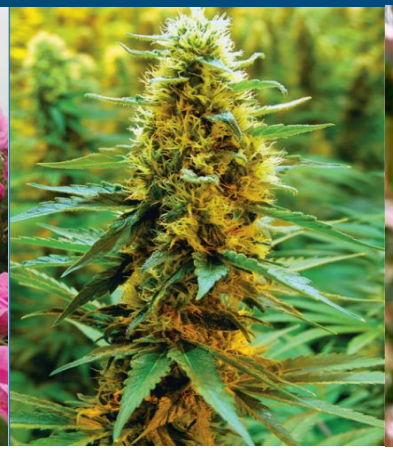
رهیافت های نوین زیست فناوری در بهره وری بیشتر از منابع زیست بوم کویر

Novel Biotechnology Approaches Towards Greater Productivity from Desert Ecosystem

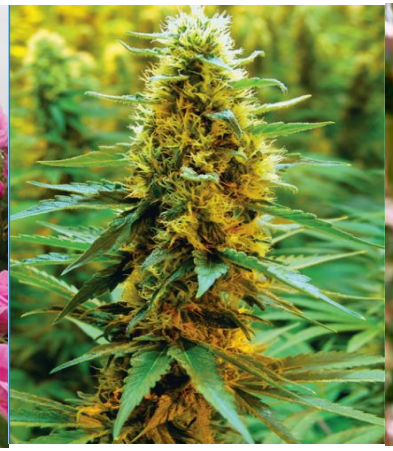
Seyed Alireza Salami

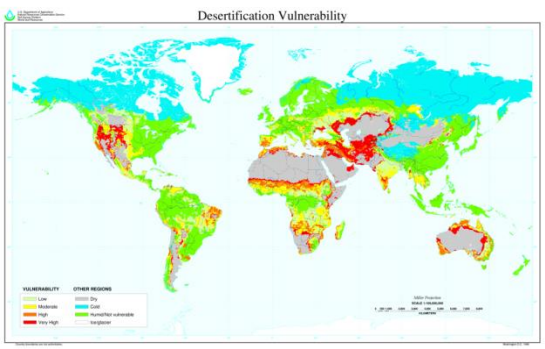
University of Tehran


Global deserts are huge

- 70% (70.8%) of the earth’s surface is water mass.
- So only 30% (29,2%) of the earth’s surface is land mass.
- 33% of the global land mass is desert.
- 33% of 30% is 10%.
- 10% of the global surface is desert.
- 10% of 510 million km2 = 51 million km2.
- 51 million km2 = 51,000,000 km2.

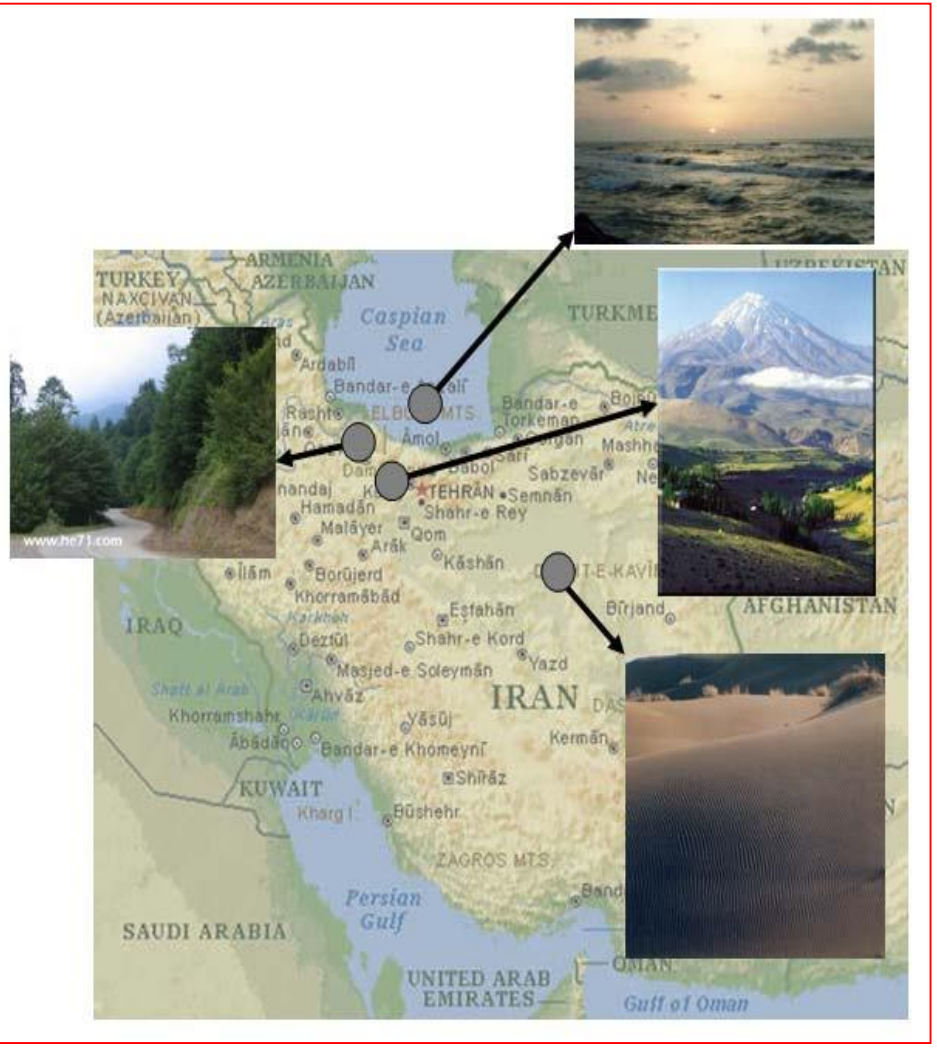



Water Stress Index

Low (< 10%)	Low to moderate (10-20%)	Medium to high (20-40%)	High (60-80%)	Extremely high (> 80%)

Source: FAO, 2016a.

Iran's **climate** is mostly **arid** or **semiarid**, to **subtropical** along the Caspian coast.



Deserts = Economy

Desert = Chance

Desert = Halophytes and Extremophiles

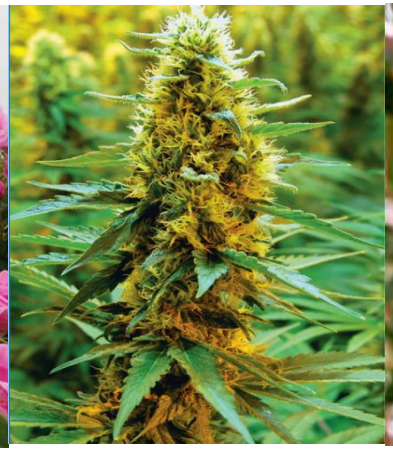
Desert = Energy

Desert = Food

Desert = Infrastructure

Desert = Valuable Microbiome

Desert = Economy



Deserts = Economy

- Except of some minor tourism, further deserts are **economic dead** . So turning deserts into economic areas makes quite a difference.

- Stupid / blind / idiot / waste of money? **Not if done right.** The first key is how to do it (key facet: not fighting nature, but let nature do the fight in your advantage). The second key is targeting low hanging fruit first (key facet: minimal investment strategy).

- All the great business models i.e. economic sectors of the world have in common that they turn **dead assets into productive assets.**

- A comprehensive **food/energy approach** is the right strategy.

Deserts = Economy

- What are the two most powerful facets/abundances of all deserts? **Space and Sun.**
- What's is the most powerful facet/abundance of oceans/seas? Salt Water. Combining those three abundances will deliver abundance in both **food and energy**.
- The most of world's water is in the oceans. It's salt, but that's no problem. No problem? Why?
- The salt water agriculture model is suitable for sand deserts with currently (almost) no rain at all.
- It will generate also evaporation and thereby increase the rain volume. The evaporation of this ocean water will cool the region down, reduce evaporation and bring rain to the region.

