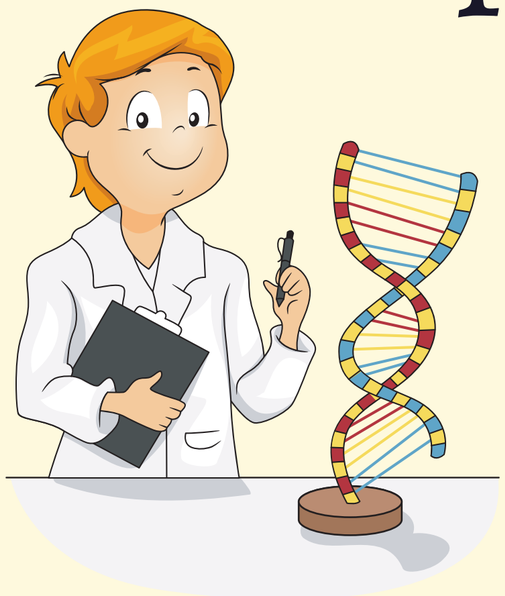
Basics of Genetic Engineering and Its Applications



Ananya Aravind

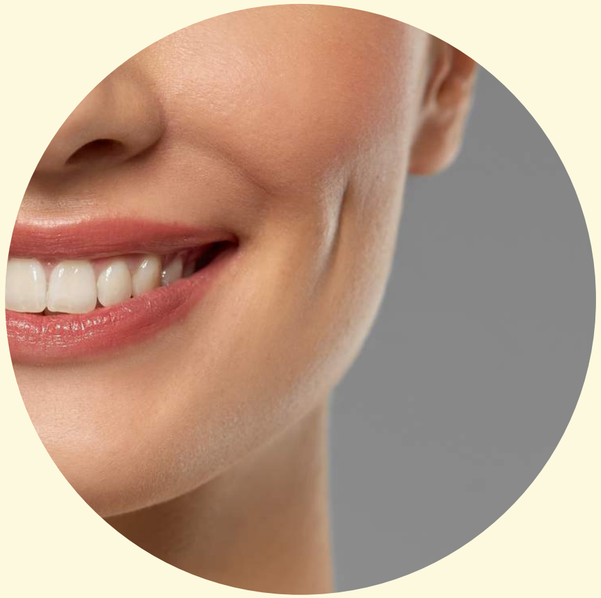
4th year, BSMS Biology major Student,
Indian institute of Science Education and Research
IISER, Thiruvanavthapuram
2017 Batch from Brindavan Vidhyalaya

HEREDITARY	GENETICS	GENE	CHROMOSOME
DNA	BASE	AMINO ACID	PROTIENS
ADENINE	THYMINE	GUANINE	CYTOSINE
MUTAIONS	GENETIC ENGINEERING	SYNTHETIC BIOLOGY	iGEM

HEREDITY

Heredity refers to the passing of traits or characteristics from one parent to the child

HEREDITORY TRAITS



DIMPLES

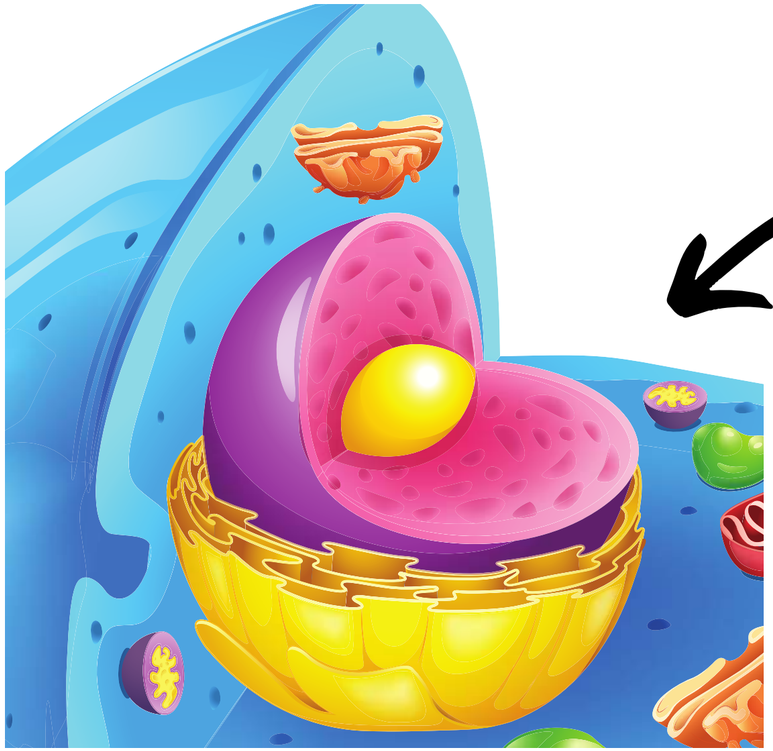
EYE COLOUR

HAND CLASPING

What causes traits to be passed on from parent to child

or

What is responsible for these differnt traits?

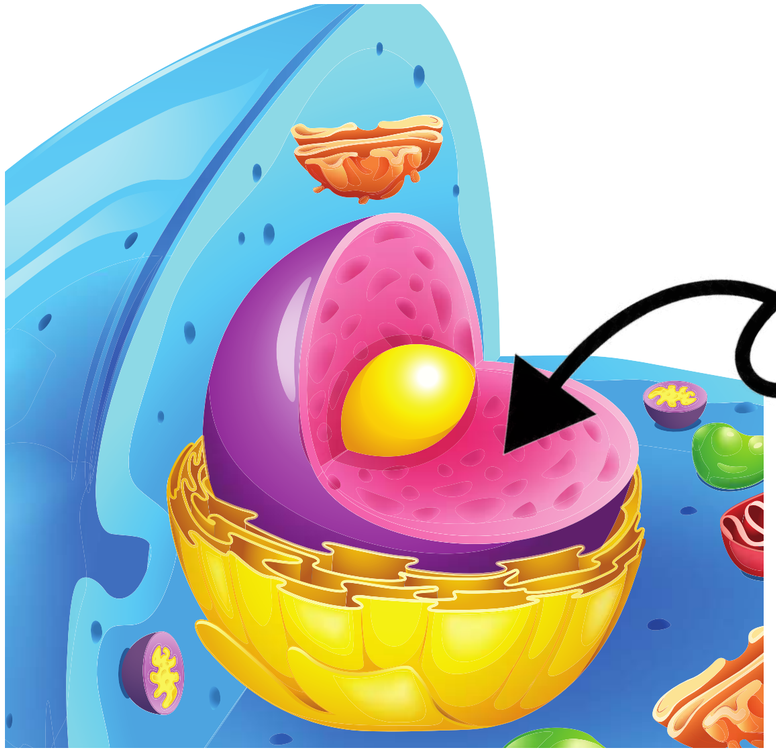


Nucleus

?

What is inside nucleus

=



Nucleus

?

