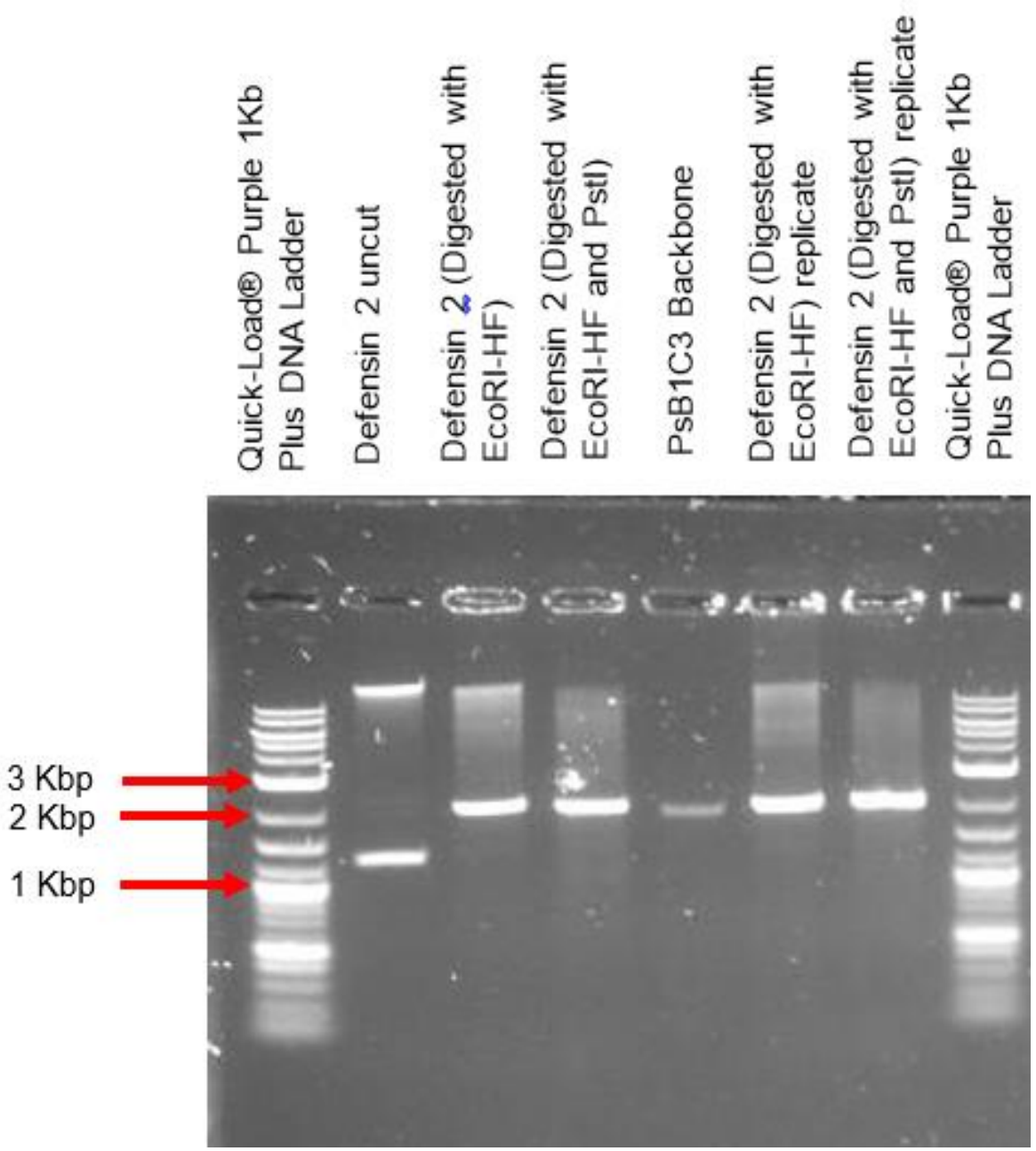
E. coli BL21 (DE3)