Deserts = Economy

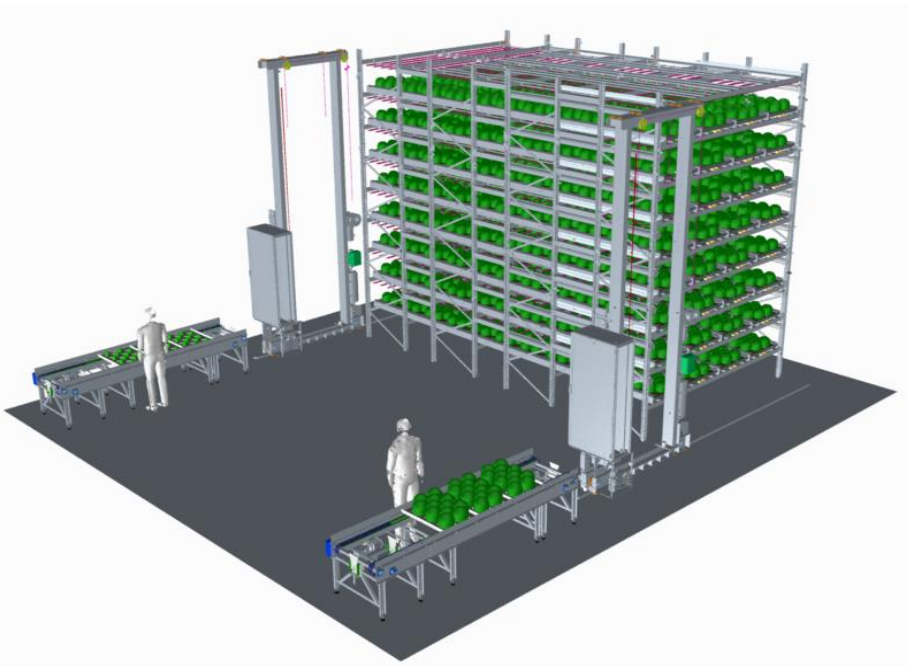
- There are 10,000 Natural **Halophytes** that grow on dry land using saline (salt water) and thereby can be irrigated with salt water.

- The main crop could be ***Salicornia*** which is rich of 30% oil and 35% protein making them better than soy. It can be considered as **Food and Feed.**

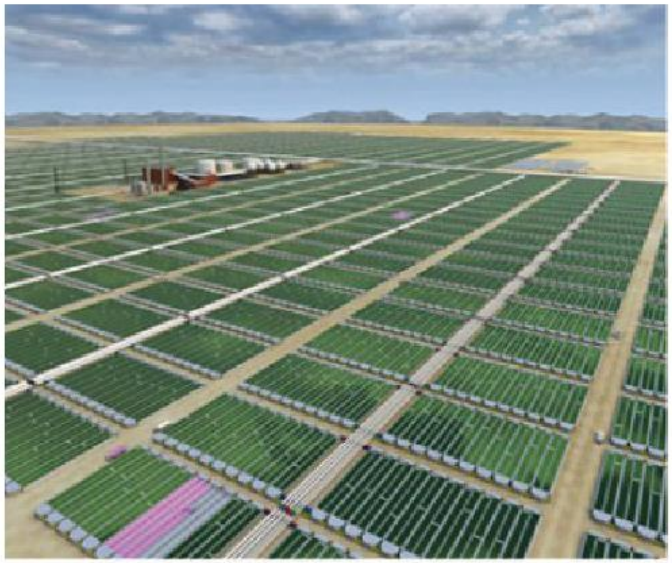
- Seawater contains some **80% of the nutrients** to grow plants. The other 20% can be added organic (aquaculture like fish etc. based on feeding *Salicornia* and as waste producing fertilizer) or by technology produced fertilizers. Seawater also contains **trace minerals** etc.

- Beside salt/halophyte agriculture, salt aquaculture could produce massive volumes of very luxurious flora and fauna species for the global gourmet food market. Salt water bushes could provide leaves and wood for several industries.

- The halophytes could also deliver a huge flow of biodiesel. The technology is simple and could be easily decentralized in small local/regional factories.

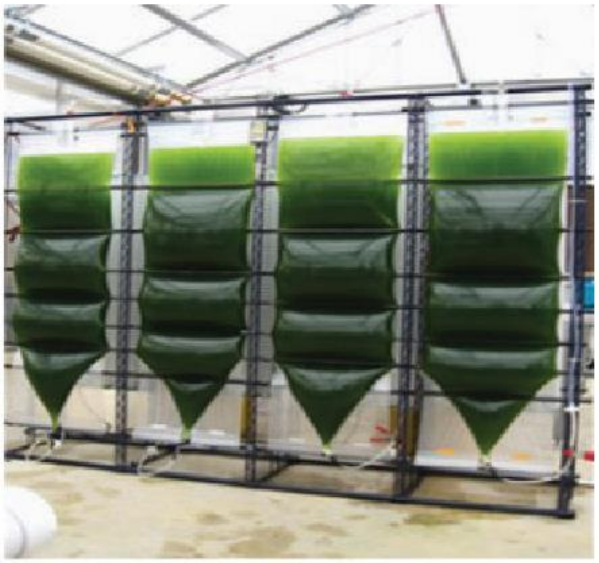


(*a*)



(*b*)

(*c*)

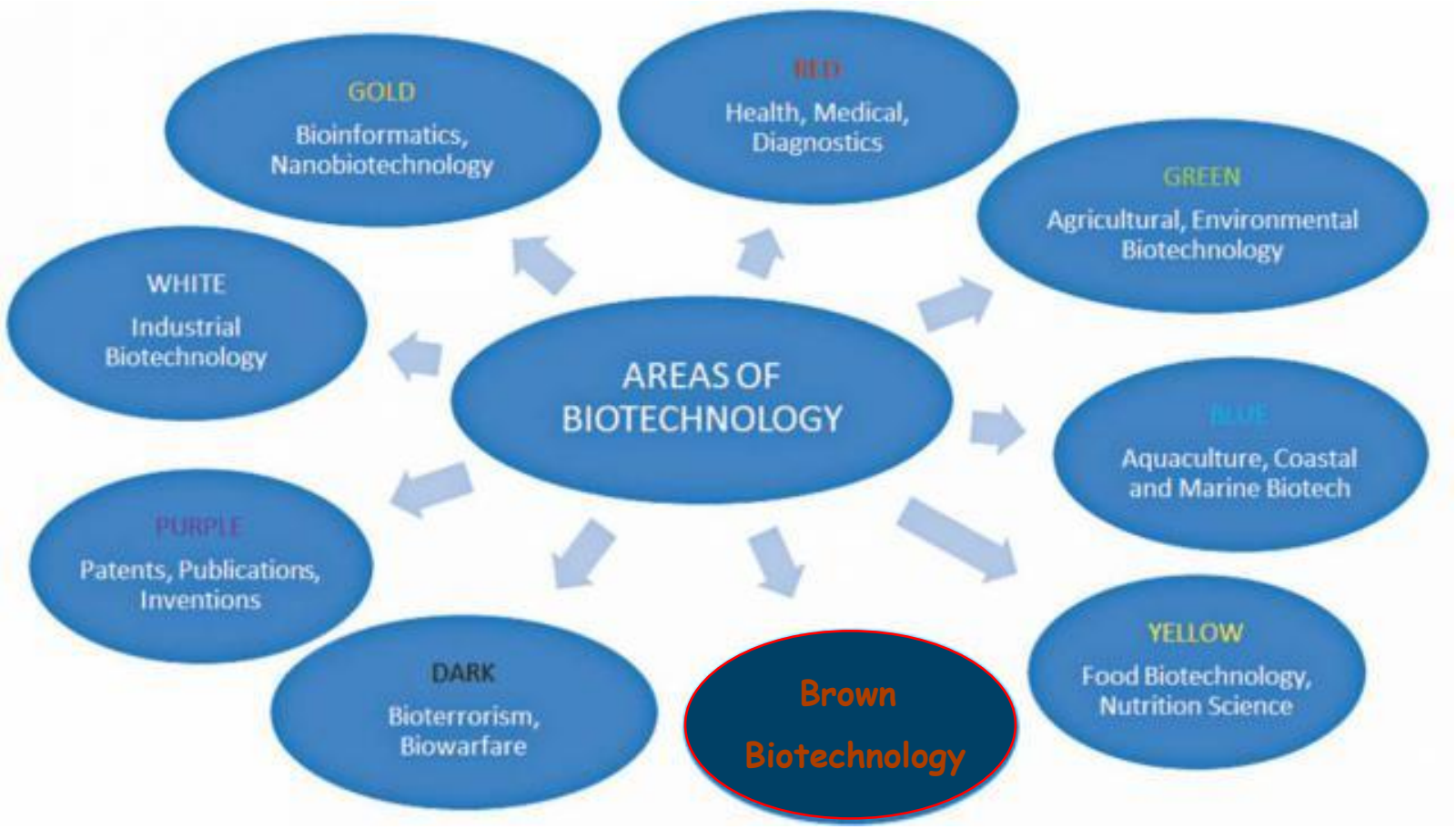


(*d*)