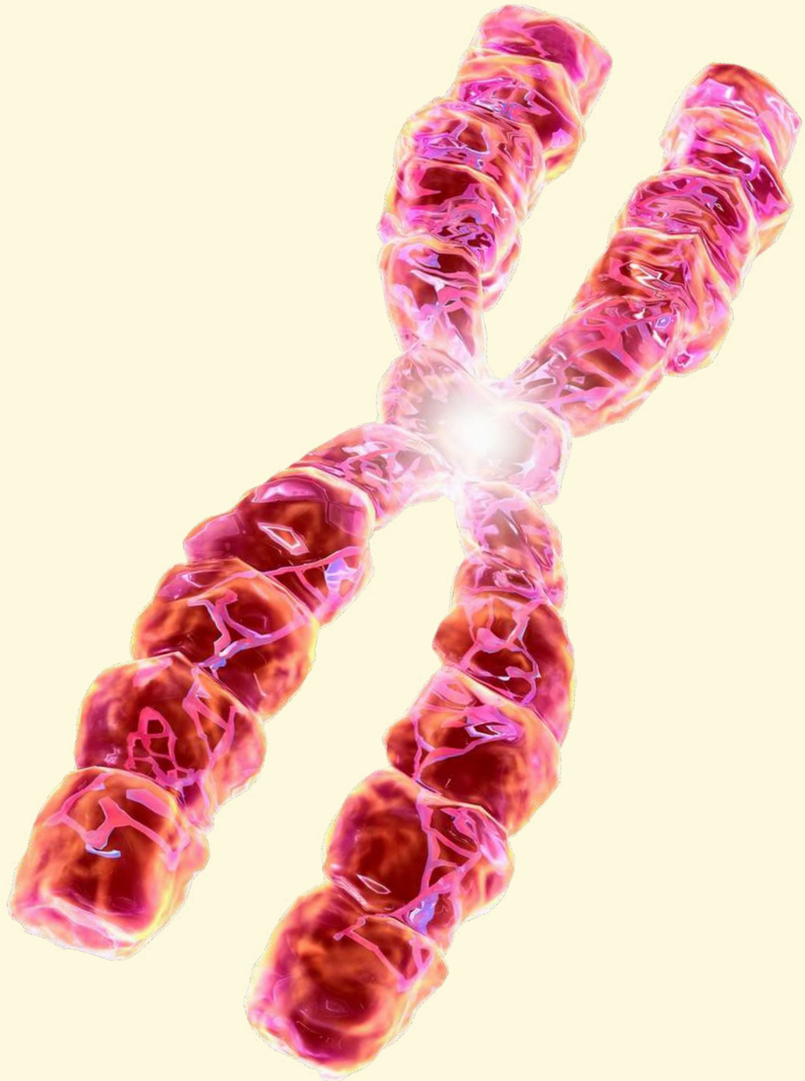
What is inside nucleus

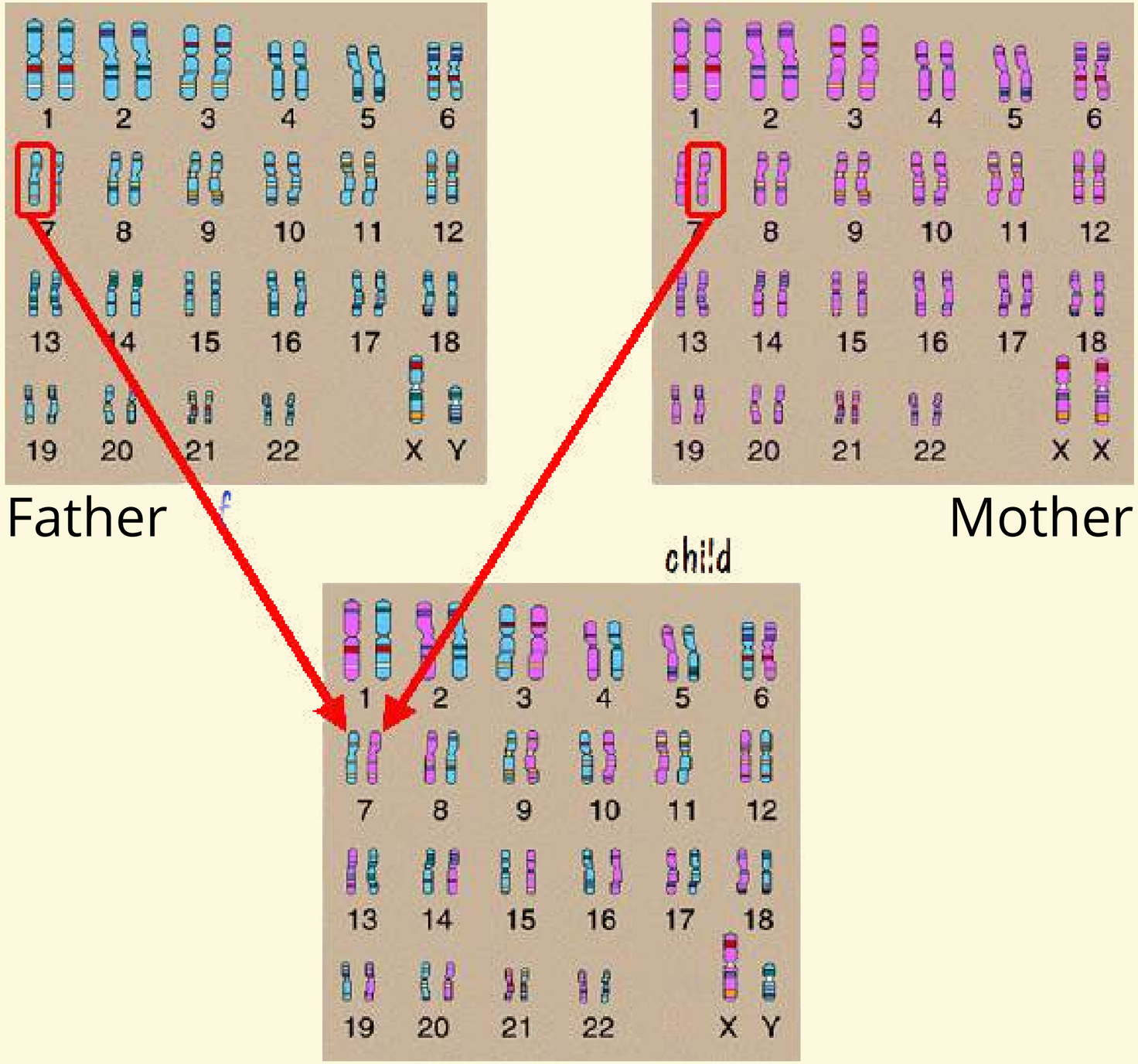
=

Chromosomes

Chromosomes

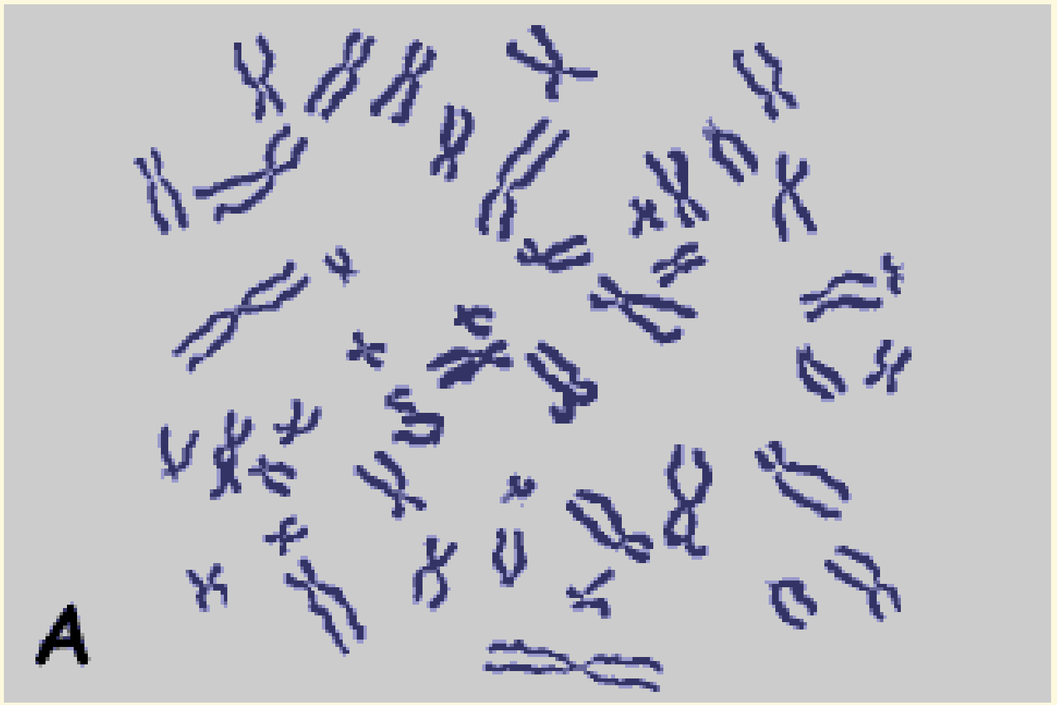
Chromosomes are thread-like structures present in the nucleus of a euKaryotic cell, which carries genetic information from one generation to another. They play a vital role in cell division, heredity, variation, mutation, repair and regeneration..




Father
Mother
child

Inside their nucleus, different organisms contain a different number of chromosomes.

Common onion has _____ pairs of relatively large chromosomes

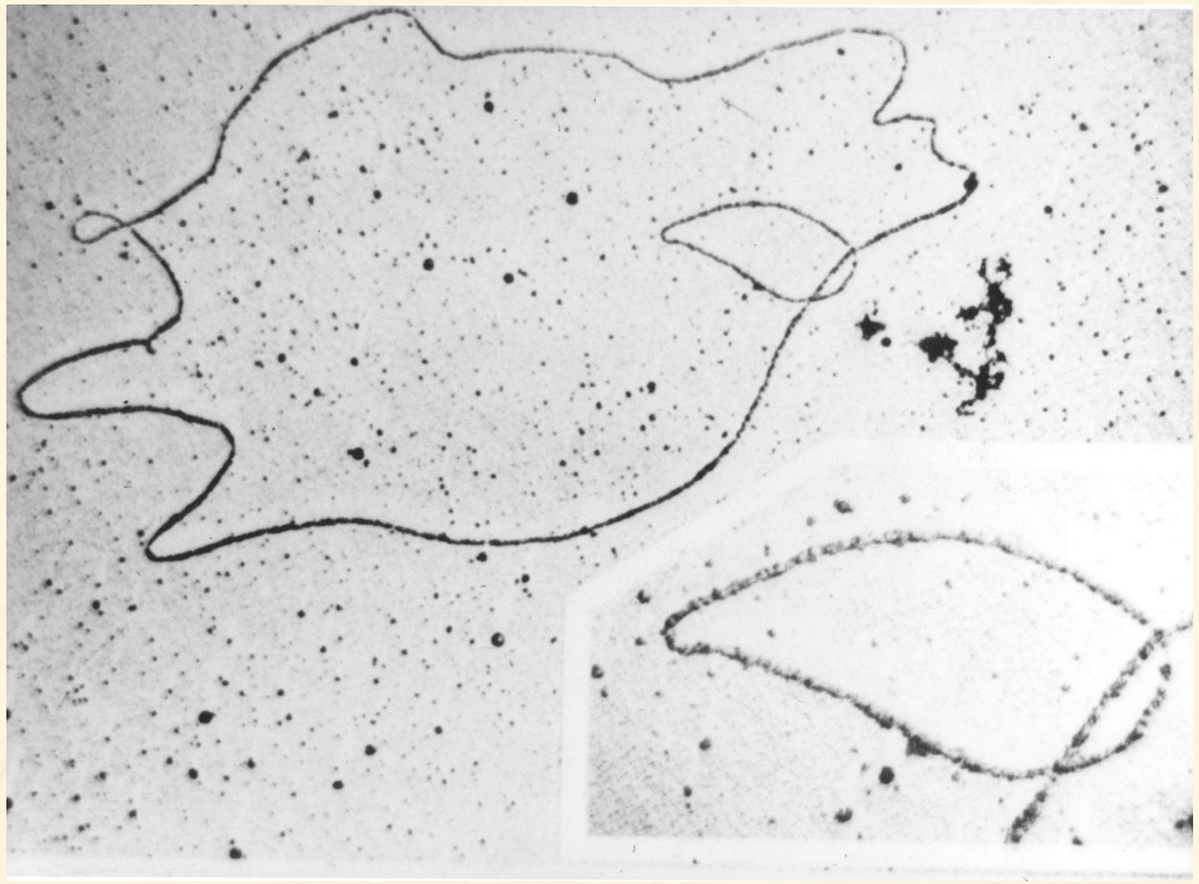


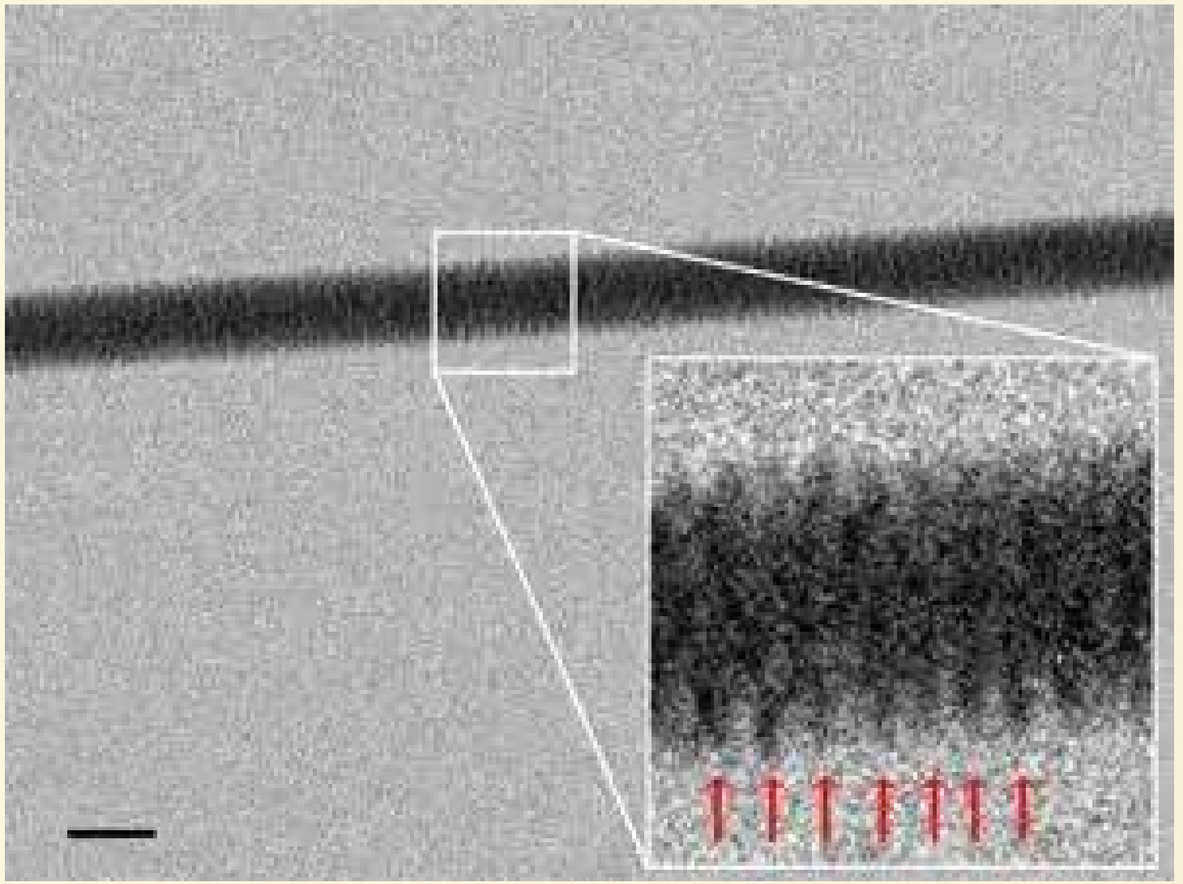
Can you count how many chromosomes we have?

Presence of more chromosome can cause grave consequences.

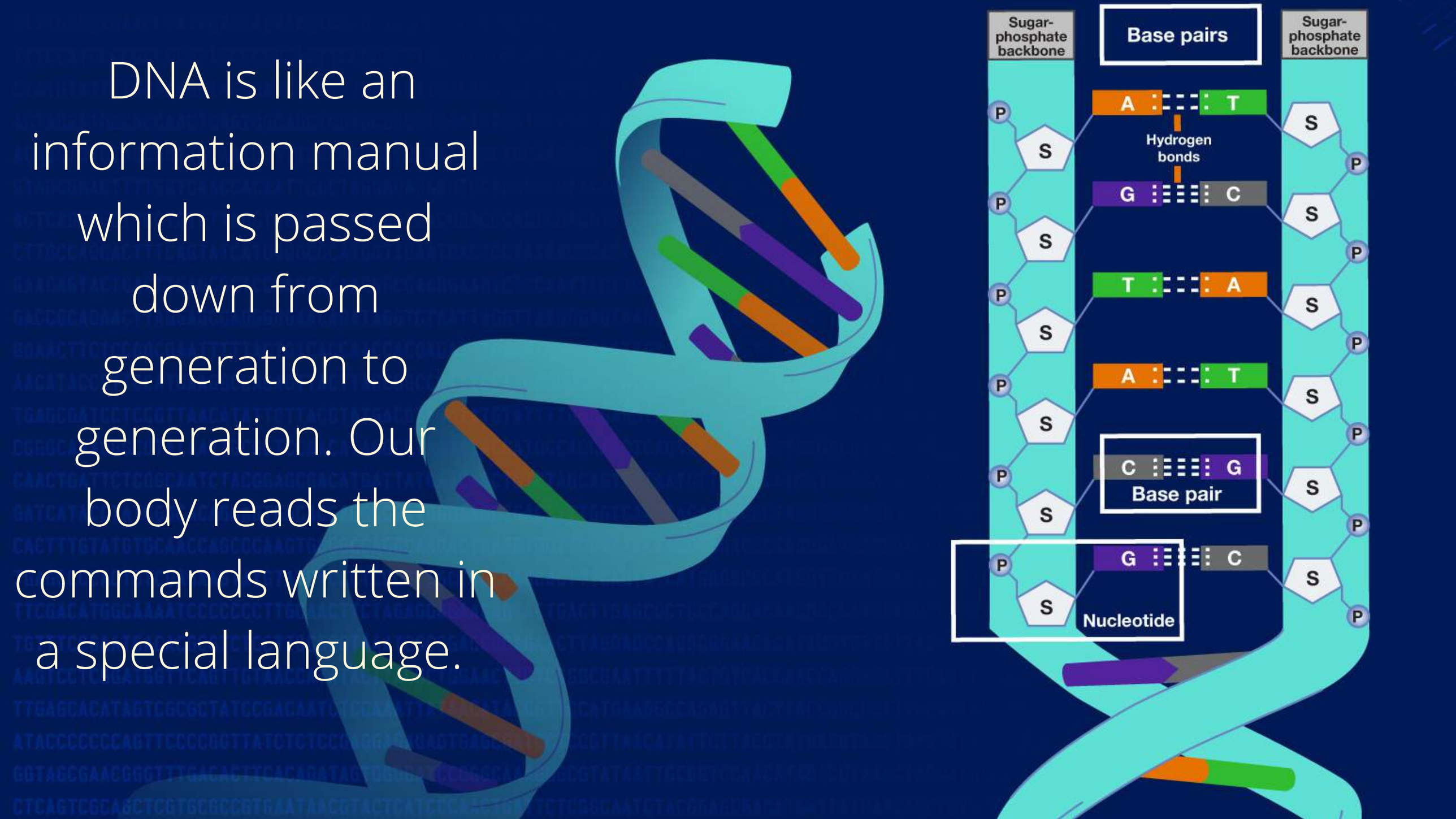
When you uncoil these chromosomes, what do you see? Long threads! These are DNA.