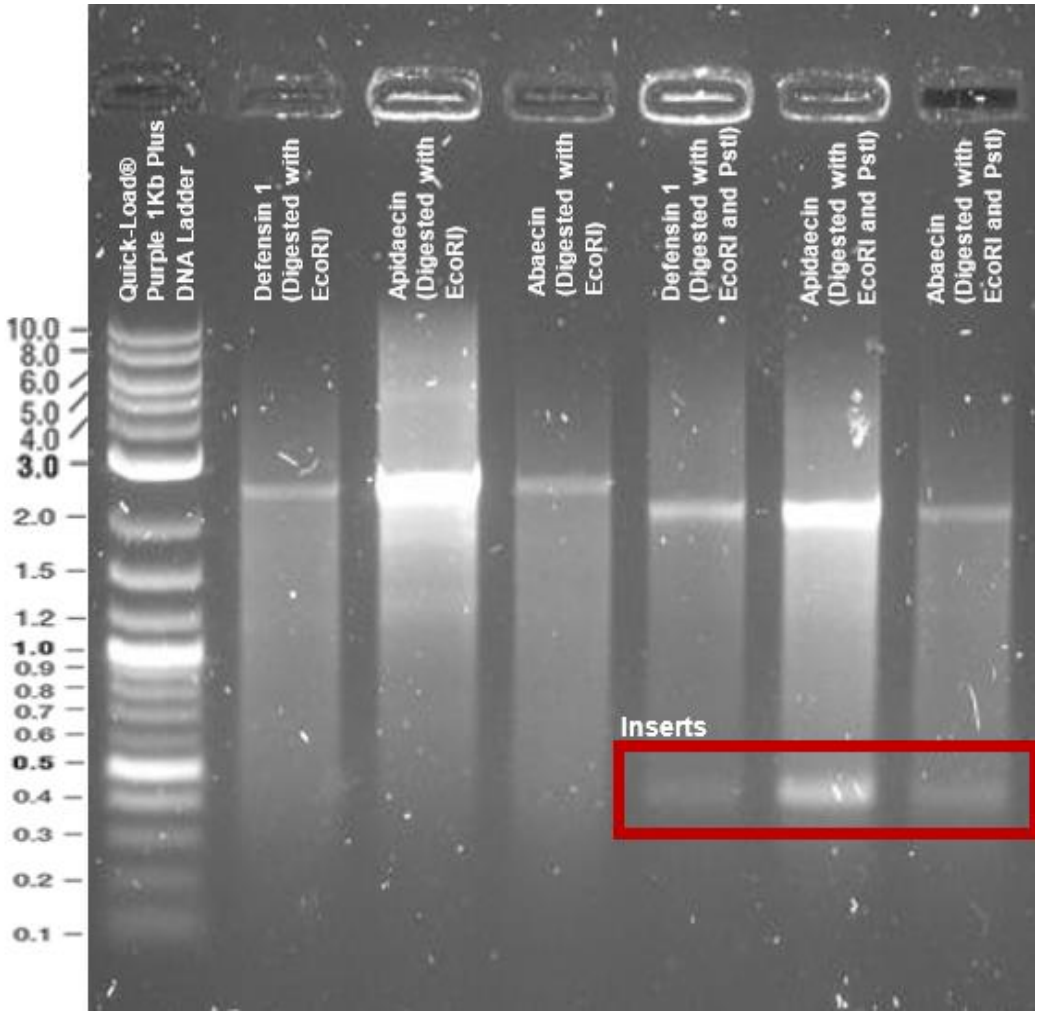


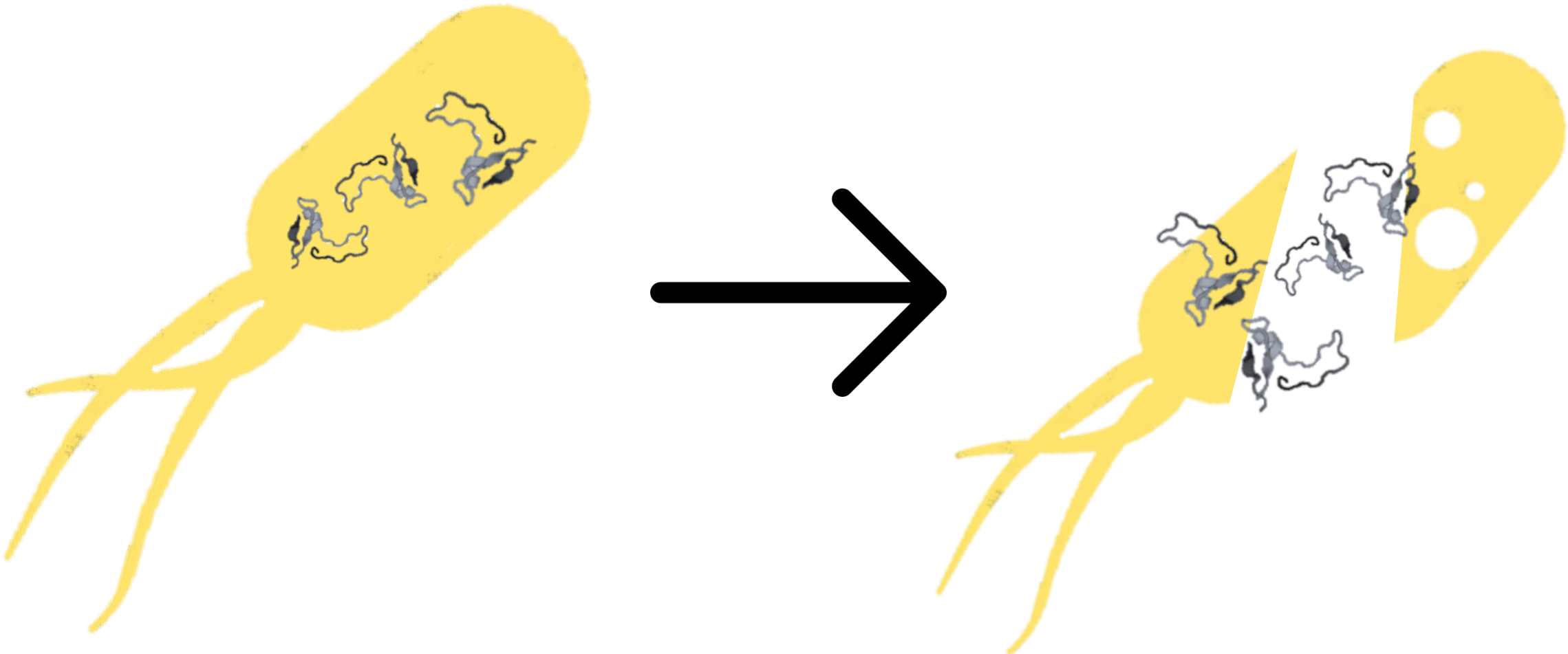
GENETIC DESIGN


T7 RNA POLYMERASE
IPTG INDUCTION
T7
PROMOTER
RBS
pelB
SIGNAL
ANTIMICROBIAL
PEPTIDE
6x HIS-TAG
rrnB
T1
terminator

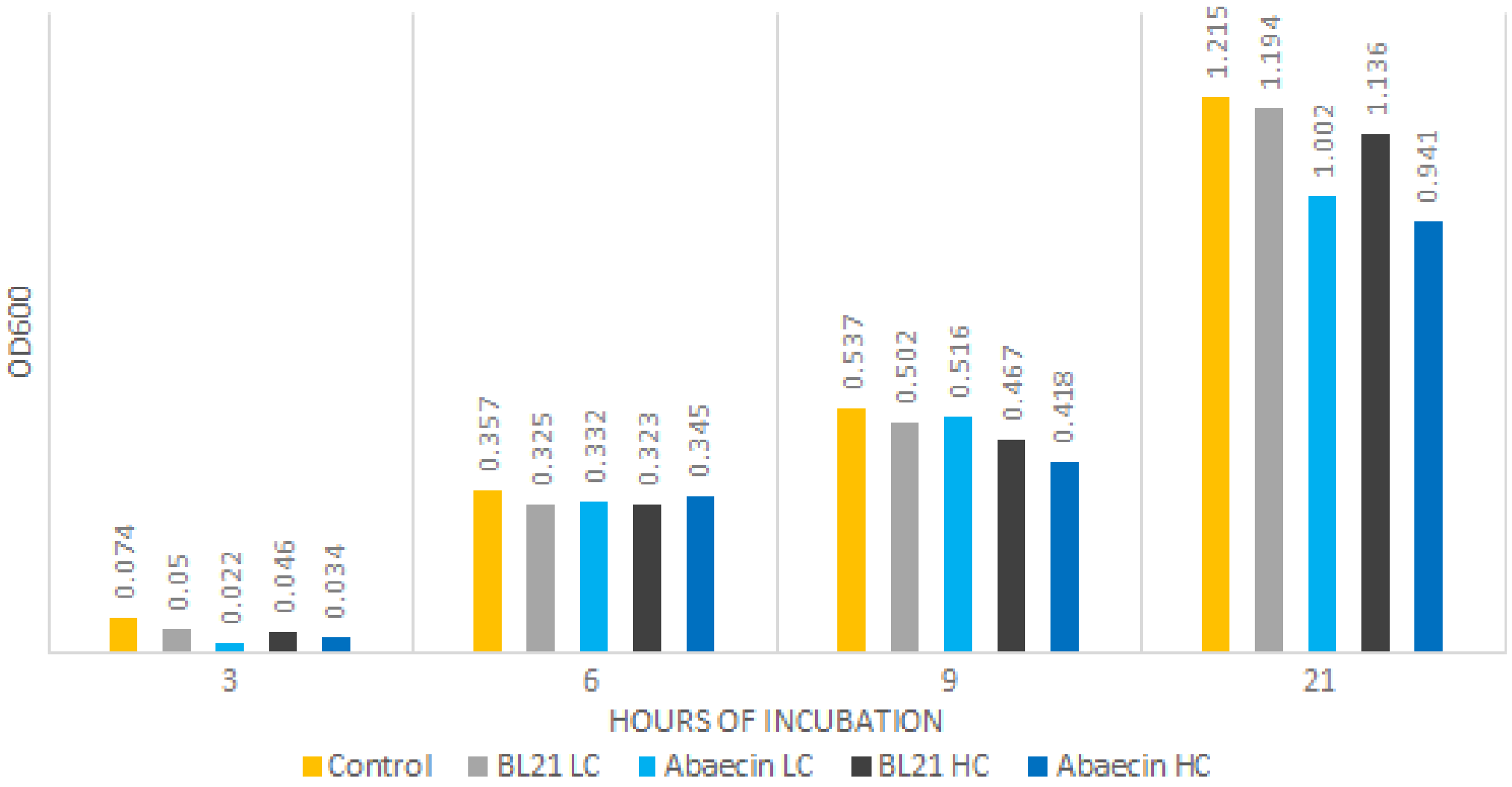

pelB SIGNAL
ANTIMICROBIAL PEPTIDE
6x HIS-TAG
Abaecin
Apidaecin
Defensin 1


Quick-Load® Purple 1Kb Plus DNA Ladder
Defensin 2 uncut
Defensin 2 (Digested with EcoRI-HF)
Defensin 2 (Digested with EcoRI-HF and PstI)
PsB1C3 Backbone
Defensin 2 (Digested with EcoRI-HF) replicate
Defensin 2 (Digested with EcoRI-HF and PstI) replicate
Quick-Load® Purple 1Kb Plus DNA Ladder
3 Kbp
2 Kbp
1 Kbp


Quick-Load® Purple 1Kb Plus DNA Ladder
Defensin 1 (Digested with EcoRI)
Apidaecin (Digested with EcoRI)
Abaecin (Digested with EcoRI)
Defensin 1 (Digested with EcoRI and PstI)