(*e*)

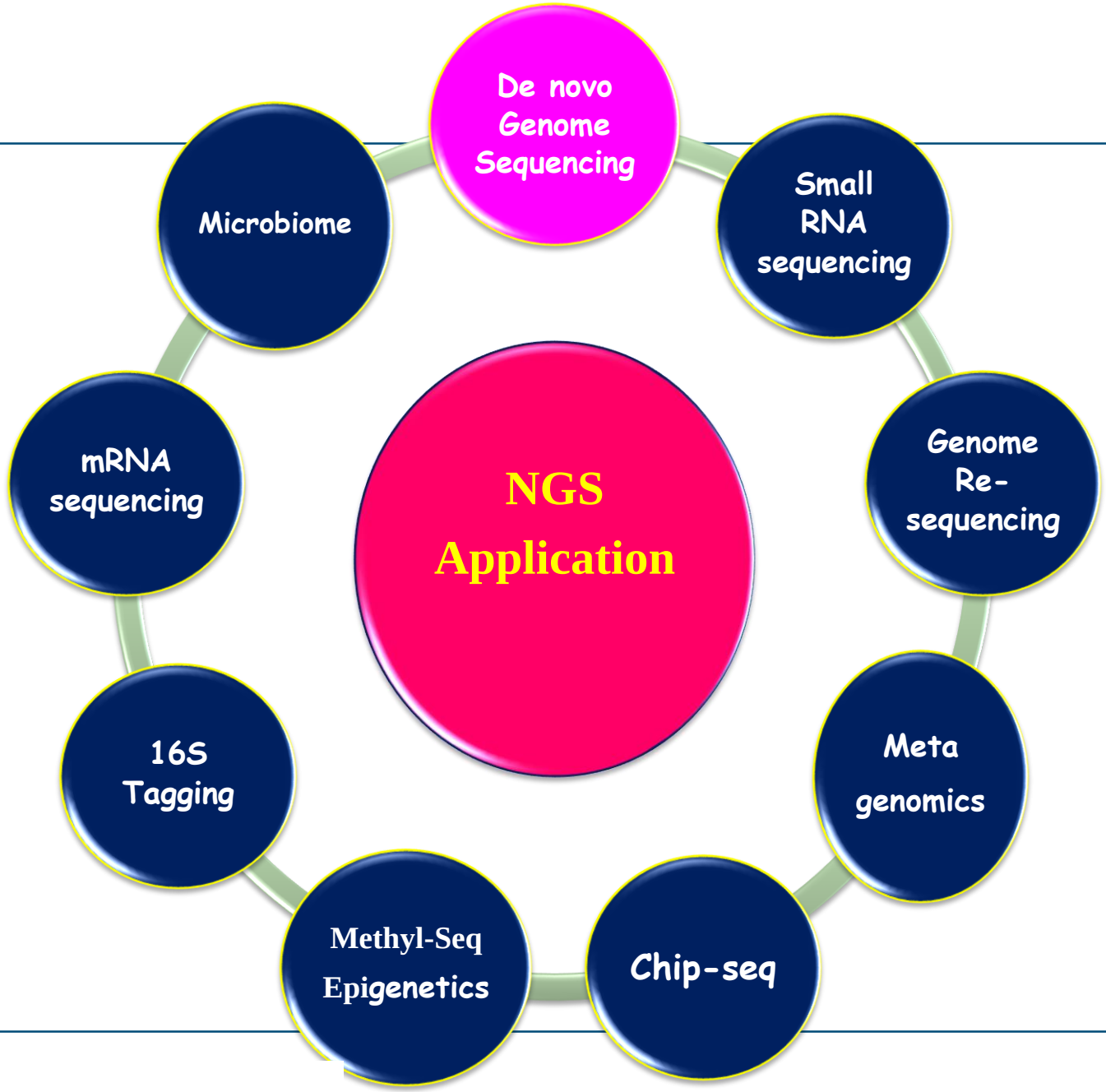
(*f*)