Actual DNA under electron microscope



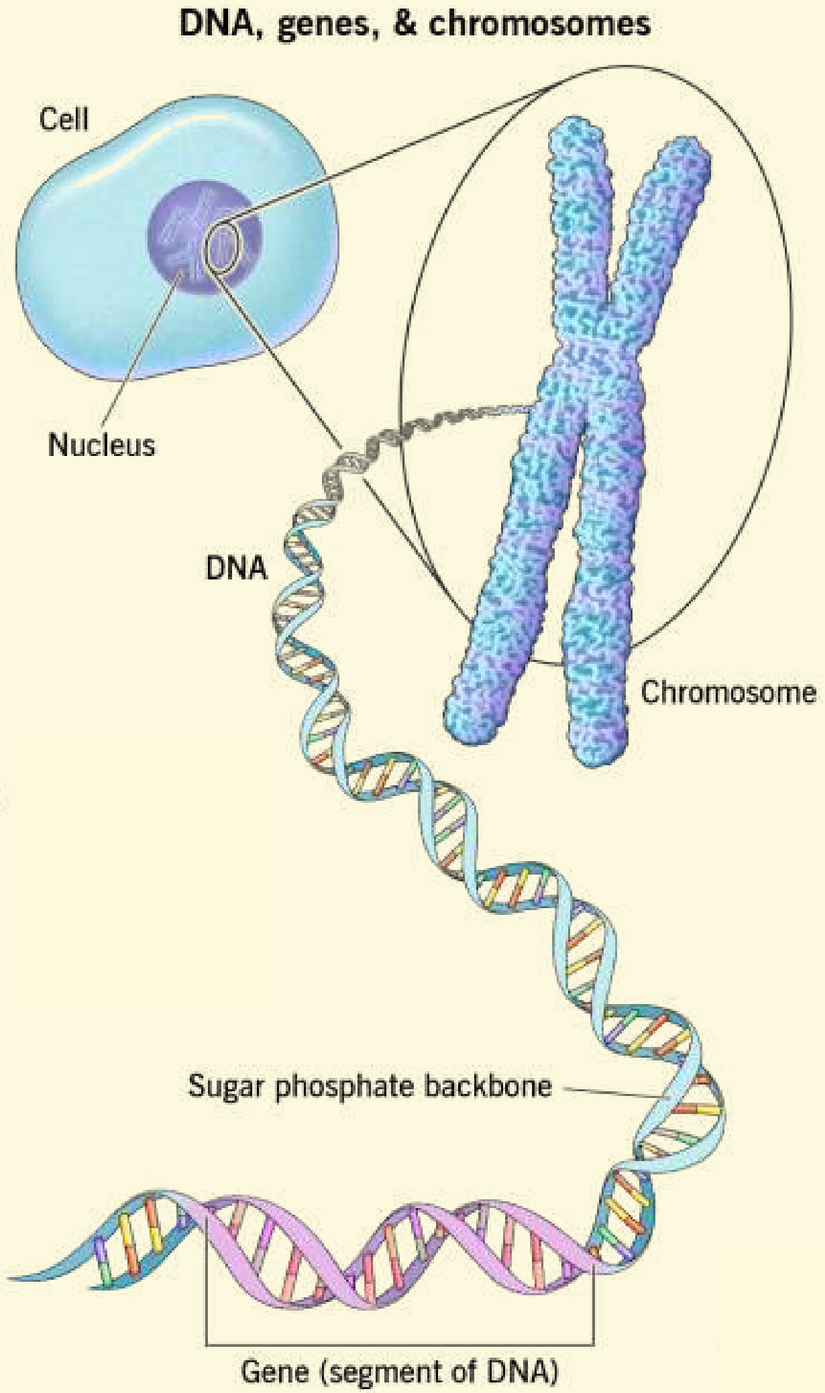


DNA is like an information manual which is passed down from generation to generation. Our body reads the commands written in a special language.



WHAT IS A DNA

DNA-
Deoxyribonucleic acid is the material that carries all the information about how a living thing will look and function.



CHROMOSOME

Chromosome is DNA in double helix arrangement with proteins

DNA

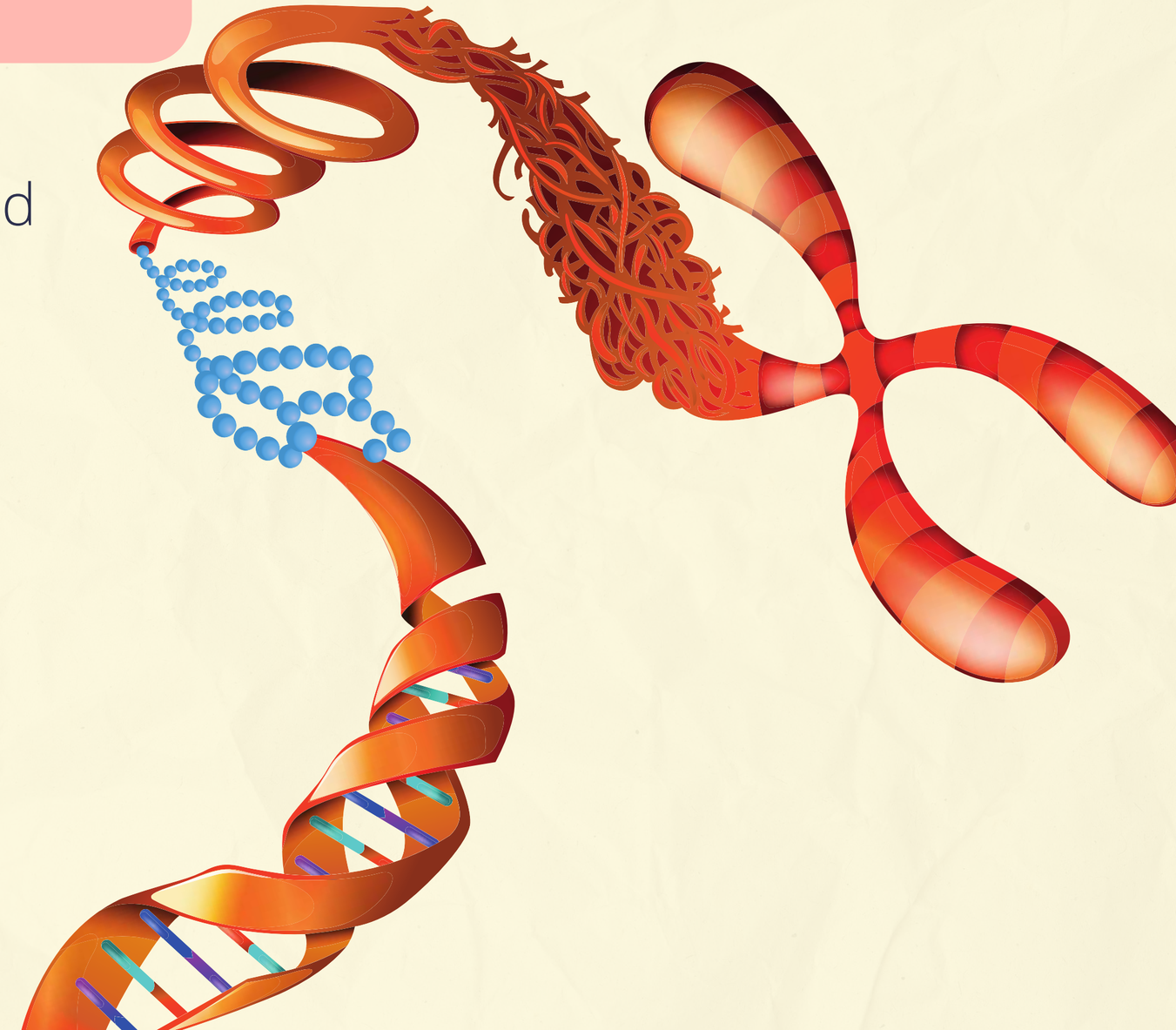
DNA is chemical that stores genetic information of an organism

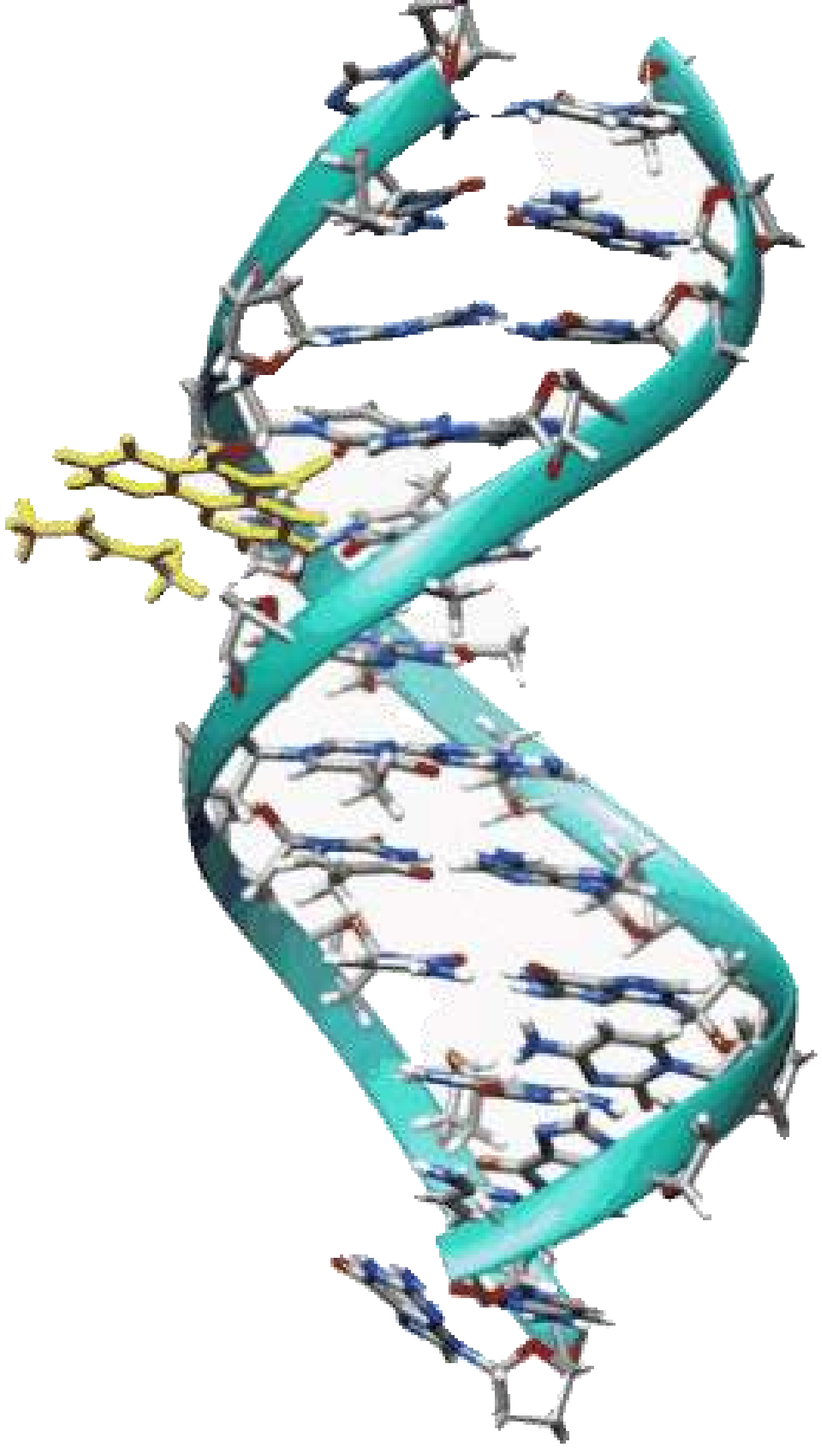
GENE

Genes are DNA stretches that determines paricular trait of an organism

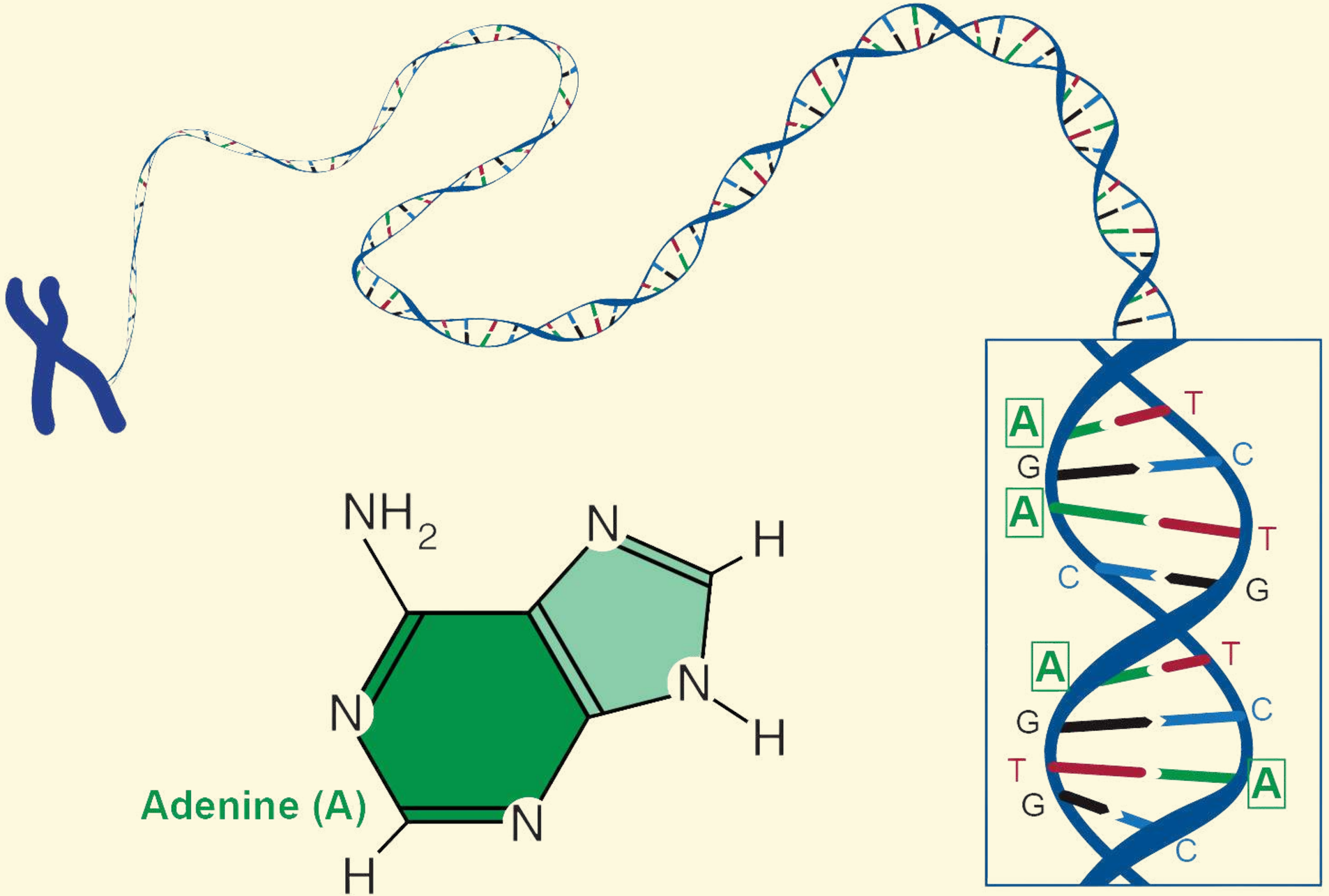
DNA -> Chromosome

These strands of DNA are first coiled and then supercoiled, much like a telephone wire.