Apidaecin (Digested with EcoRI and PstI)
Abaecin (Digested with EcoRI and PstI)
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.5
1.2
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Inserts



B. subtilis VS Abaecin



HUMAN PRACTICES

BEEKEEPERS

BEEKEEPING SOCIETIES

SPECIALIST AND INVESTIGATORS

GOVERNMENTAL ORGANIZATIONS

UN EVENTS

BEEKEEPING COMMUNITY

LACK OF RESEARCH

NO EFFECTIVE SOLUTIONS

SPECIALISTS AND INVESTIGATORS

REALISTIC DESIGN

GOVERMENT INSTITUTIONS

SAFE

RESPONSIBLE

UNITED NATIONS

INTERNATIONAL STANDARDS

SOCIAL
Sustainable Development
$ ECONOMIC
ENVIRONMENTAL

LEGAL PLAN

CRAFTING
PACKAGING
DISTRIBUTION
PRODUCT DEVELOPMENT
USE CONDITIONS
RISK ASSESSMENT
CONTINGENCY PLAN

ENVIRONMENTAL

Hive incineration avoidance

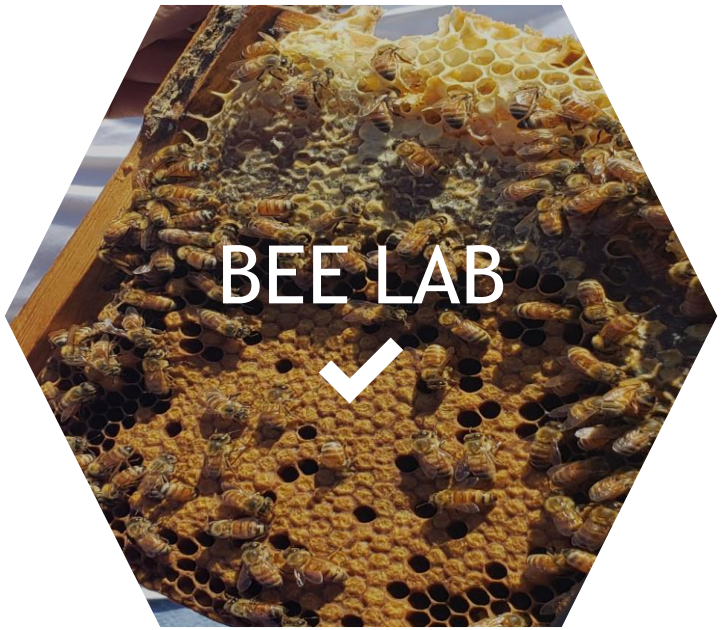
Possible environmental risks of our product