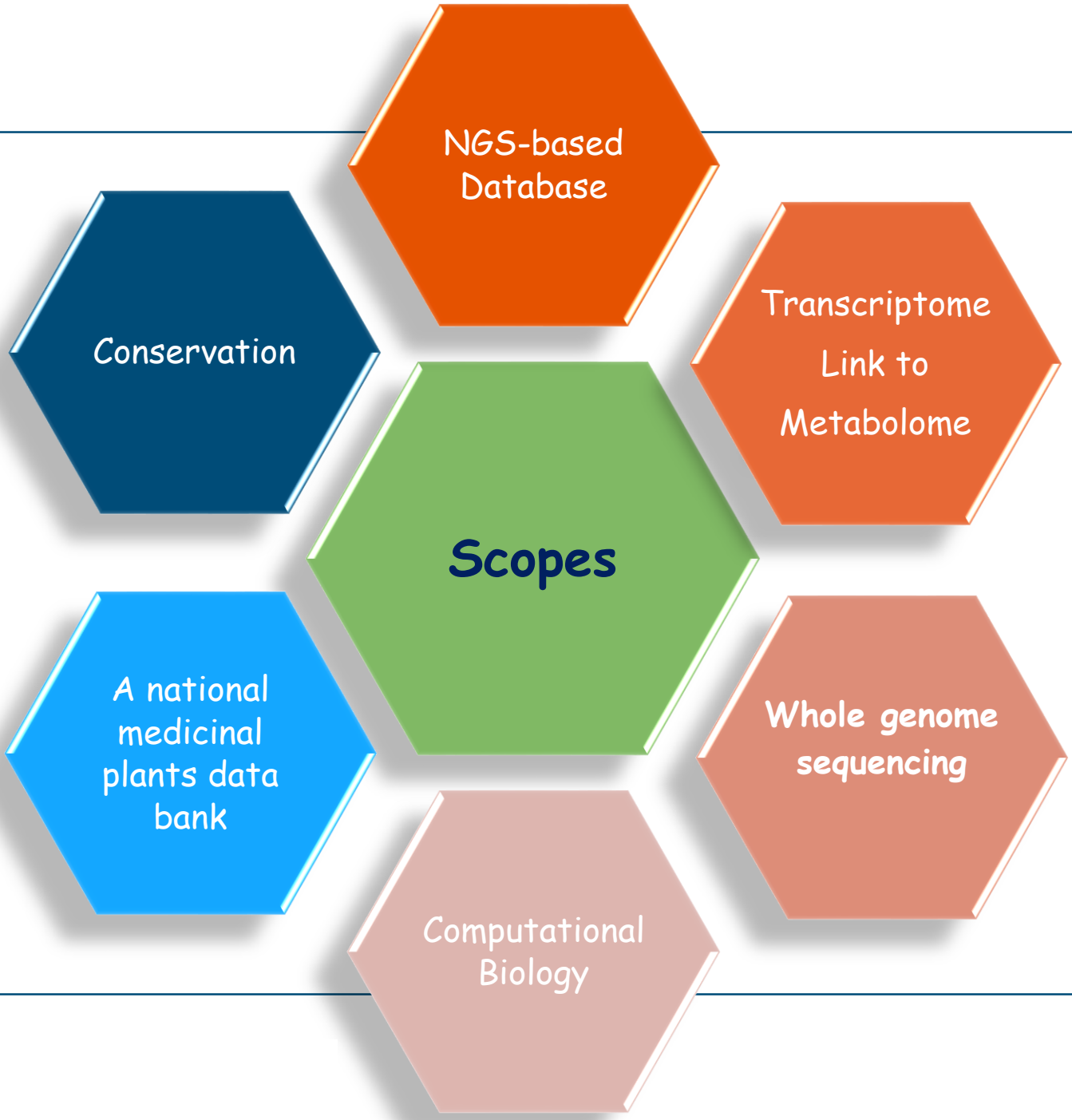
Desert Biotechnology

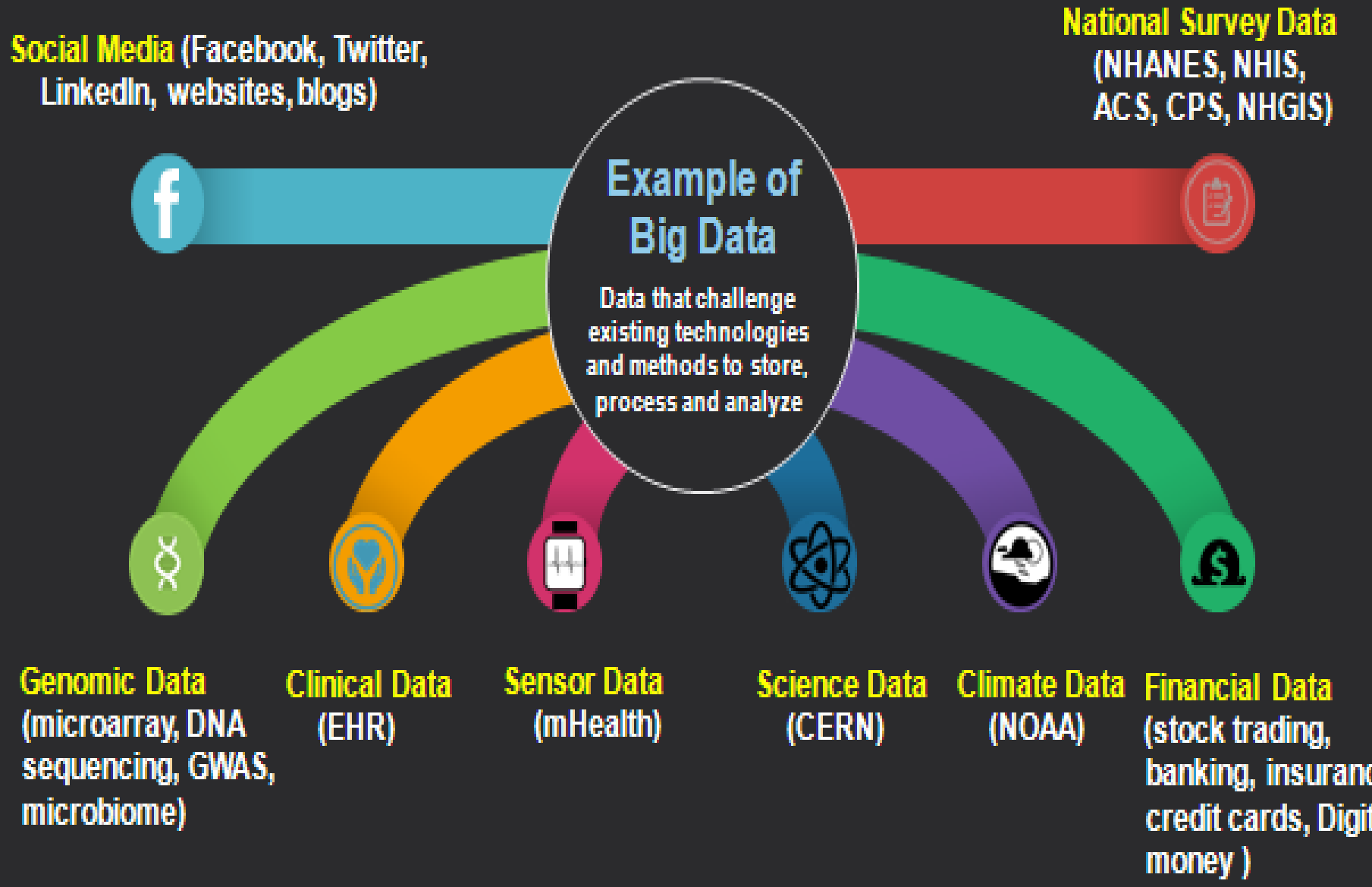


Approaches …

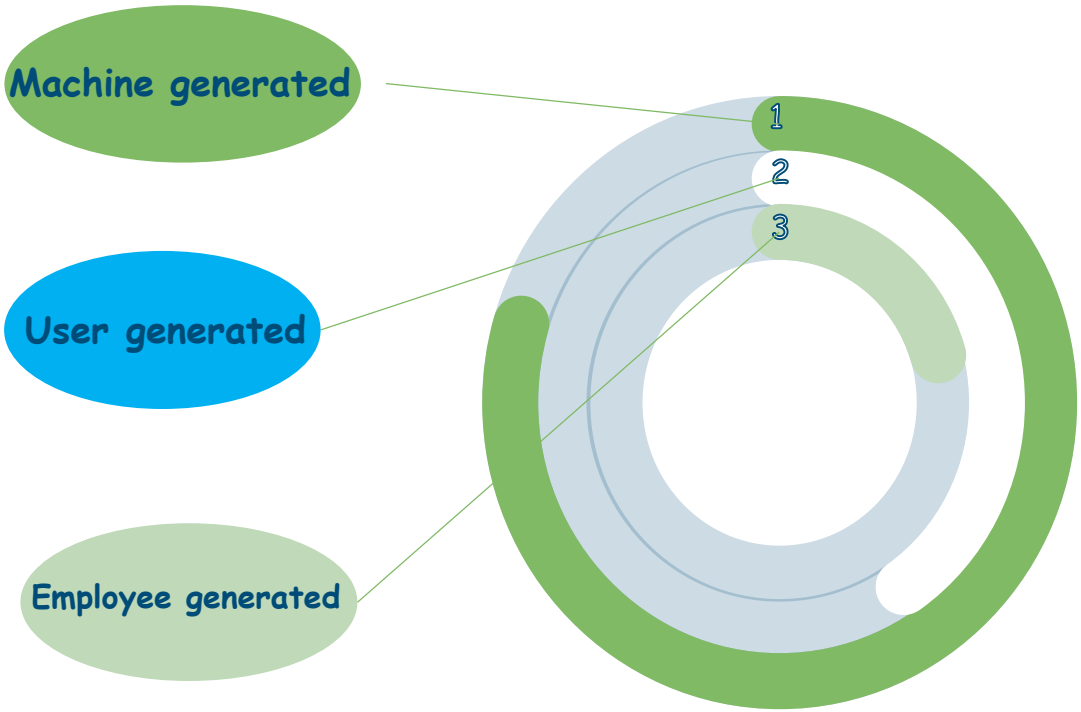
- Understanding the capabilities and potentials of desert and desert areas
- Available technologies and infrastructures
- Productivity of vast resources such as space, sun, salinity, heat and wind
- Discover the desert ecosystem (rare plants, halophytes, microbes, animals, etc.)
- Biodiversity conservation (Ex situ, In situ, In vitro, …)
- Diversity through **DNA fingerprinting** and **DNA barcodes**
- Understanding the mechanisms of both abiotic stress resistance (including salinity, drought and heat stresses)
- Transformation, Cis-Genesis, CRISPR-Cas, SATI, …
- **OMICS** sciences (e.g. Genomics, Transcriptomics, Proteomics, Metabolomics)
- Novel technologies: **Next Generation Sequencing (NGS)**