DNA made up of carbon, hydrogen, oxygen, nitrogen, and phosphorus


A
T
G
C
A
T
C
G
A
T
G
C
T
G
A
C
NH2
N
H
N
H
N
N
H
Adenine (A)

4 BASES

ADENINE

THYMINE

GUANINE

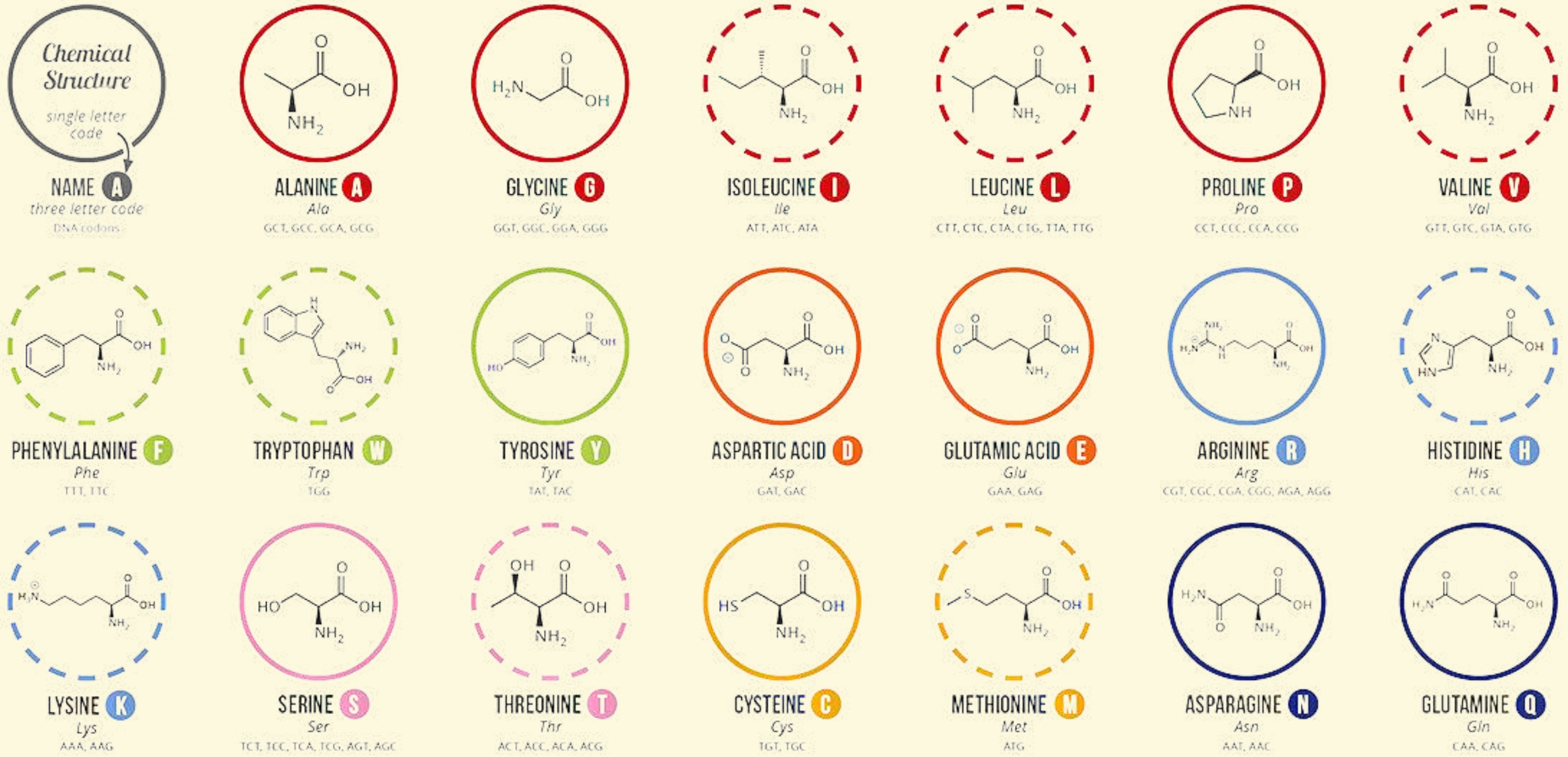
CYTOSINE

LANGUAGE OF LIFE

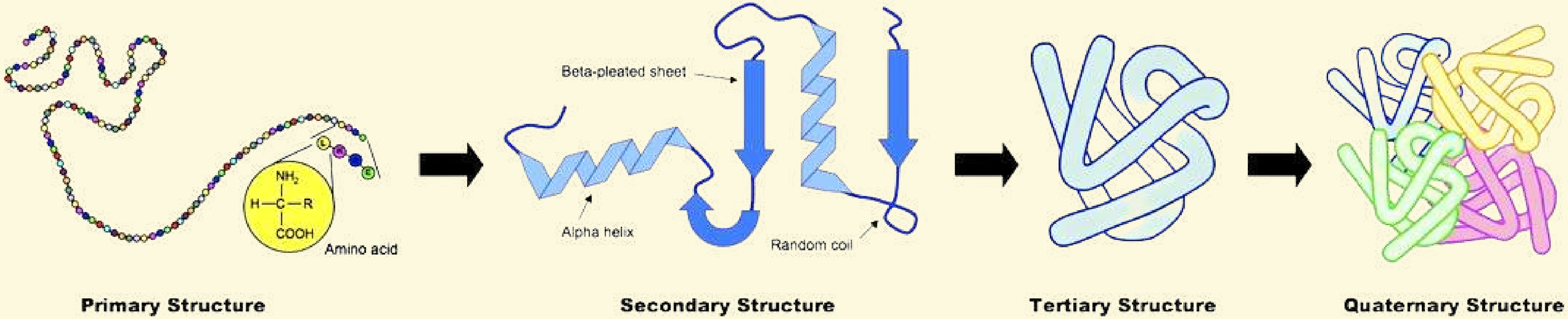
Make words from the 26 English alphabets . similarly, there is 3-letter words or 'codons' using only 4 letters of the alphabet: A, T, G and C.

Each word that can be made using these ATGC letters are called aminoacids

Words makes a sentence.
Similarly, Amino acids make proteins



These Proteins are very important for proper functioning of Living body.



A	Alanine	GCT
B		GCA
C	Cysteine	TGC
D	Aspartic acid	GAT
E	Glutamic acid	GAG
F	Phenylalanine	TTT
G	Glycine	GGG
H	Histidine	CAT
I	Isoleucine	ATA
J		ATC
K	Lysine	AAG
L	Leucine	CTC
M	Methionine	ATG
N	Asparagine	GAC
O		GAT
P	Proline	CCC
Q	Glutamine	GAG
R	Arginine	CGT
S	Serine	TCA
T	Threonine	ACT
U		ACG
V	Valine	GTC
W	Tryptophan	TGG
X		GTA
Y	Tyrosine	TAC
Z		TAT

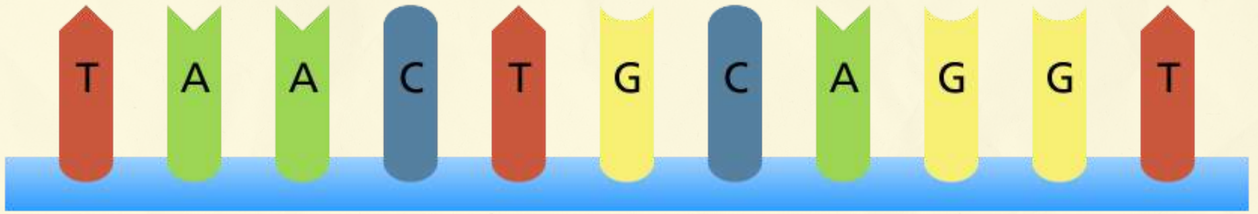
What is DNA code of your name?

EXAMPLE - ANANYA

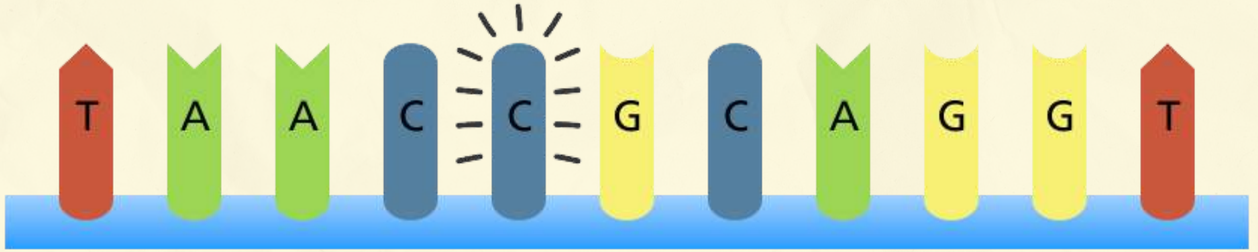
GCT GAC GCT GAC TAC GCT

MUTATIONS IN DNA

Original sequence

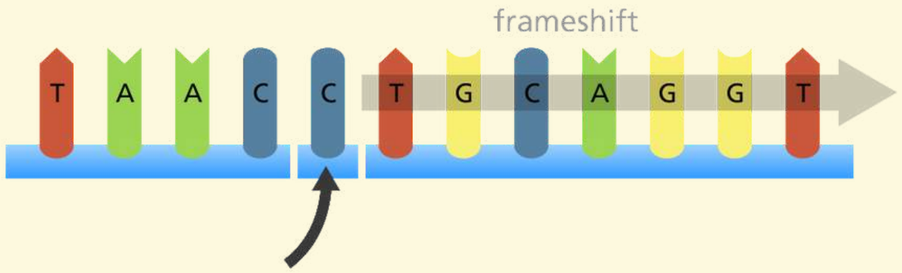


Point mutation



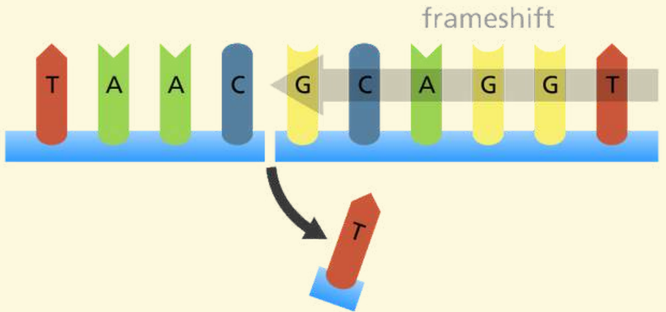
Original sequence

Insertion

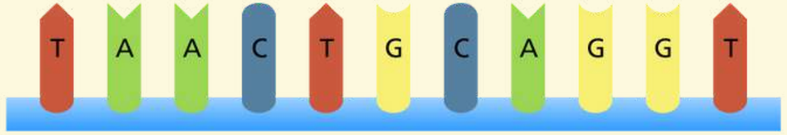


Original sequence

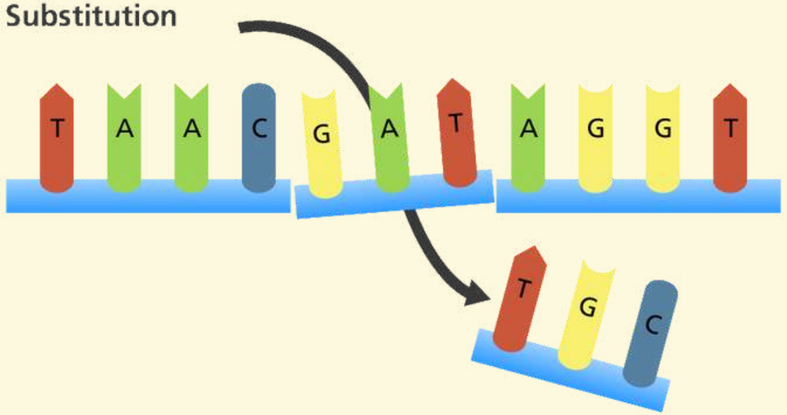
Deletion



Original sequence

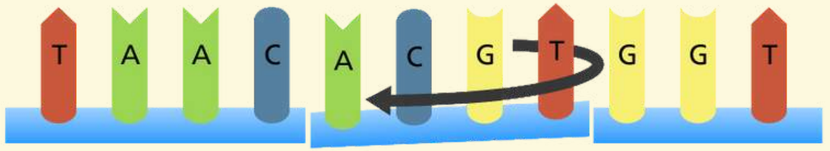


Substitution



Original sequence

Inversion

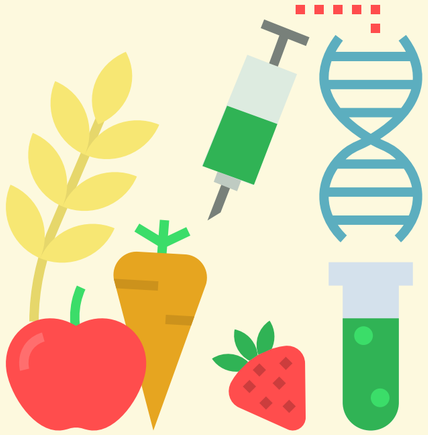


DIMPLES ARE TYPE OF MUTATION

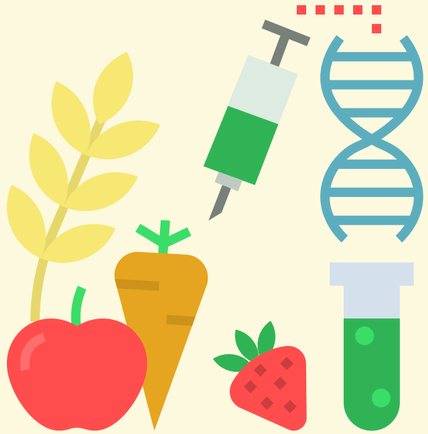
The gene responsible for facial dimples is said to be carried by chromosome 5, and it influences the formation of defective muscle to develop, resulting in the formation of dimples.