ECONOMIC

ENTREPRENEURSHIP

- Unique product
- Outcompetes current treatments
- Strengthens bees' immune system
- In accordance to international regulations
- Aimed at big scale *Apis mellifera lingustica* handlers

PHARMACEUTICAL COMPANY


BEE LAB

BEE HIVES FOR EXPERIMENTATION

APPLICATION METHOD

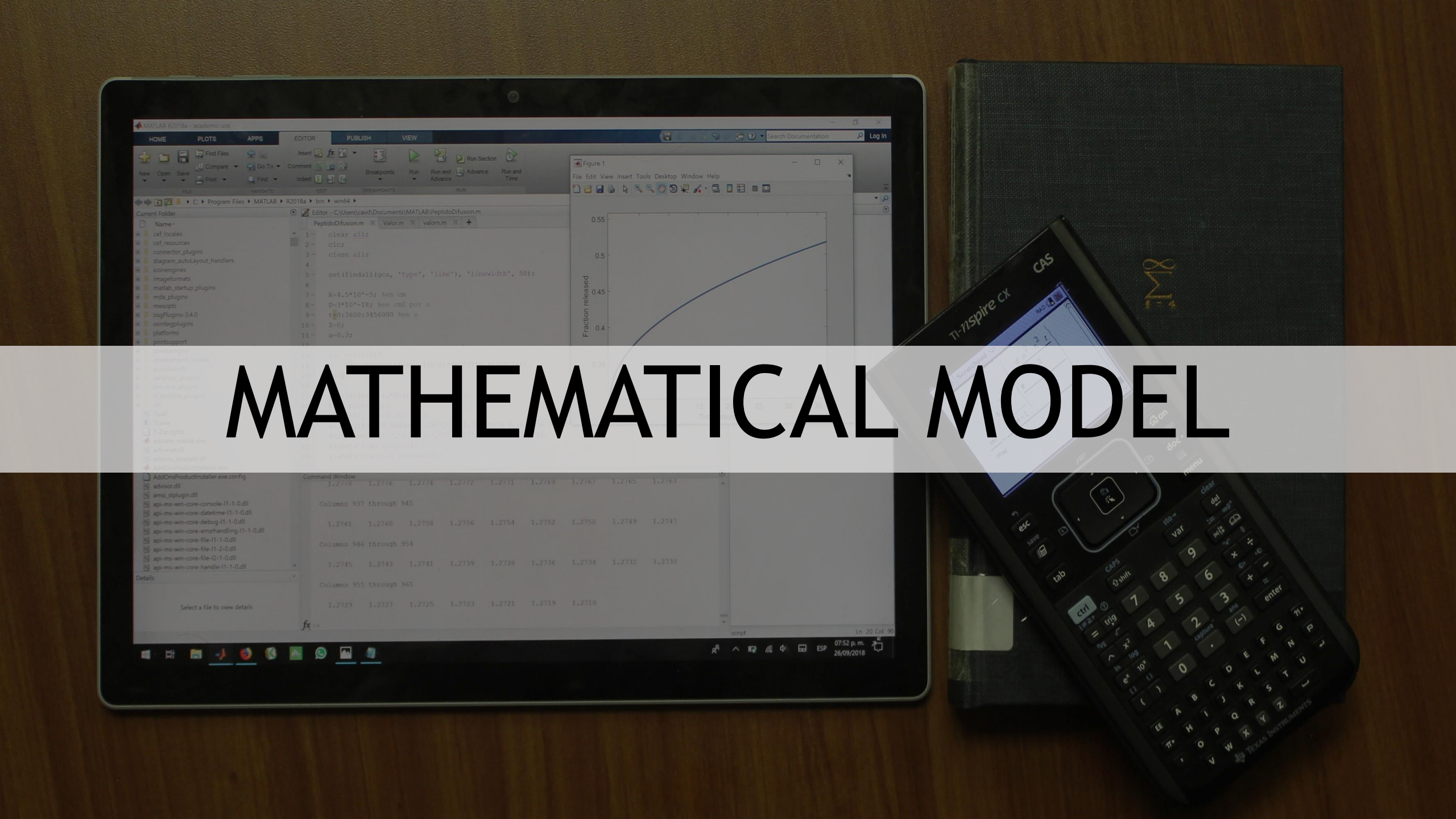
Application in bee bread

Meeting with Ing. Manuel Ramírez Salcido
May 26

Sprinkle product over the bee boxes

Video call with MVZ. Ernesto Tanús Sánchez
June 7

Application in the liquid food


MATHEMATICAL MODEL

Fickian diffusion equation

$$\frac{M_t}{M_\infty} = 1 - \frac{6}{\pi^2}\sum_{n=1}^{\infty}\frac{1}{n^2}\exp\left(-\frac{n^2\pi^2}{R^2}Dt\right) + \alpha$$