NGS
Application
De novo
Genome
Sequencing
Small
RNA
sequencing
Genome
Re-
sequencing
Meta
genomics
Chip-seq
Methyl-Seq
Epigenetics
16S
Tagging
mRNA
sequencing
Microbiome


NGS-based Database
Conservation
Transcriptome Link to Metabolome
Scopes
A national medicinal plants data bank
Whole genome sequencing
Computational Biology


Social Media (Facebook, Twitter, LinkedIn, websites, blogs)
National Survey Data (NHANES, NHIS, ACS, CPS, NHGIS)
Example of Big Data
Data that challenge existing technologies and methods to store, process and analyze
Genomic Data (microarray, DNA sequencing, GWAS, microbiome)
Clinical Data (EHR)
Sensor Data (mHealth)
Science Data (CERN)
Climate Data (NOAA)
Financial Data (stock trading, banking, insurance, credit cards, Digital money)

Generation of Big Data: How different source produce big content and volume



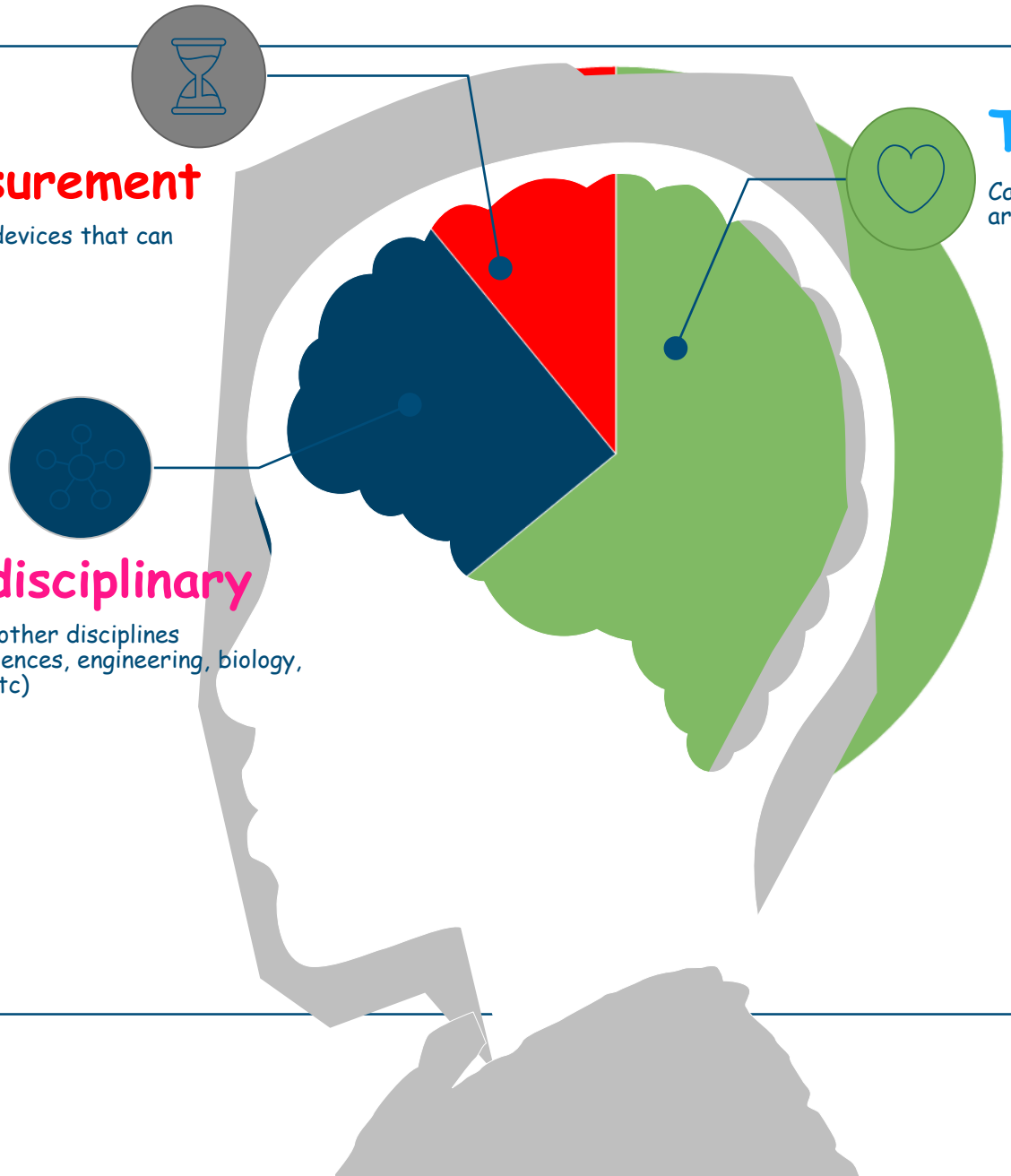
- ✓ >3 Zeta bytes of data exist in the digital universe today.
- ✓ Facebook stores, accesses, and analyzes 30+ Petabytes of user generated data.
- ✓ In 2008, Google was processing 20,000 terabytes of data (20 petabytes) a day.
- ✓ 100 terabytes of data uploaded daily to Facebook.
- ✓ Data production will be ~10 times greater in 2020 than present.
- ✓ In the last 5 years, more scientific data were generated than the total amount of data generated in previous human history.

Think Measurement

Do we have measurement devices that can generate big data?

Think Big

Can we use historically collected and archived big data?