Genetic engineering

genetic engineering may involve adding a gene from one species to an organism from a different species to produce a desired trait. Used in research and industry, genetic engineering has been applied to the production of cancer therapies, brewing yeasts, genetically modified plants and livestock, and more.



Why do we need them?

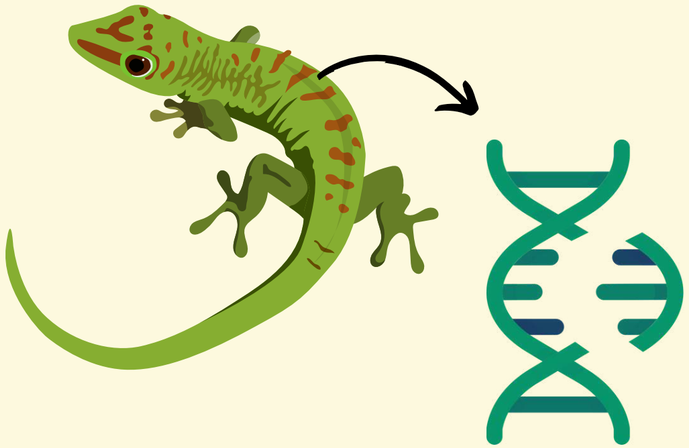


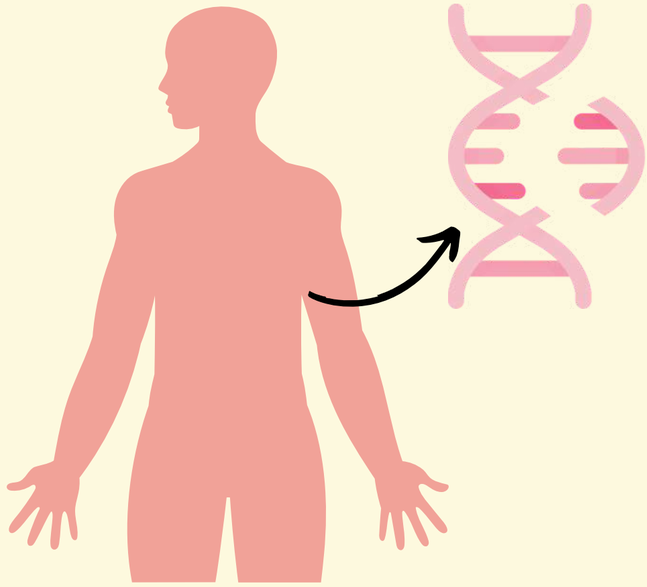
A fresh new report from the World Resources Institute notes that GMOs and genetically modified food are going to be an important tool for feeding a global population that is expected to reach 10 billion people by 2050.

GM crops, particularly Bt cotton, have resulted in significant reductions in pesticide poisoning cases due to reduced applications and reduced levels of insecticide exposure. Reductions in farmer pesticide poisonings have been quantified in China, India, Pakistan and South Africa.

Insulin is used to treat diabetic patients. This insulin was initially extracted from the pancreas of slaughtered cattle and pigs which developed allergic reactions in human body. Hence, genetically engineered human insulin was synthesized.

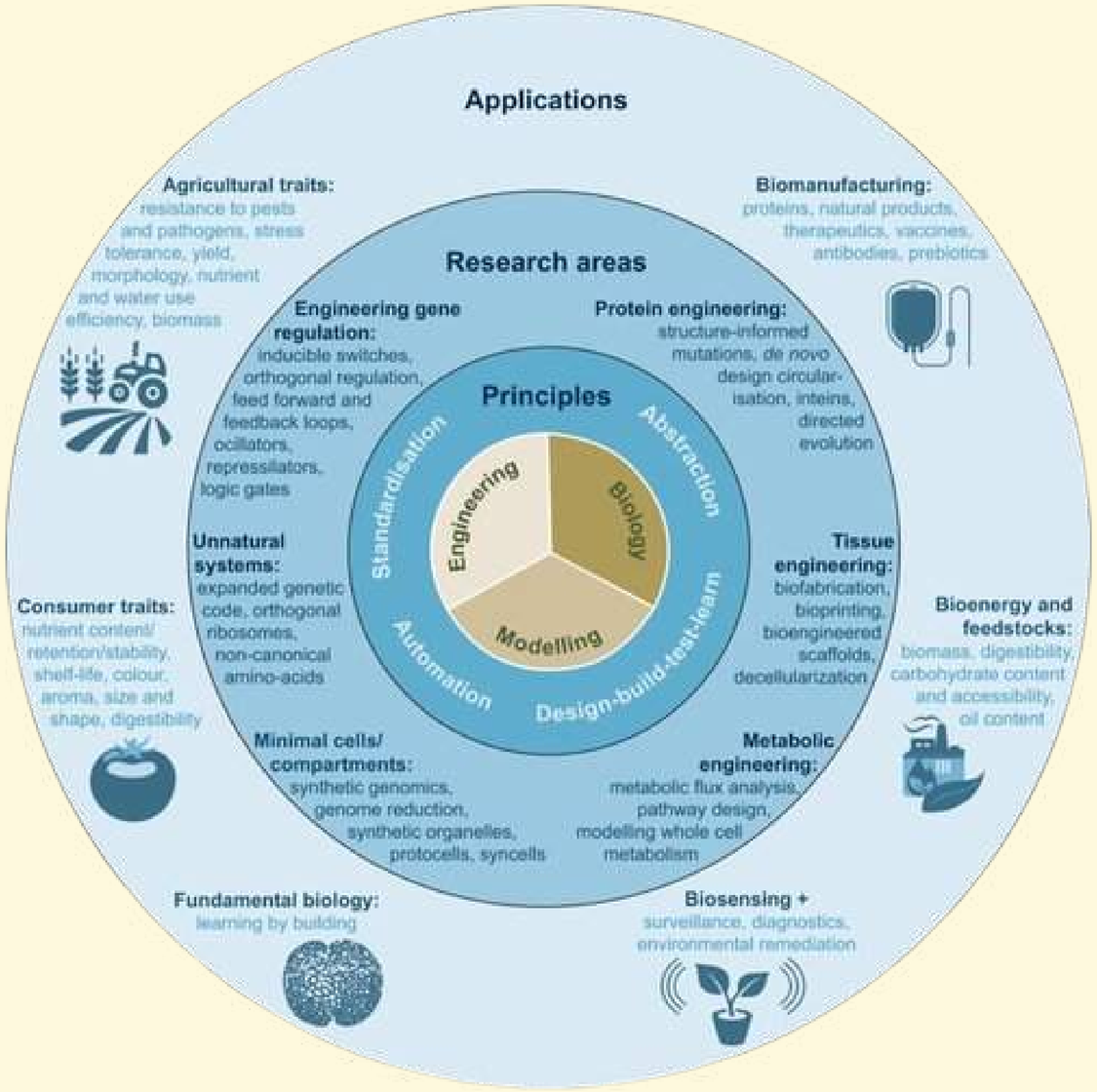
Wrong Example but a True Fact





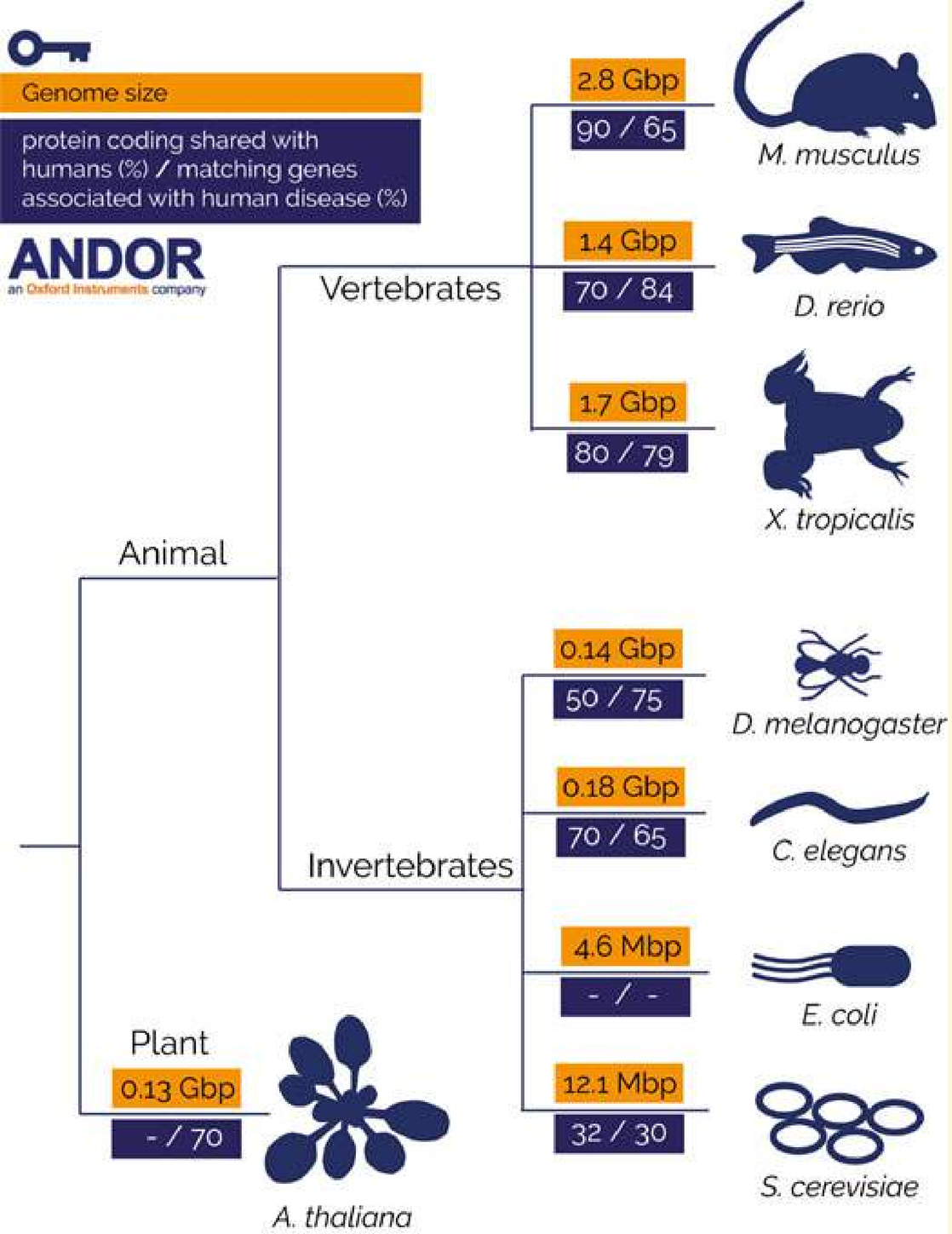
Using DNA from reptiles, who naturally regrew lost limbs, Connors created a serum which went wring and it turned him into The Lizard

Synthetic Biology



Synthetic biology is a field of science that involves redesigning organisms for useful purposes by engineering them to have new abilities.

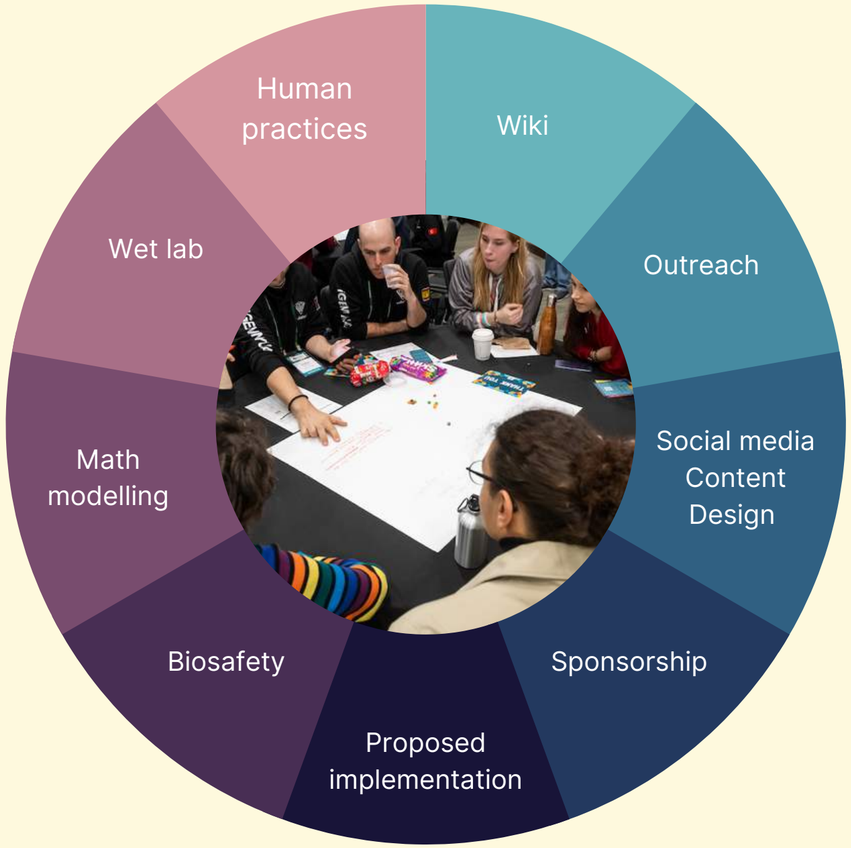
Synthetic Biology is an innovative field bringing together different subject areas and many more to create useful tools to solve everyday problems.