Dosage equations

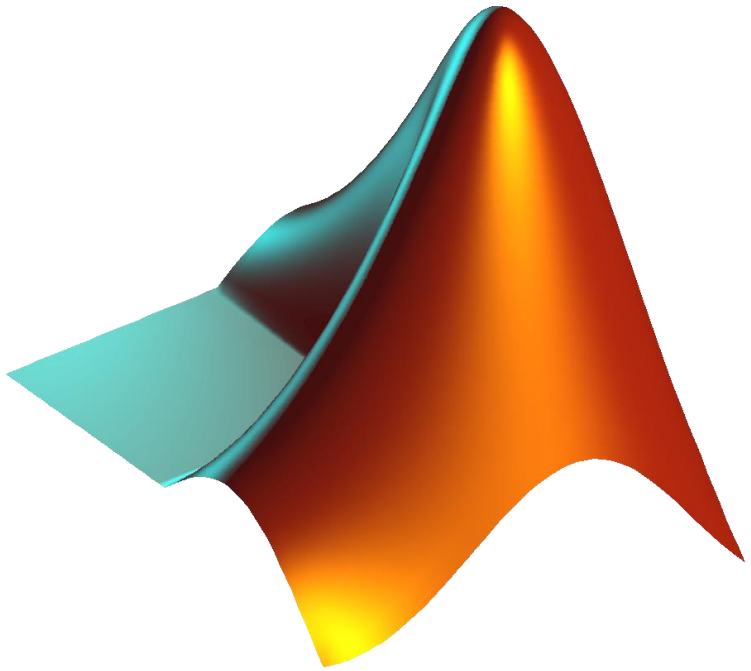
Within nurse bee

$$\delta_{0\to t_d} = \frac{6}{\pi^2}\sum_{n=1}^{\infty}\frac{1}{n^2}exp\left(-\frac{n^2\pi^2}{R^2}D_1 t\right) - \alpha$$

In royal jelly

$$\delta_{t_d\to\infty} = \delta_{t_d}\left[\frac{6}{\pi^2}\sum_{n=1}^{\infty}\frac{1}{n^2}exp\left(-\frac{n^2\pi^2}{R^2}D_2 t\right)\right]$$

Best fit diffusion calculator



Concentration measured **5 times**

Value at:

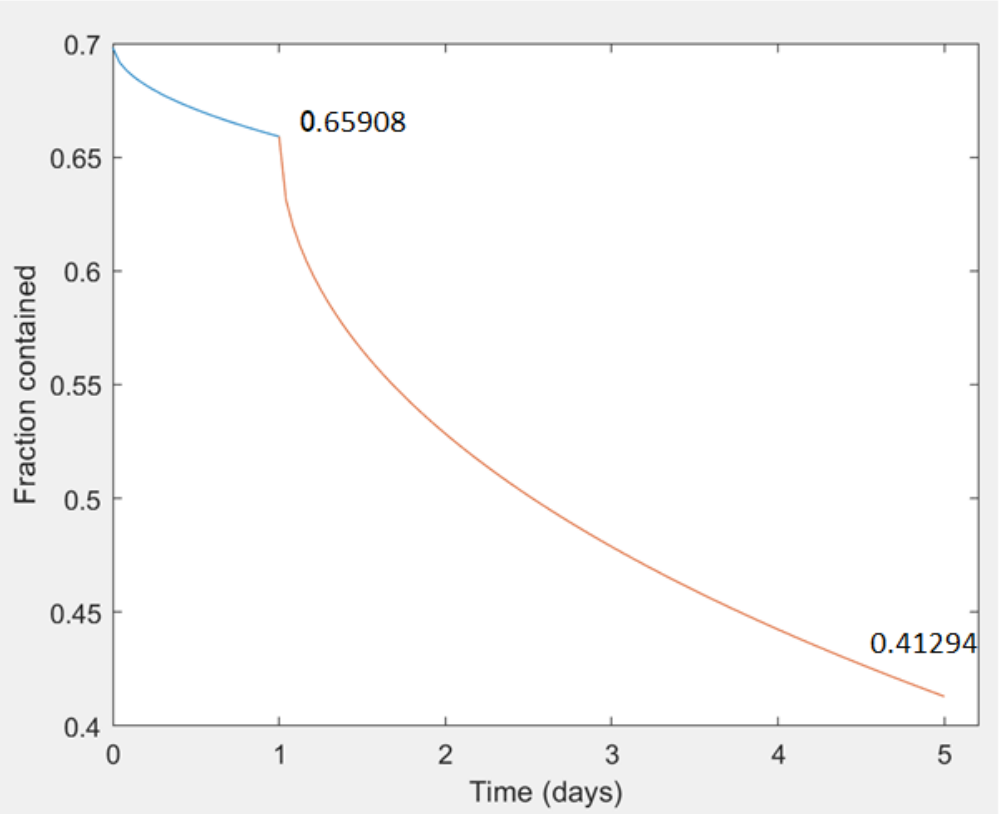
0 hours = 0.30
24 hours= 0.32
48 hours= 0.35
72 hours= 0.37
96 hours= 0.40

Diffusion coefficient that best explains this behaivour

3.5000e-18

Dosage loss simulator

```
What is the radius of nanoparticles? 4.5*10^-5
What is the diffusion coefficient inside honey bees? 3.5*10^-18
What is the diffusion coefficient in royal jelly? 9*10^-17
```



Effective release = 65.9% - 41.29% = 24.61%

Initial Concentration = Minimum Inhibitory Concentration / 0.24614

Abaecin's MIC for *P. larvae* is 200 µg/mL

200 / 0.24614 = Initial Concentration

<u>Initial concentration of 812.68 µg/mL</u>

PUBLIC ENGAGEMENT

BEE CULTURE

IV STATE'S BEEKEEPING FORUM

XXVI INTERNATIONAL APICOLA UPDATE CONGRESS

MEXMUN

ERA GUIDE FOR GMOs

YOUTH
BIOTECH
ESCO

CONCLUSION

- We produced honey bee AMPs in *E. coli*.
- We thoroughly assessed the social, environmental, and economical impact.
- We explored the factors needed to take up this business venture.
- We developed a model to simulate peptide diffusion.
- We established a back and forth exchange that continues to shape our project.
- We worked hand in hand with beekeepers, experts, and fellow iGEMers to achieve satisfactory results.