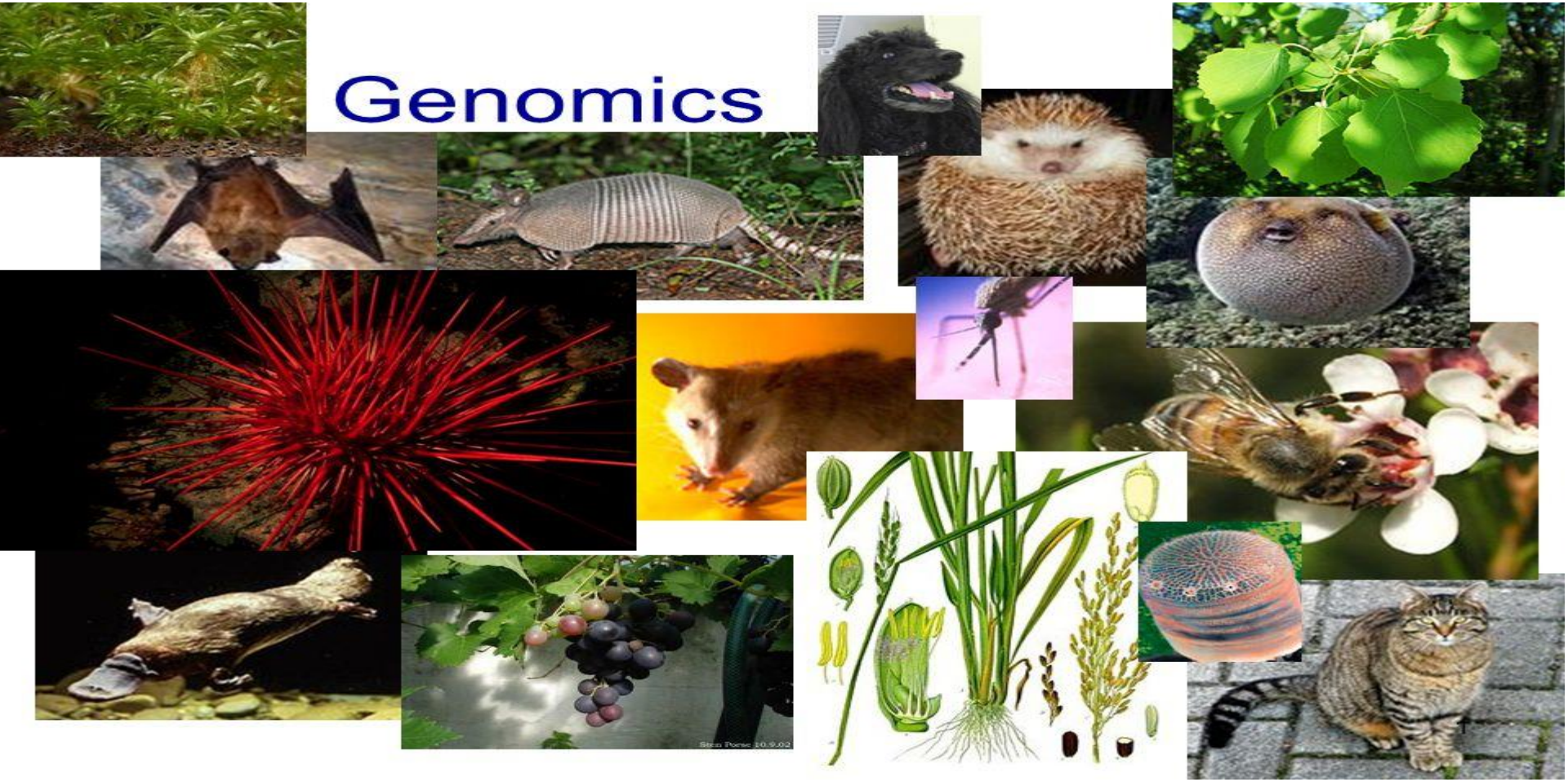


Think Multidisciplinary

Do we have experts from other disciplines (informatics, computer sciences, engineering, biology, mathematics, statistics, etc)

UK National Genome Projects

Other National Genome Projects

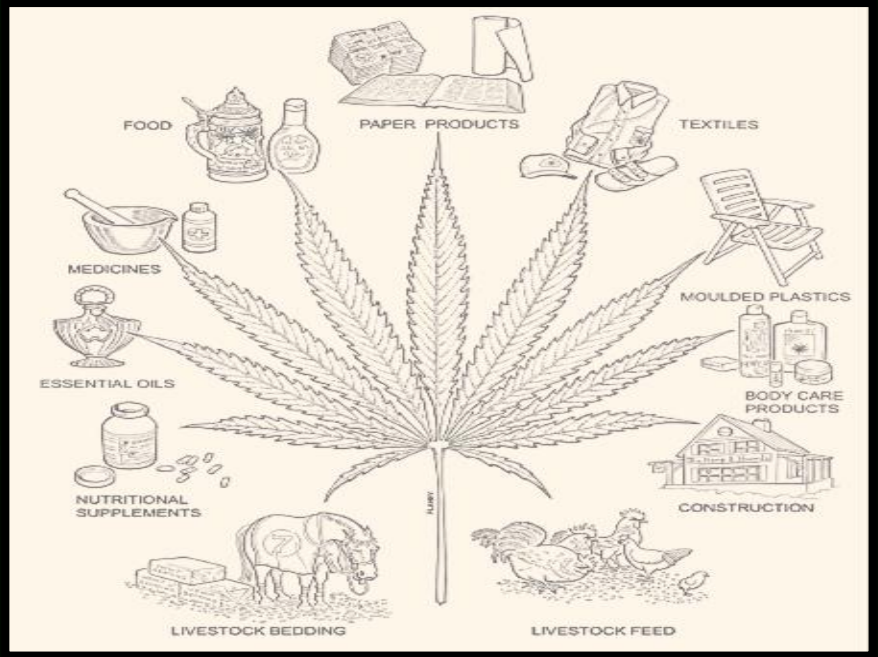


National Genome Projects

=

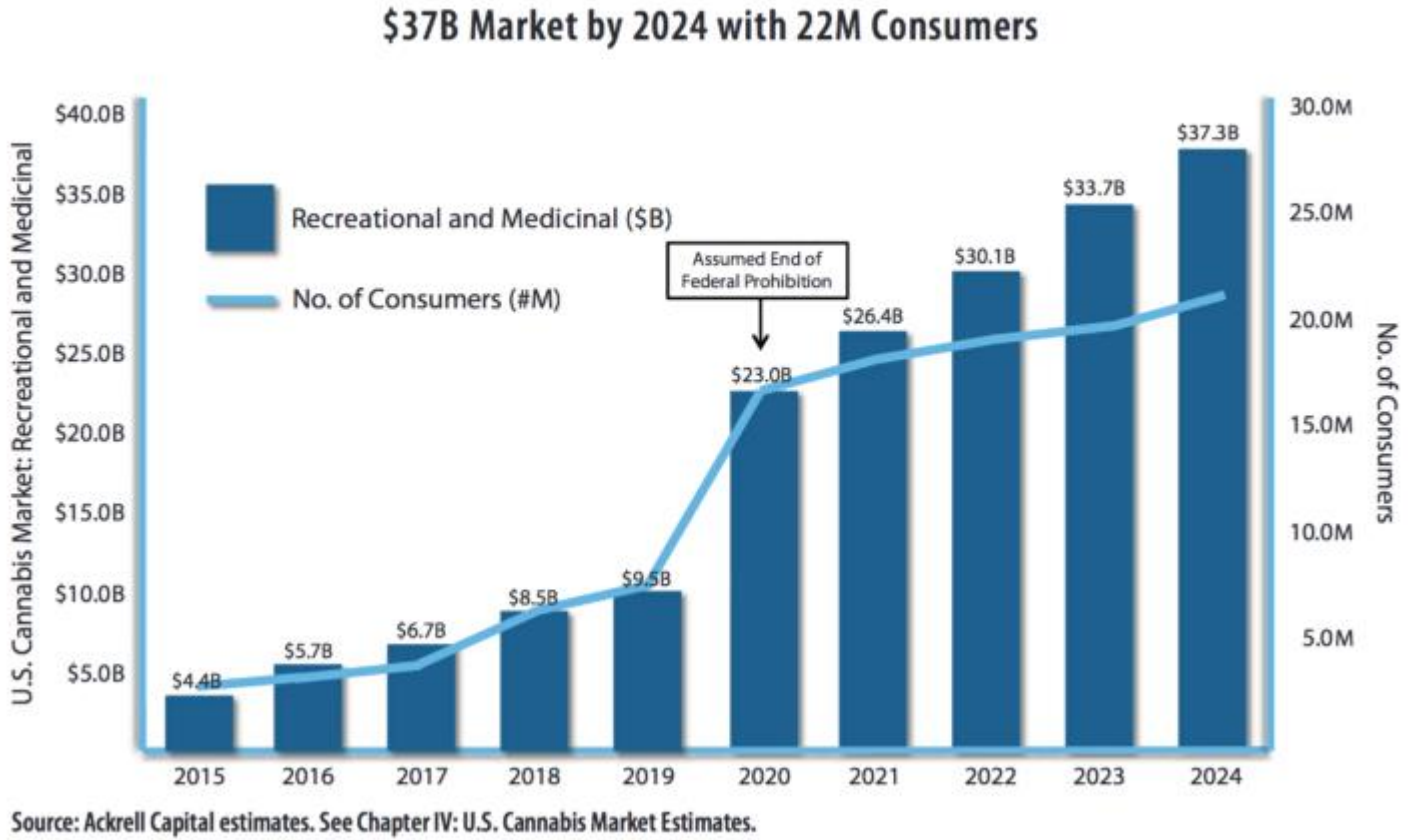
National DataBase

- The only source for Cannabinoids, THC, CDD, …
- Cancer
- Chemotherapy
- AIDS
- Pain
- Anti Spasm
- Anti-Emetic
- Asthma
- Cure MS (Sativex)
- Fiber
- Seeds, Proteins, Oil
- Soap, shampoo, cosmetics and balms