Model Organisms

A model organism is a non-human species that is extensively studied to understand particular biological phenomena, with the expectation that discoveries made in the model organism will provide insight into the workings of other organisms.

iGEM Competition



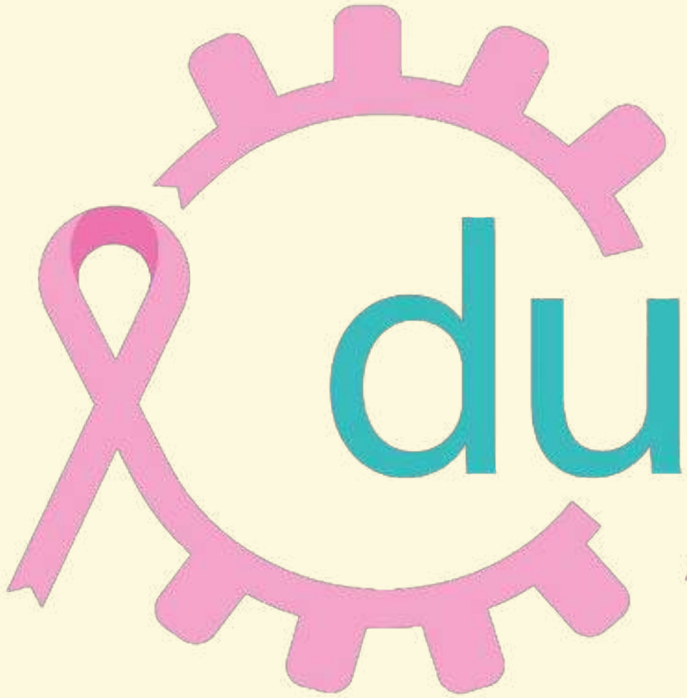
International Genetically Engineered Machine (iGEM) is a synthetic biology competition started at MIT in 2004. iGEM provides a platform for young researchers to asK critical questions that address relevant real-world problems and develop innovative solutions using synthetic biology and genetic engineering

iGEM encourages the teams to go beyond their lab worK and

- conduct outreach and educational activities,
- interact with staKeholders,
- construct simulations and predictions using mathematical modeling and
- integrate entrepreneurial aspects to synthesize a holistic project.

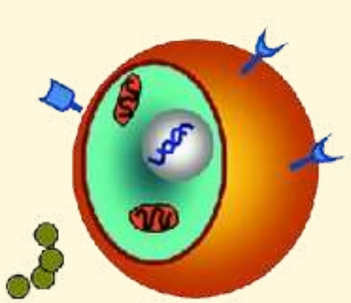
Over 15 teams from India comprising IISERs, IITs, and IISc participate annually in this competition.

Our project

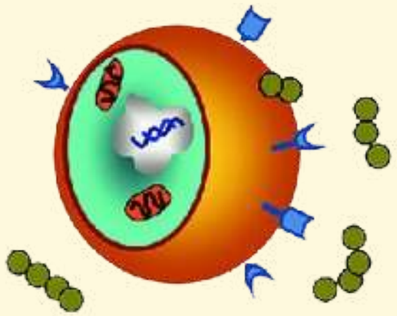


duonco

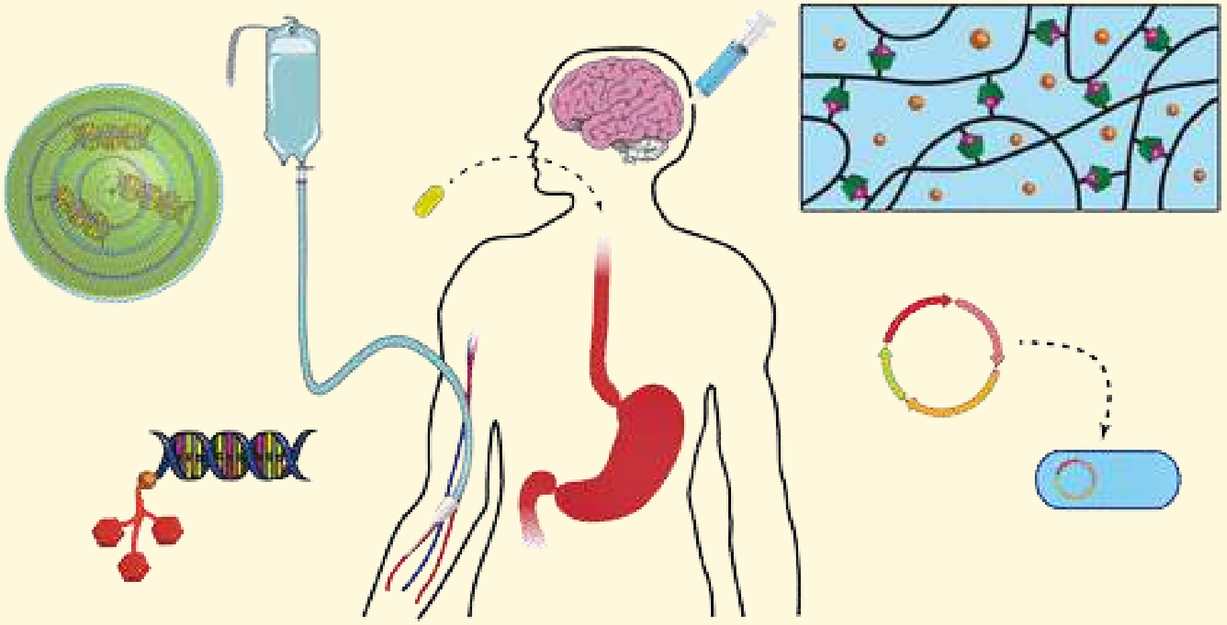
A dual nanovesicle drug delivery system.

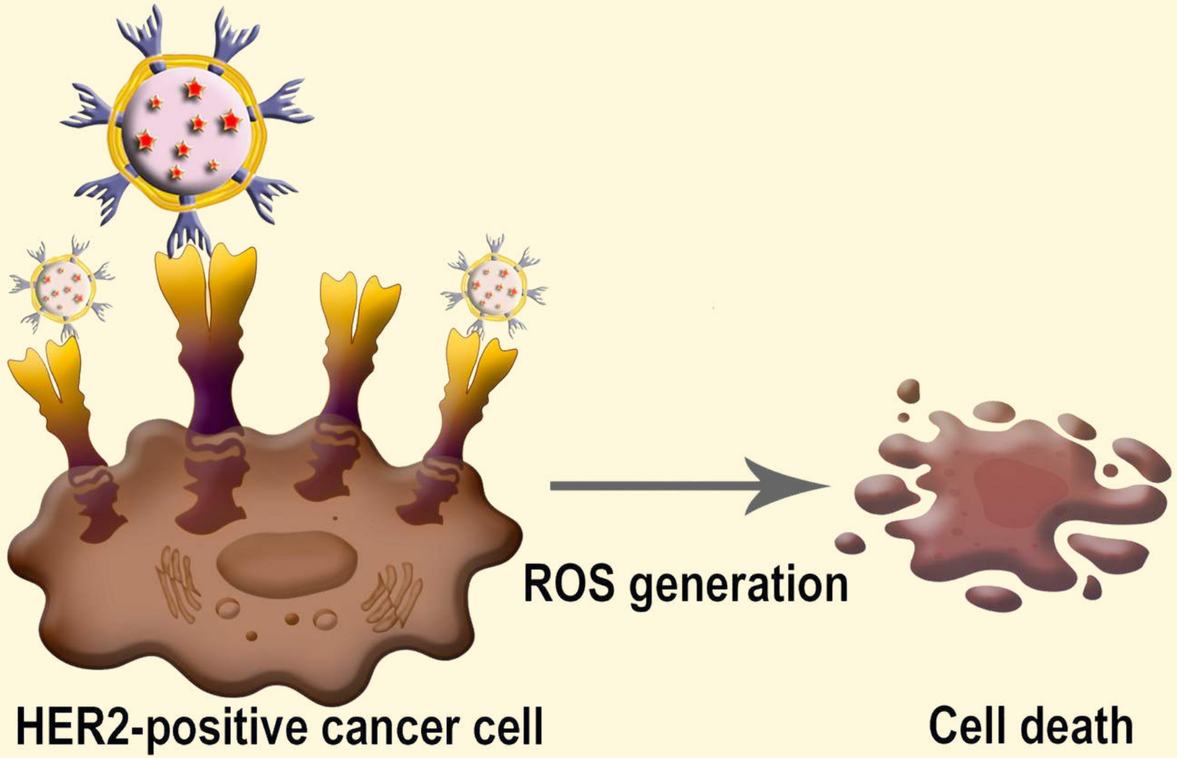


Normal cell



Tumor cell



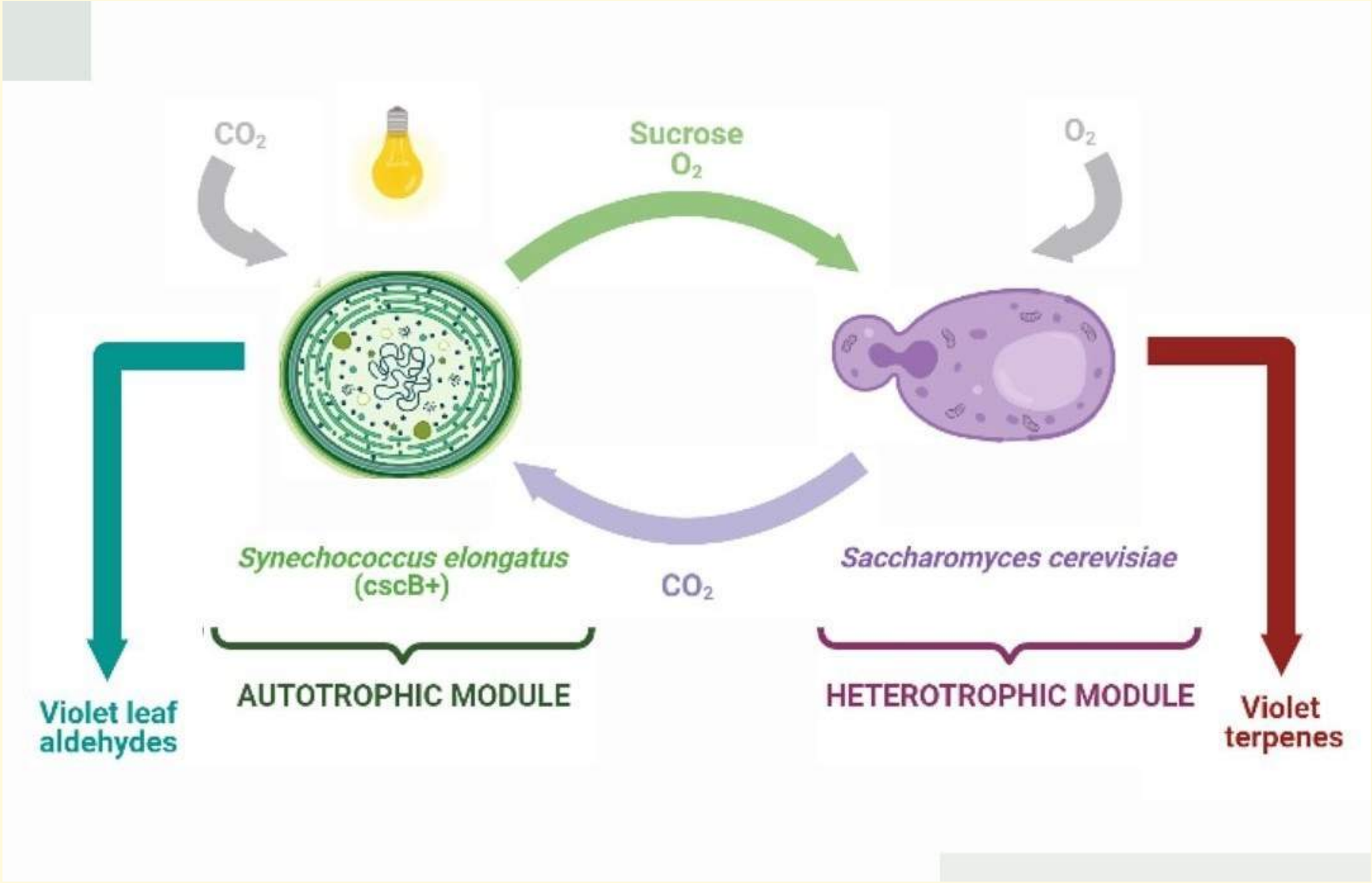


Poor specificity is a fundamental issue with contemporary cancer drug therapy, necessitating improved alternatives. We have developed Duonco, a dual nanovesicle system which targets two cell surface markers over-expressed in HER2+ breast cancer. We bioengineered E. coli to produce two distinct nanovescicles, to selectively deliver chemotherapeutic prodrugs and their cognate enzymes, respectively, into tumour cells. This system is developed such that it functions analogous to an AND gate, where the drug is only activated in cells that overexpress both markers, and remains inactivated or undelivered in normal cells..