ATTRIBUTIONS

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M.S. Alejandro Romo Chacón

M.S. Adrián Ponce de León

MVZ. Ernesto Tanús Sánchez

Lic. Felipe Esquivel Díaz

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MVZ Adolfo Arroyo

Eng. José Luis González Miranda

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Ph.D. María Antonia Luna Velasco

M.S. Mario Loya Rivera

Eng. José Carlos Trejo Muñoz

Raime Bustos

Raúl Lizarrarás Durán

Luis Miguel Almanza Rueda

Our families and friends

Dr. Ernesto Guzmán Novoa

MVZ Juan Diego Pérez de la Rosa

FAI presidential staff member

Lorenzo Della Morte

Ph.D. David De Jong

Arturo Martínez

Kim Flottum

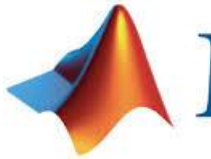
Elías Solís Rivera

DiagTech team

Mr. Bryan Saavedra

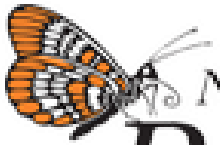
SPECIAL THANKS TO

Tecnológico de Monterrey



MathWorks®

ThermoFisher SCIENTIFIC



NEW ENGLAND BioLabs® Inc.

IDT INTEGRATED DNA TECHNOLOGIES

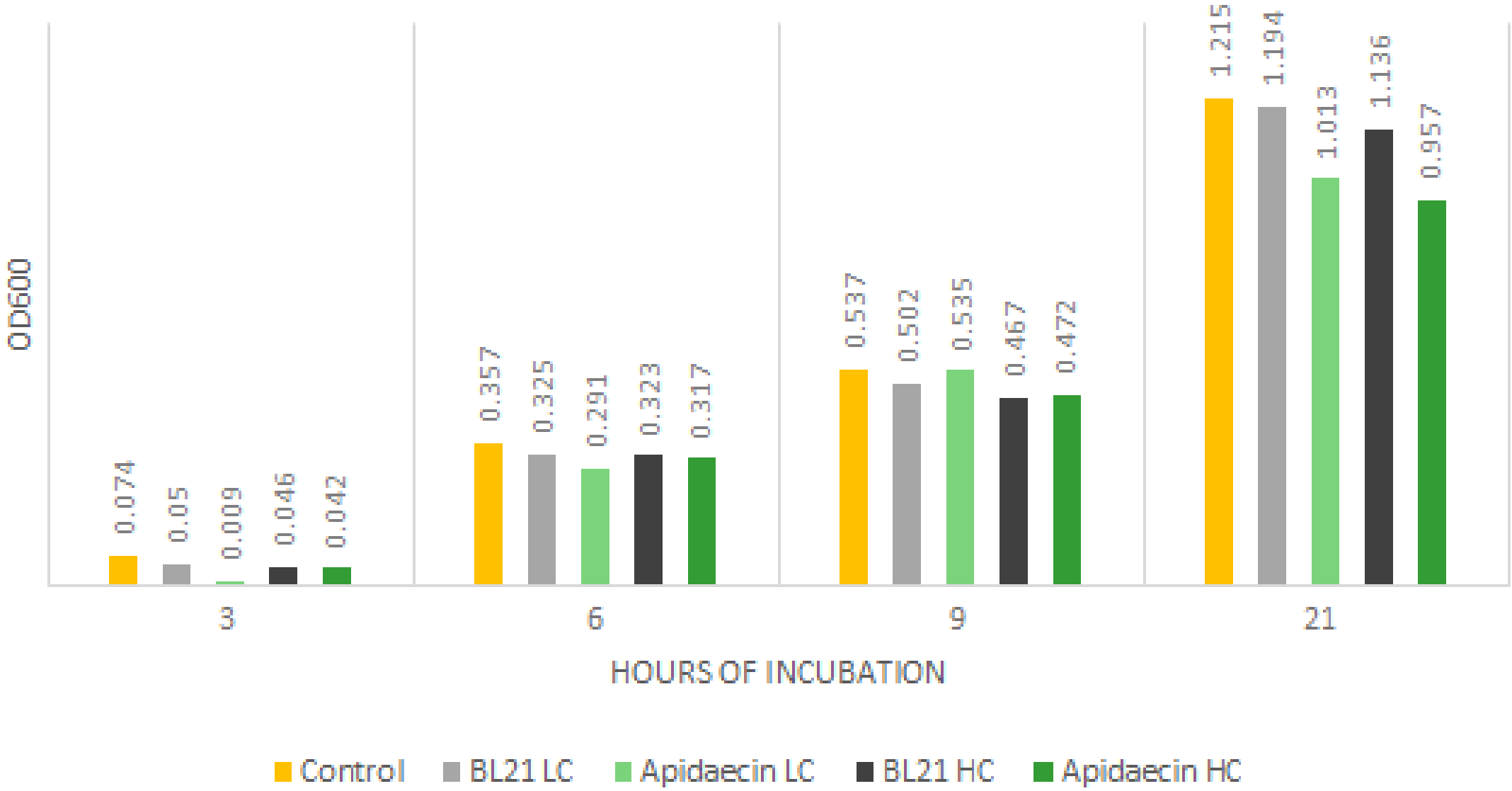
SnapGene®
Software for molecular biology

Química Tech S.A. de C.V.