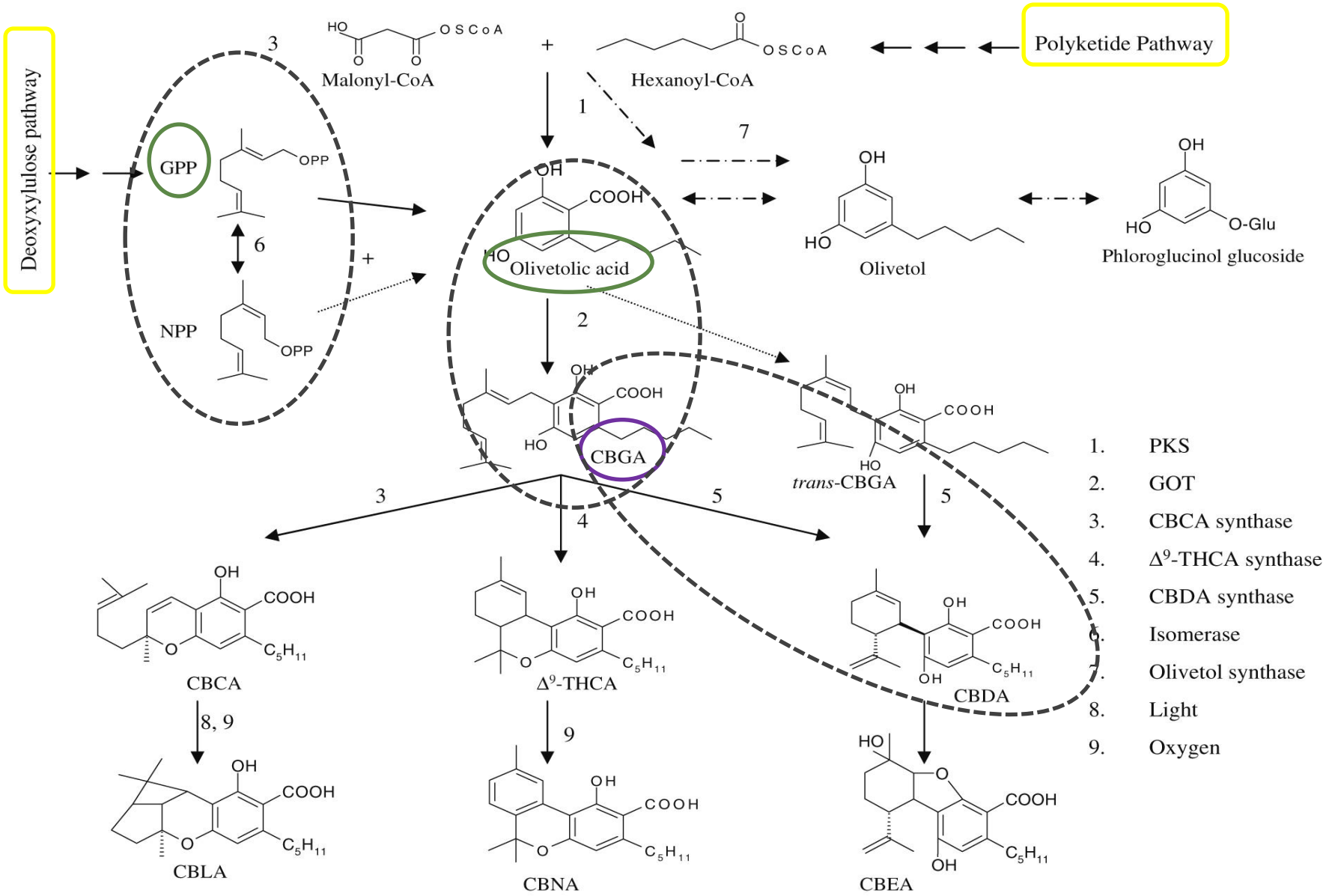


- **HEMP – Plant for the 3RD millennium**
- **HEMP can save the planet !**

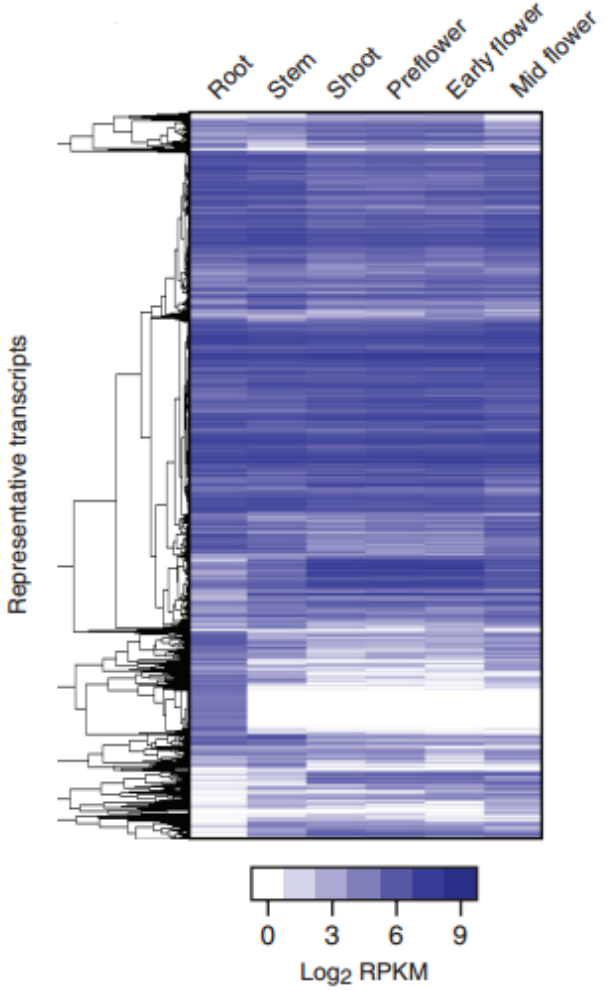
U.S. Cannabis Consumer Market: Recreational and Medicinal

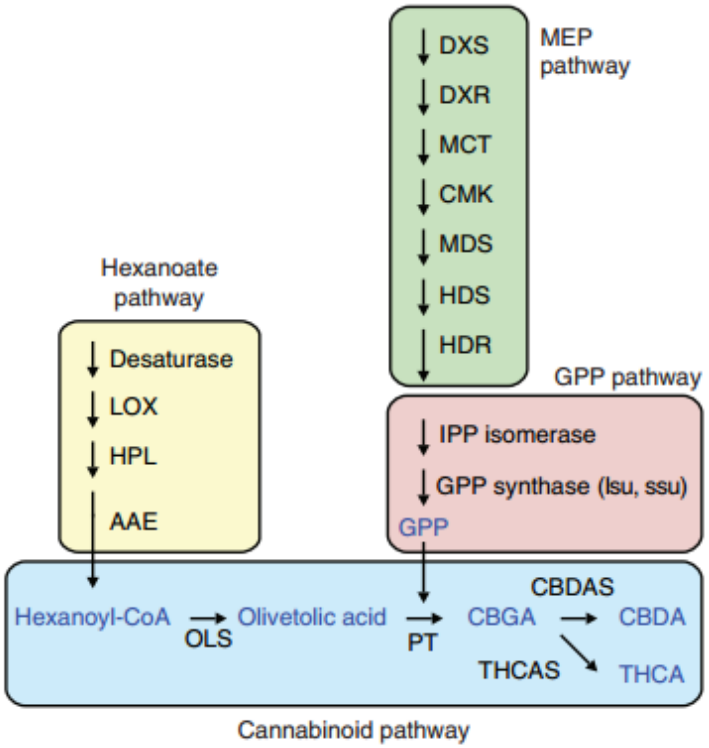


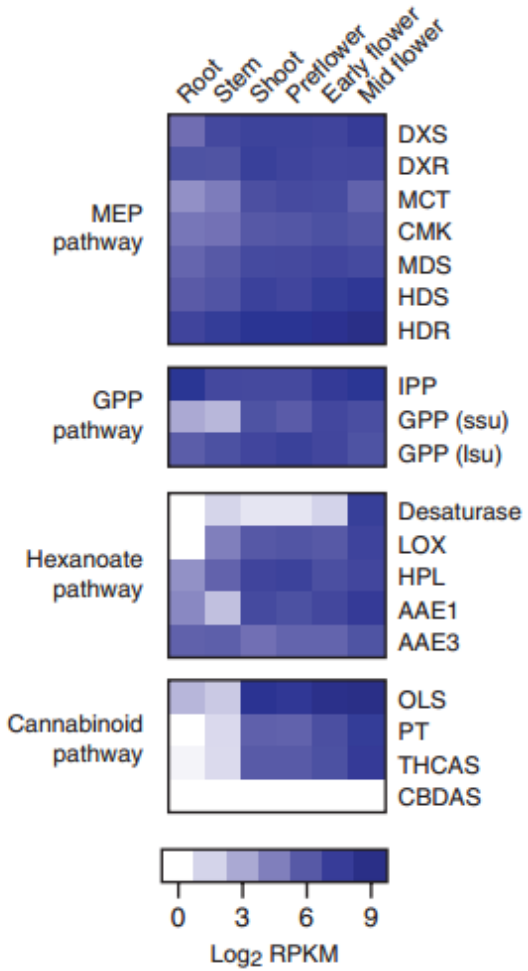
Source: Ackrell Capital estimates. See Chapter IV: U.S. Cannabis Market Estimates.