IGEM TOULOUSE

ELIXIO 2021

The aim of their project is to give back its voice to the violet in perfume and cosmetic compositions using synthetic biology to produce the fragrance molecules of violets.


CO_2
Sucrose
O_2
O_2
Violet leaf aldehydes
Synechococcus elongatus (cscB+)
CO_2
Saccharomyces cerevisiae
AUTOTROPHIC MODULE
HETEROTROPHIC MODULE
Violet terpenes


IGEM IISER PUNE
HYDRAZOME

The Problem: Waterlogging

12 million hectares of waterlogged land in India

Land degradation including waterlogging pegged at **Rs. 72,000 crore**

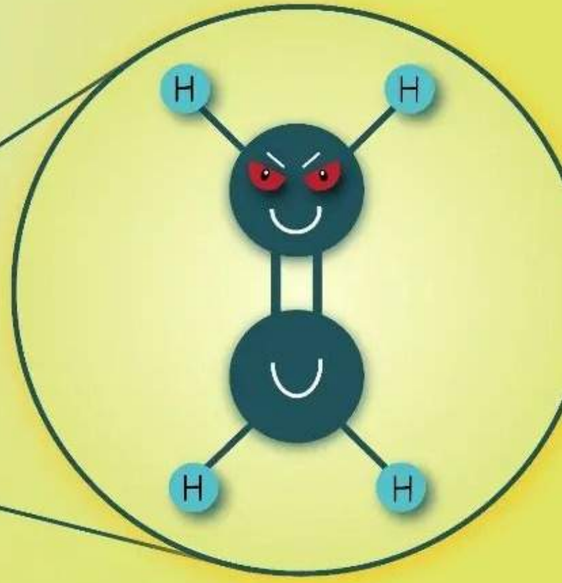
Massive **Agricultural sector losses**

1 billion hectares of agricultural land globally affected

The Effects of Waterlogging

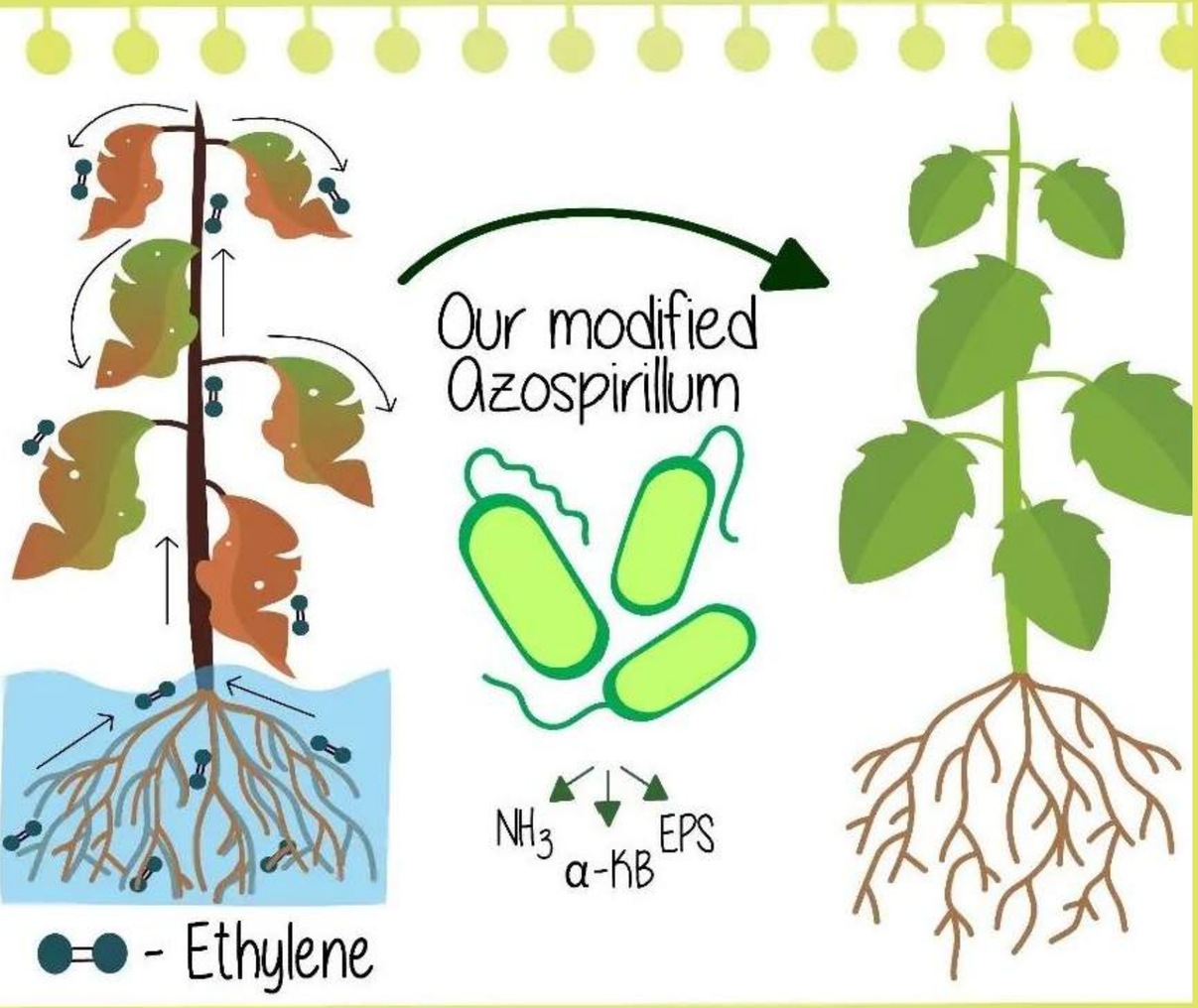
Waterlogged Plant

- Plant death
- Low productivity
- Land degradation
- Increased salinity

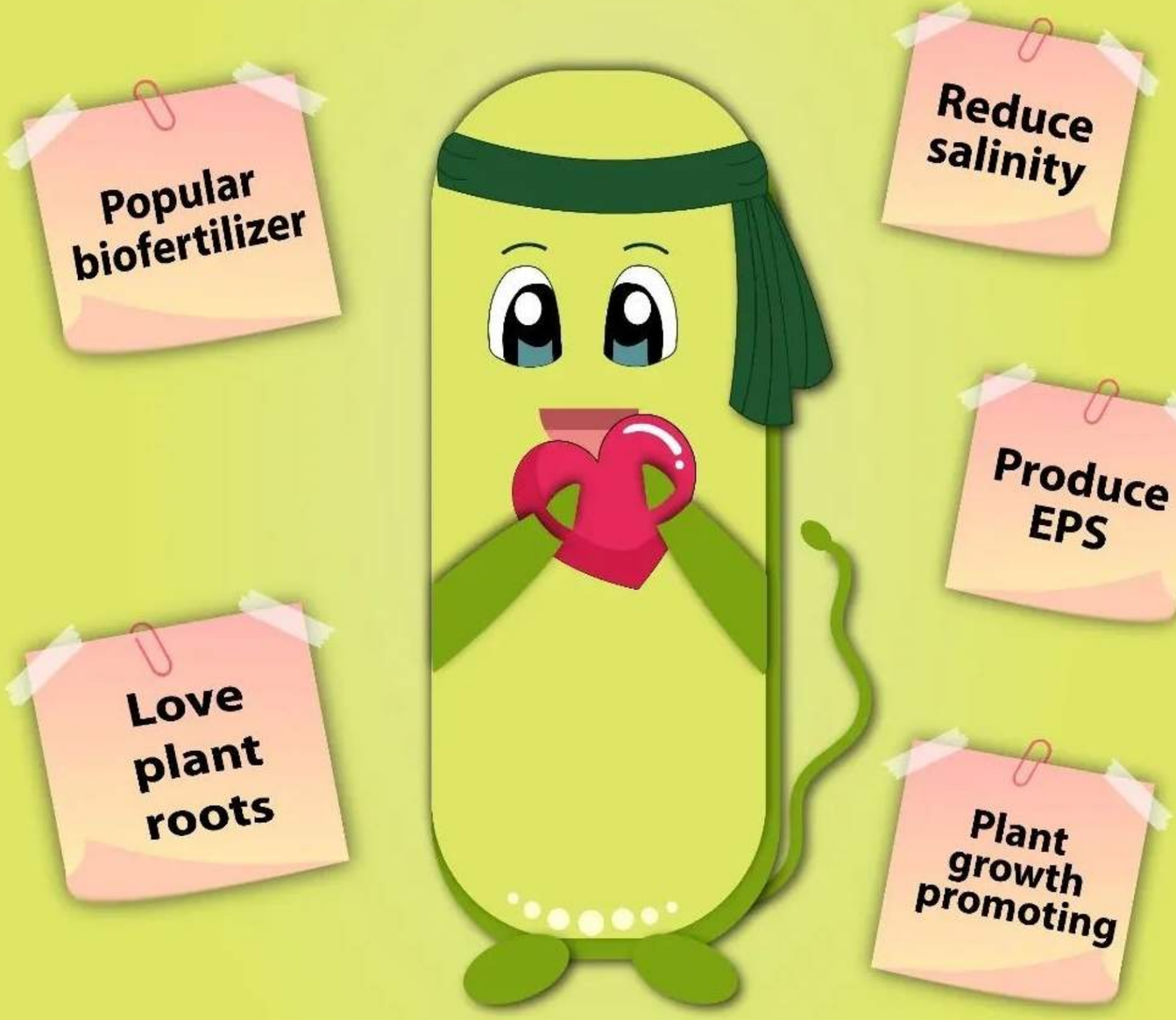


Ethylene

Our Solution: Hydrazome



Why Azospirillum?

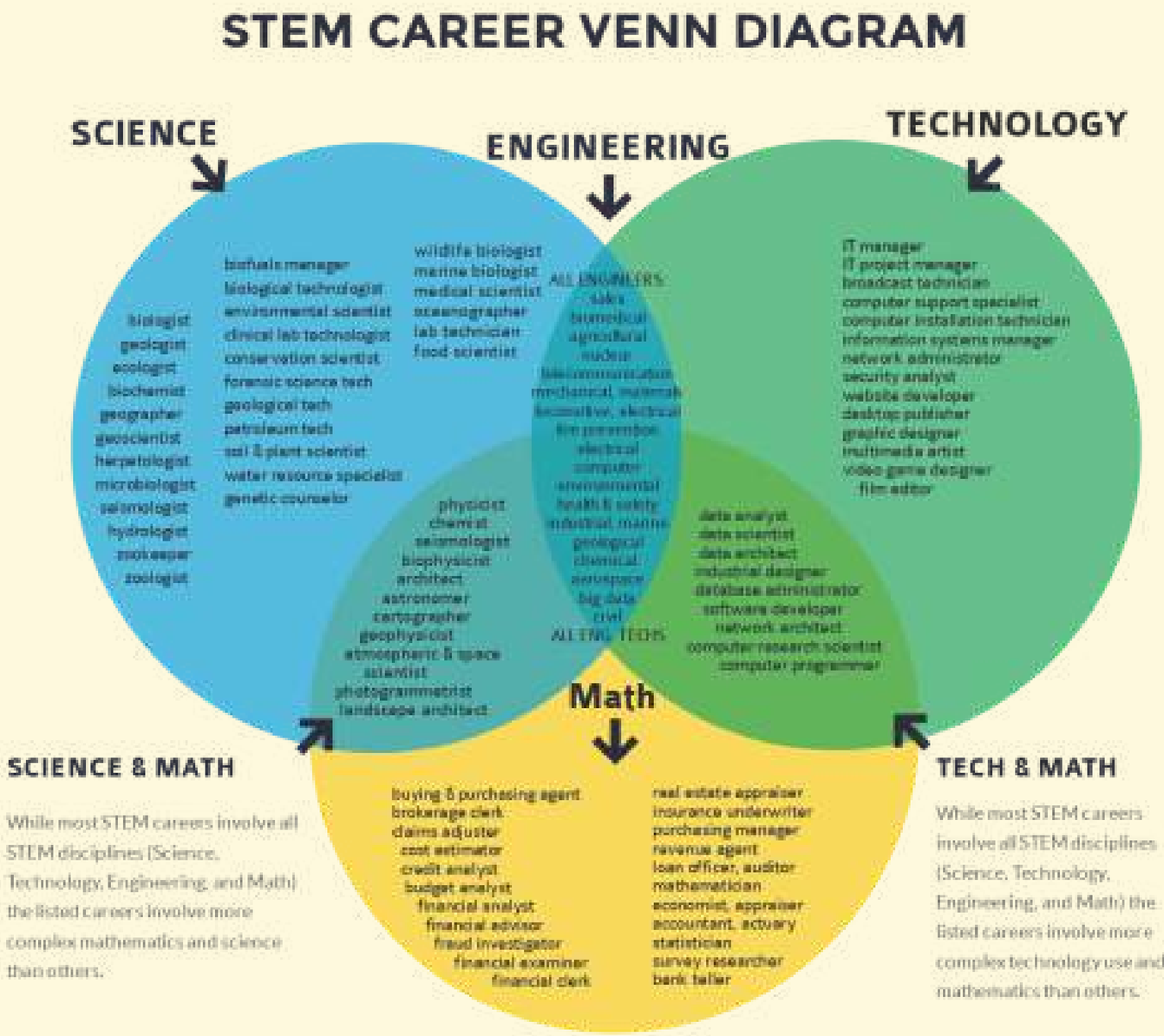


Team:GreatBay SZ - 2019.igem.org

SPIDroin EngineeRing with chroMoprotein And Natural dye

The current approach is to produce recombinant spidroins (silk proteins) from other chassis and spin them into silk. This year , we aim to manufacture recombinant spider silk with E.coli and color the silk for application in cloth industry.