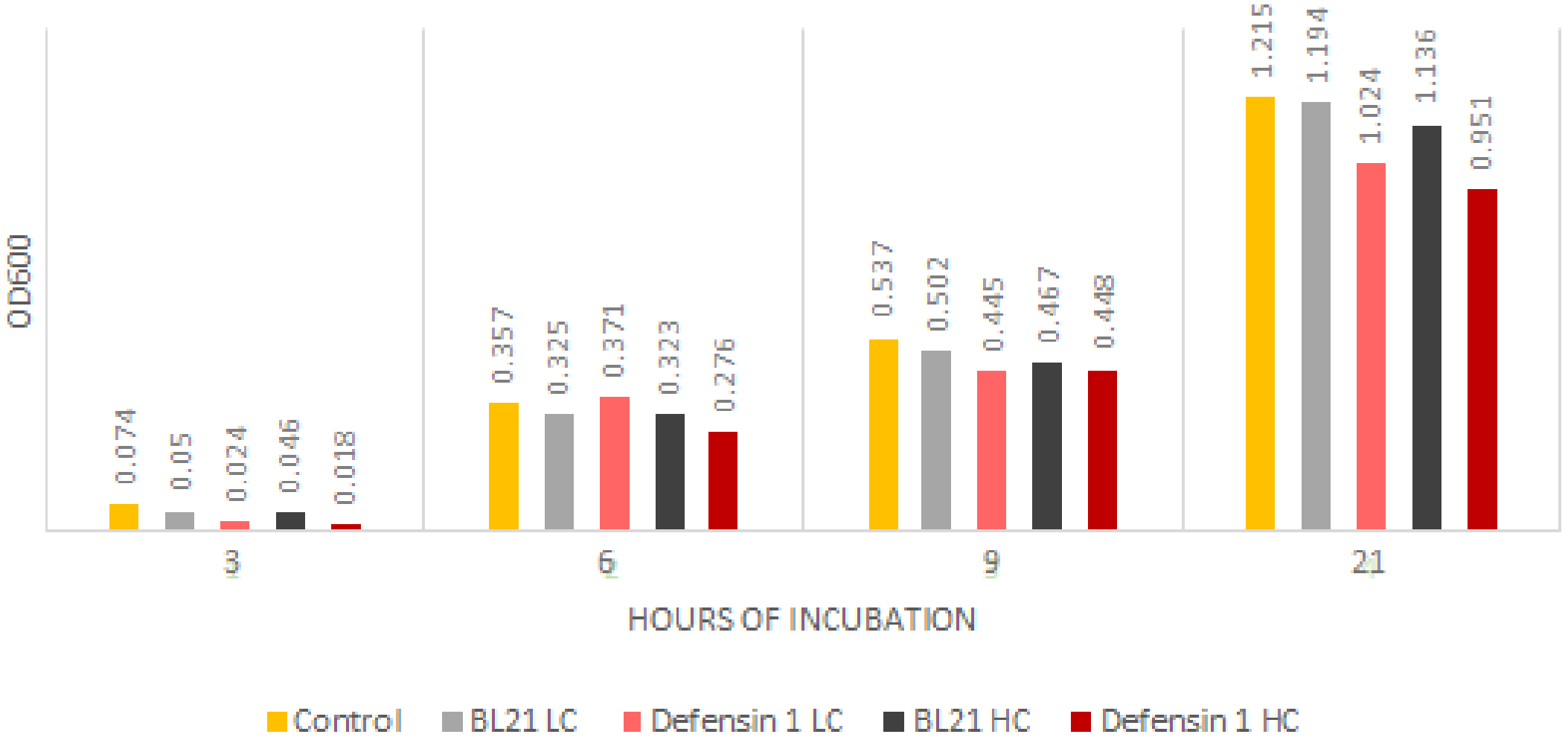
THANK YOU!