Interdisciplinary Career



India Literacy Project

http://www.ilpnet.org

10th standard (SSLC)

where do I go from here

Distance Education & Correspondence Courses

- Bachelors Preparatory Program — 6 months, Pass in SSLC
- Certicate Programmes in computing, teaching of English, guidance, food and nutrition — Pass in SSLC
- Diploma — Civil Engineering — 3 years, 10th 55%, 12th Science pass
- Certicate Courses
  - Business English
  - English Proficiency
  - Library Science

BA, B. COM, BTS, BSW

Polytechnic Diploma

₹ 1000 - 7000 | Yrs 3 | % 55+

- Automobile Engineering
- Aeronautical Engineering
- Agricultural Engineering
- Architecture Engineering
- Civil Engineering
- Mechanical Engineering
- Electrical Engineering
- Electrical & Electronics Eng
- Computer Science Eng
- Plastics Technology
- Plastics mould Technology
- Textile Technology
- Carpet Technology
- Fashion Technology
- Interior Decoration
- Library Science
- Telecommunication

Junior Engineers

B. E. → M. Tech (2 Years) → Ph.D.

Diploma & then further do Engineering, B.A. / B. Com / BCA, Job oriented courses

Paramedical Courses

₹ 3000 - 7000 | Yrs 2-3 years | % 50

- Diploma in Nursing
- Diploma in Operation Theatre Technology
- Health Inspector- Ray Technology
- Dental, Ceramic Technology
- Diploma in Occupational Therapist
- Ophthalmic Technology
- Dental Mechanic / Hygiene
- Diploma in Medical Records Technology
- Dialysis Technology
- Diploma in Cardiac care Technology
- Medical Laboratory Technology

Paramedical Staff work in Hospital

- B. Sc. in Medical Lab Technology
- Operation Theatre Technology
- Nursing
- Renal Dialysis
- X-ray Technology
- Cardiac care Technology
- Radiotherapy
- Radiology & Imaging Technology
- Optometry
- Occupational Therapy
- Physiotherapy
- Cardio Pulmonary Perfusion Technology
- Audiology & Speech Language Pathology

M. Sc.

Industrial Training Institute (ITI)

₹ 500 - 1000 | Yrs 1-2 | % 10th Pass/Fail

- Automobile, Draughtsman (Civil)
- Draughtsman (Mechanical)
- Diesel Mechanic
- Foundryman
- Mason
- Plumber
- Sheet metal worker
- Welder
- Wireman
- Carpenter
- Fitter
- Surveyor
- Lab Assistant
- Mechanic (Refrigeration & Air Conditioning)
- Mechanic Radio & TV)
- Mechanic (Machine tool maintenance)
- Turner
- Information Technology & Electronics systems maintenance (IT & ES)
- Tool & Die making
- Press tools
- Production & Manufacturing
- Electrical
- Electronics

Vocational Courses

₹ Free to nominal | Yrs 3 mths - 2 yrs | % 10th pass/fail

- Air ticketing
- Apparel Technology
- Fashion Technology
- Lift Technology
- Cyber Laws
- Jewellery Designing
- Agricultural Sciences
- Interior Designing
- Information Technology
- Fire and Safety
- Hotel Management
- Footwear Technology
- Dairy Technology
- Fisheries Science
- Electrical Technician
- Bakery Technology
- Beautician
- Computer Hardware
- DTP
- TALLY
- Mechanist Training course
- Mobile Repair
- Course, Retail Management
- Screen painting
- Plastic Engineering and Technology
- Two Wheeler Servicing
- Bala Sevika Training
  - Unnati
  - Schneider
  - Government
  - GMR foundation

NTTF (Nettur Technical Training Foundation)

₹ 100000 | Yrs 3 - 4 | % 35

Diploma

- Tool and Die Making
- Electronics
- Computer Engineering
- Mechatronics
- Information Technology
- Manufacturing Technology

Post Diploma

- Tool Design
- Power Electronics
- Embedded Systems
- Industrial Automation

Govt. Tool Room & Training Center

₹ 50000 | Yrs 3 - 4 | % 50

Diploma

- Tool and Die Making
- Electronics & Telecommunications Engineering
- Precision Manufacturing
- Mechatronics

BOSCH

₹ Free | Yrs 3 - 4 | % 60

- Fitter turner
- Mechanic
- Electrician
- Electronic
- Mechanic
- Machine Tool Maintenance
- Tool & Die Maker

Schneider Electric India Foundation

₹ Free | Yrs 3 | % 50

Free hostel, Food, Stipend and Scholarship. Entrance Test for Selection.

Unnati

₹ Free | Yrs 3 months | % 10th pass/fail

Age: 18 - 28, BPL card holders

- Retail Sales
- Guest Care
- Industrial Tailoring
- Industrial Painting
- Data Entry
- Beautician

Higher Secondary Course (HSC)

Science

- 2 Years
- 70+%
- Fee - G: 200 - 300, A: 5000 - 7000, UA: 12000 - 15000

PCMB

- B. Sc. (Physics, Chemistry, Maths,Biology,Biochemistry) Actuarial Science, Electronics Media — 3 years, 60%, Fee: G: 1200 - 1500, A: 5000 - 7000, UA: 15000 - 30000
  - M. Sc. — 2 year, 60%, Fee: G: 12000, UA: 15000-30000
    - M. Phil. / Ph.D. — 2 - 4 years, 55%
  - B. Ed. — 1 year, 50%, Fee: 10000
  - Competitive Exams / Jobs — IAS, Banking Exams; Private Jobs: MNC & BPO
  - MBA — 2 years
- BCA — 3 years, 50%, Fee: 10000 - 20000 — MCA — 2 years
- BDS — 4 years + 1yr internship — MDS — 2 years
- B. Arch — 5 years, 70%, Fee: 20000 - 60000 — M. Arch — 2 years
- Technical Entry in Indian Army — 12th Class of 10+2 System of Education/ Equivalent with a minimum aggregate of 70% in Physics, Chemistry & Maths(PCM)
- NDA(Army, Navy, Air Force) — 10+2 pass out with Physics and Mathematics as subjects.
- Film and Television Diploma — 3 years, 35%, Fee: 4000
- B. E. — 4 years, 70%, Fee: 20000 - 60000, Refer Anna University for Branches — M.Tech — Ph.D. — 2 years
- B. Pharm — 4 years, 50%, Fee: 15000 - 50000 — M. Pharma. — 2 years
- AYUSH — (BAM, BNYS, BUMS, BSMS, BHMS) 5.5 years (4.5 years of academics & 1 Year Internship), 85%, Fee: 110000 to 200000 — MS, MD — 2 years
- MBBS — 5.5 years (4.5 years of academics & 1 year internship), 85%, Fee: 110000 to 200000 — MD — 2 years — Specialization
- B. Sc. - Dairy, Biotech, Nursing, Home Science, Botany, Zoology, Microbiology, Plant Biology, Plant Bio-Technology, Adv. Zoology & Bio-Technology, Food Science& Mgt, Nutrition, Dietetics & Food Service & Mgt — 3 years, 50%, Fee: 10000 - 20000 — M. Sc. — 2 years — Ph.D.
- B. Sc. - Agriculture, Sericulture, Horticulture,Forestry — 3 years, 50%, Fee: 10000 - 20000 — M. Sc. — 2 years — Ph.D.
- B.F.Sc (Fishery Science) — 4 year — M.F.Sc. — 2 year — Ph.D.
- B. V Sc. (Veterinary Science) — 4.5 years Semesters of core courses + Internship programme of 6 months 50 %
- Paramedical Courses — 2 years, 50%, Fee: 3000 - 7000

PCPHs

- B. Sc. (Home Science) — 3 years, 60%, Fee: G: 1200 - 1500, A: 5000-7000, UA: 15000 - 30000
  - M. Sc. — 2 years — Ph.D.

PCMG

- B. Sc. (Geology) — 3 years, 60%, Fee: G: 1200 - 1500, A: 5000-7000, UA: 15000 - 30000
  - M. Sc. — 2 years — Ph.D.

PCMS

- B. Sc. (Statistics) — 3 years, 60%, Fee: G: 1200 - 1500, A: 5000-7000, UA: 15000 - 30000
  - M. Sc. — 2 years — Ph.D.

PCME / PCMCs

- B. Sc. (Physics, Chemistry, Maths, Electronics / Computer Science) — 3 years, 60%, Fee: G: 1200-1500, A: 5000-7000, UA: 15000-30000 — M. Sc. — 2 years — PhD
- NDA — 10+2 pass with Physics and Mathematics as subjects, 50%, Fee: NA
- B. Arch — 5 years, 70%, Fee: 20000 - 60000, CET — M. Arch — 2 years
- Technical Entry in Indian Army — 12th Class of 10+2 System of Education / Equivalent with a minimum aggregate of 70% in Physics, Chemistry & Maths (PCM)
- B. E. — 4 years, 70%, Fee: 20000 - 60000, CET — M. Tech — 2 years — PhD
- BCA — 3 years, 50%, Fee: 10000 - 2000 — MCA — 2 years
- Film and Television Diploma — 3 years, 35%, Fee: 4000
- BBM — 3 years, 50%, Fee: 10000 - 20000 — MBA — 2 years
- BHM — 3 years, 50%, Fee: 10000 - 20000 — MBA — 2 years

Commerce

- History, Economics, Accountancy, Computer Science, Business Studies, Statistics, Maths
- 2 Years, 50+%
- Fee - G: 200-300, A: 1500 - 2000, & UA: 3000 - 5000

- ICWA (from the Institute of Cost & Works Accountant)
- Company Secretary (from the Institute of Company Secretaries of India)
- Chartered Accountant

- B. Com — 3 years, 35%, Fee G: 500 - 15000 (Corporate Secretaryship, Banking Management Accounts & Finance, E-Commerce, Computer Application)
  - M. Com — 2 years
    - BBM — 3 years, 50%, Fee: 10000 - 20000
    - BHRM — 3 years, 50%, Fee: 10000 - 20000 — MBA — 2 years
    - BCA — 3 years, 50%, Fee: 10000 - 20000 — MCA — 2 years
    - BHM — 3 years, 50%, Fee: 10000 - 20000

Arts

- History, Economics, Political Science, Sociology, Geography, Education, Logic, Psychology, Tamil / English (Optional), Music, Journalism, Mass Communication
- 2 Years, 35+%
- Fee: G: 200-300, A: 1500 - 2000, UA: 3000 - 5000

- BA — 3 years, 35%, Fee: G: 200 - 1500
  - M.A. — M. Phil. / Ph.D.
  - B. Ed. — 1 year — M. Ed. — 1 year
  - LLB — 3 years — LLM
  - MBA — 2 Years
- D. Ed. — 2 Years, 35%, Fee: 3000 - 12000
  - BSW — 3 years, 45%, Fee: 6000 - 12000 — MSW — 2 years
- LLB - Foundation — 5 years, 40%, Fee: 5000 - 15000
  - LLM — 2 years
  - Foreign Languages Diploma
- BBM — 3 years, 50%, Fee: 10000 - 20000
- BBA — 3 years, 50%, Fee: 10000 - 20000 — MBA — 2 Years
- BHM — 3 years, 50%, Fee: 10000 - 20000
- Fashion Designing Diploma — 1 or 2 years
- B.Des — 4 years (Product, Communication Textile, Leather, Knitwear Fashion Communication)
- Interior Designing Diploma — 3 years, 45%

Entrepreneurship

- Find Practical Solutions
- Improve Local Economy
- Be Your Master

Eligibility: at any point, preferably after graduation

- National Institute for Entrepreneurship and Small Business Development
- Indian Institute of Entrepreneurship
- Bharatiya Yuva Shakti Trust (BYST)
- Rural Self Employment Training Institutes
- The Commonwealth Youth Credit Initiative
- Khadi and Village Industries Commission (KVIC)
- Entrepreneurship Development Institute of India

Competitive Exams / Jobs

Eligibility: Graduate

- TNPSC
- UPSC (IAS, IPS, & IFS)
- Banking Exams

Eligibility: HSC

- CLAT (common law admission test)
- Competitive Exams/Jobs
- SDA (second division assistant)
- Police, Railways
- BPO

Academics and Career Guidance Chart

Multi-Dimensional Learning Space (MDLS)

An initiative of India Literacy Project (ILP)

PCMB/PCME/PCMCs/PCMG/PCBHs/PCBS: Physics, Chemistry, Mathematics, Biology, Electronics, Computer Science, Geology, Home Science, Statistics | G: Government A: Aided UA: Unaided | **B. Sc:** Bachelor of Science **M. Sc:** Master of Science **M. Phil:** Master of Philosophy PhD: Doctor of Philosophy **B. Ed:** Bachelor of Education **MBA:** Masters in Business Administration **B. Arch:** Bachelor of Architecture **NDA:** National Defense Academy **BCA:** Bachelor of Computer Application **MCA:** Master of Computer Applications **B.E.:** Bachelor of Engineering **BBM:** Bachelor of Business Management **BHM:** Bachelor of Hotel Management **B. Pharm:** Bachelor of Pharmacy **BAMS:** Bachelor of Ayurveda, Medicine and Surgery **MBBS:** Bachelor of Medicine and Bachelor of Surgery **BHMS:** Bachelor of Homeopathic Medicine and Surgery **BUMS:** Bachelor of Unnani Medicine and Surgery **BSMS:** Balchelor Siddha Medicine & Surgery **B.Des :** Bachelor of Design **B. V Sc.:** Bachelor of Veterinary Science **CA:** Charted Accountant **B. Com:** Bachelor of Commerce **M. Com:** Master of Commerce **BSW:** Bachelor of Social Work **MSW:** Master of Social Work **LLB:** Bachelor of Laws **LLM:** Master of Laws **BDS :** Bachelor of Dental Surgery **MDS :** Master of Dental Surgery **BNYS:** Bachelor of Naturopathy and Yoga Science | **BA:** Bachelor of Arts **MA:** Master of Arts **D. Ed.:** Diploma in Education