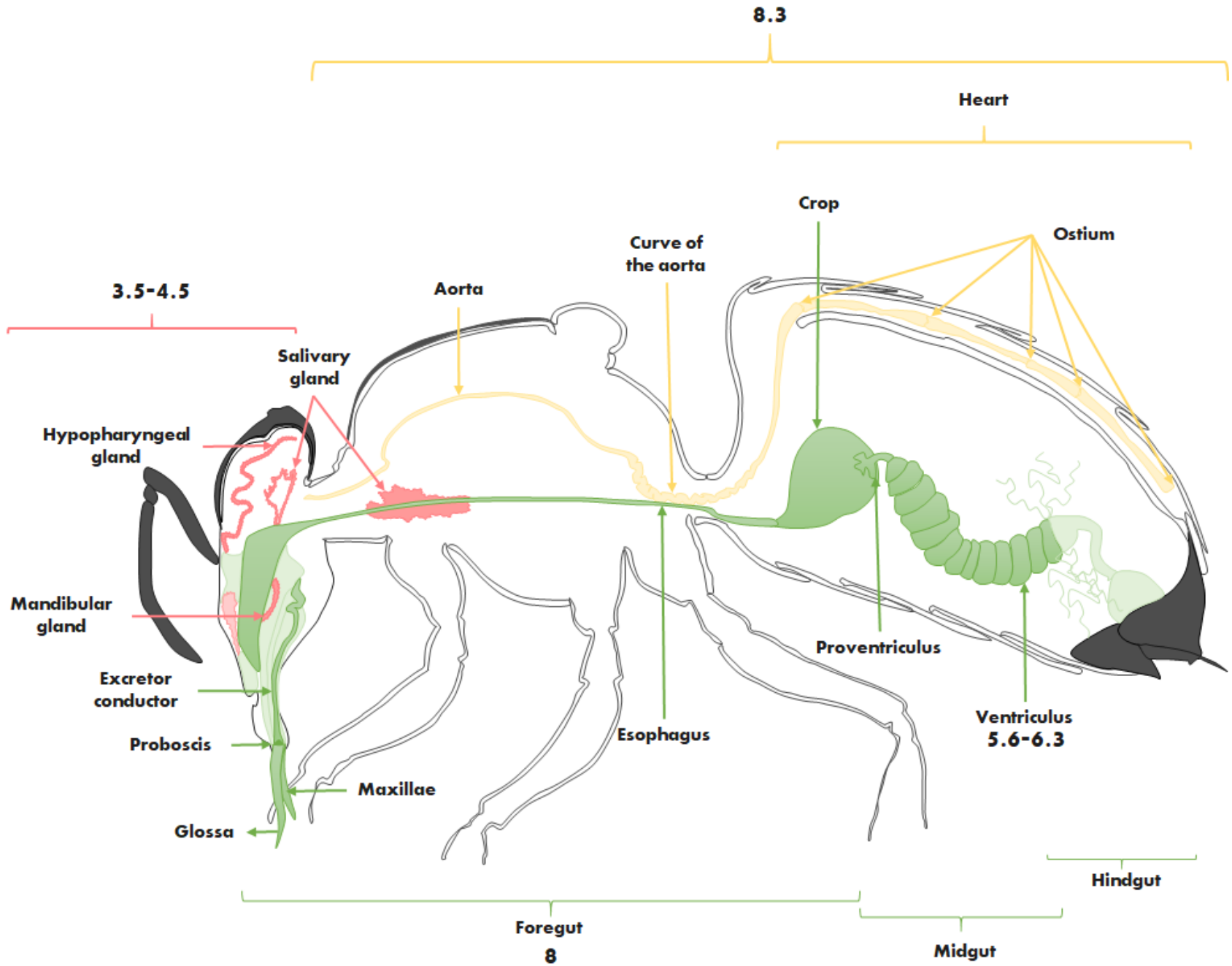
AMPABEE
Tec-Chihuahua
Mexico

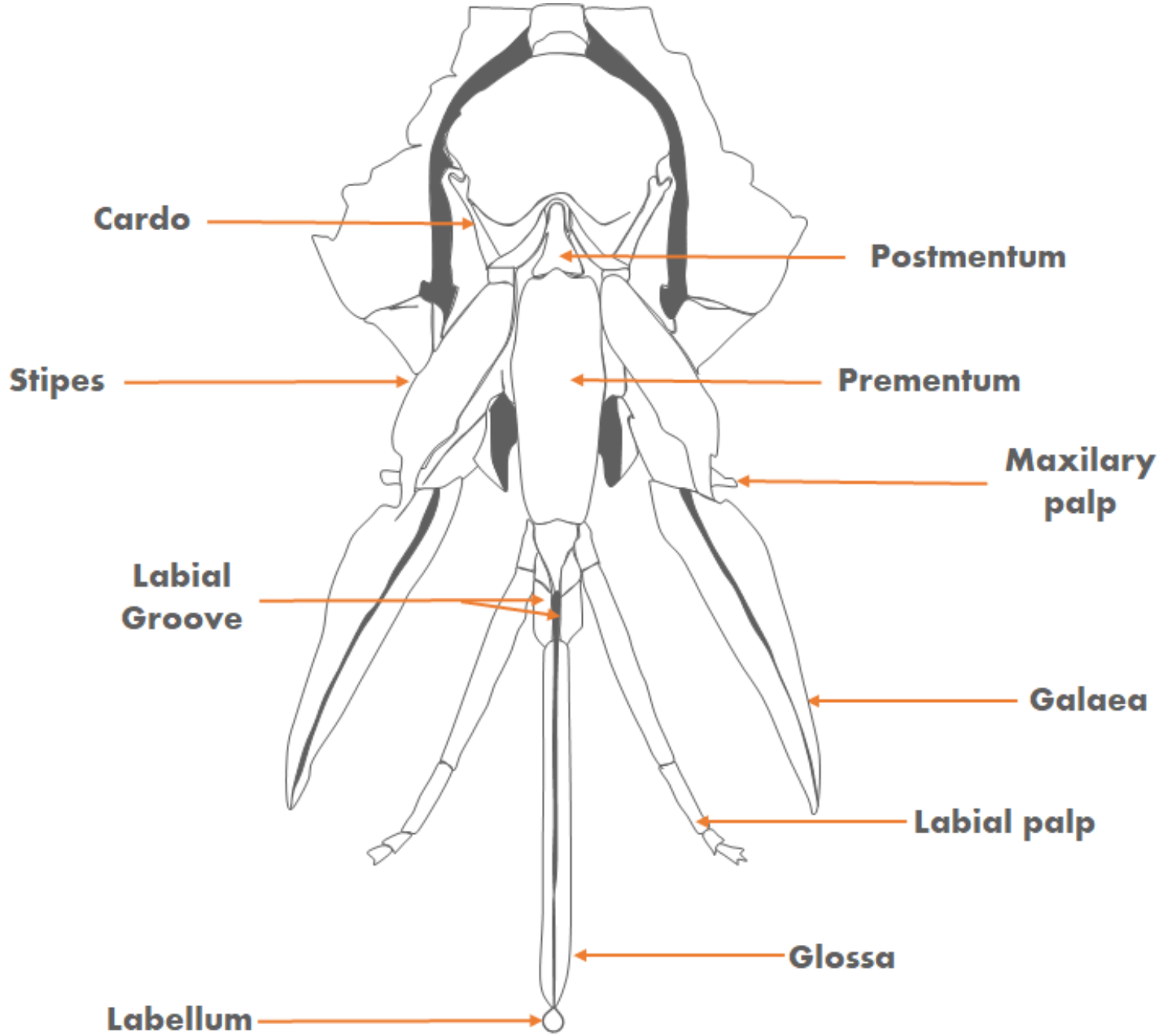
B. subtilis VS Apidaecin



B. subtilis vs Defensin 1




8.3
Heart
Crop
Ostium
Curve of
the aorta
3.5-4.5
Aorta
Salivary
gland
Hypopharyngeal
gland
Mandibular
gland
Excretor
conductor
Proboscis
Maxillae
Glossa
Esophagus
Proventriculus
Ventriculus
5.6-6.3
Hindgut
Foregut
8
Midgut


Cardo
Postmentum
Stipes
Prementum
Maxilary palp
Labial Groove
Galaea
Labial palp
Glossa
Labellum