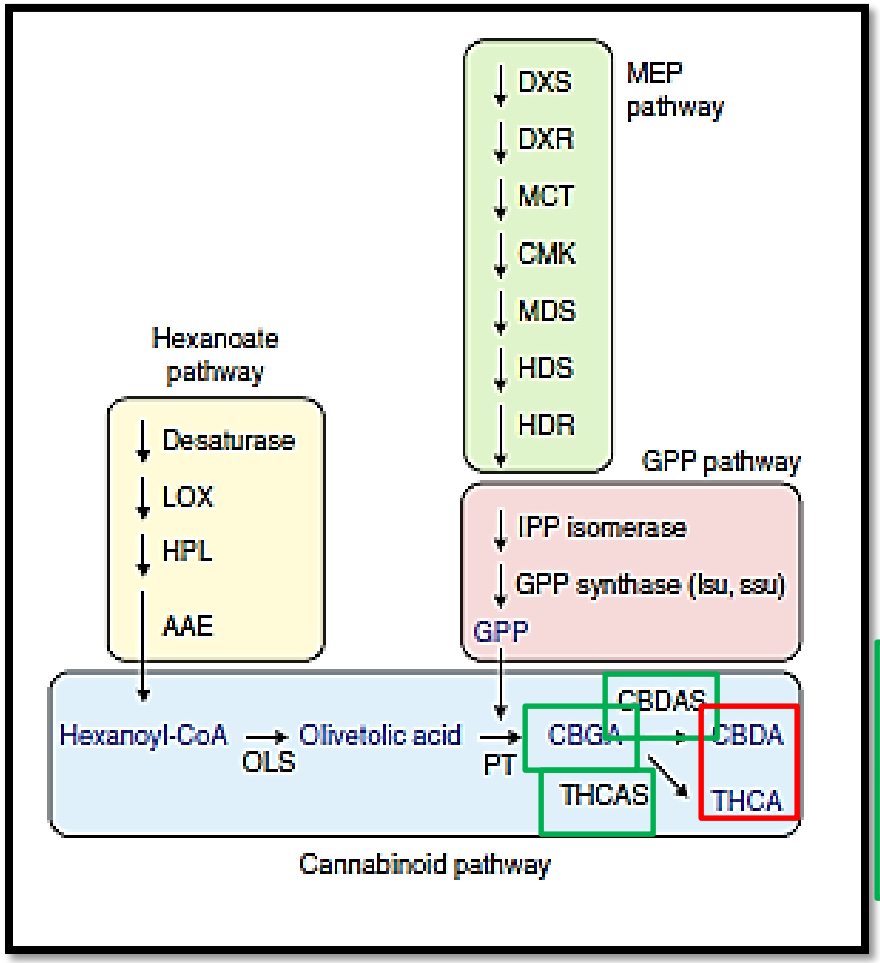

Deoxyxylulose pathway
Polyketide Pathway
Malonyl-CoA
Hexanoyl-CoA
GPP
NPP
OPP
Olivetolic acid
Olivetol
Phloroglucinol glucoside
O-Glu
CBGA
trans-CBGA
CBCA
Δ9-THCA
CBDA
CBLA
CBNA
CBEA
1. PKS
2. GOT
3. CBCA synthase
4. Δ9-THCA synthase
5. CBDA synthase
6. Isomerase
7. Olivetol synthase
8. Light
9. Oxygen

Cannabinoid pathway







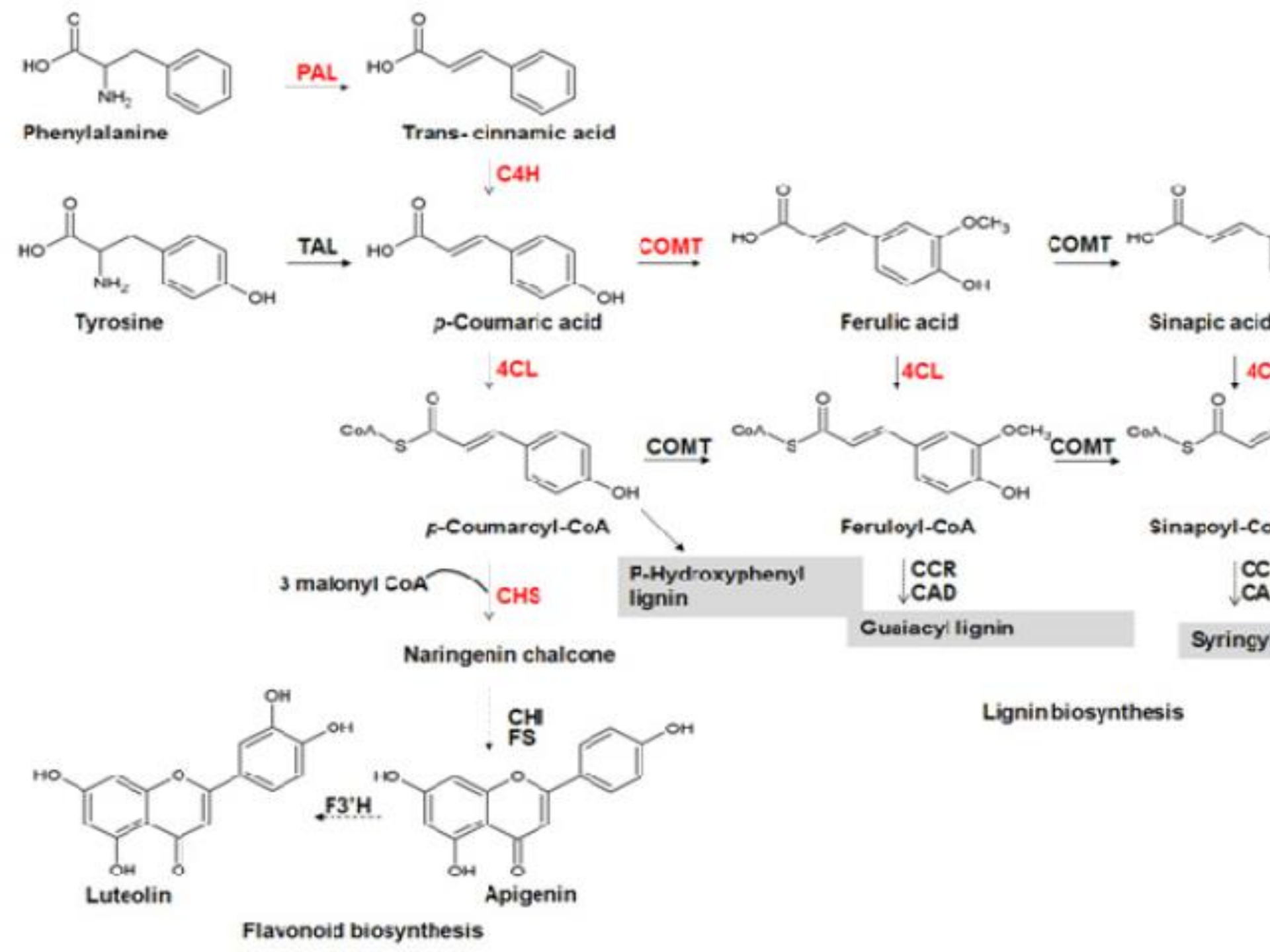


$$\frac{THC}{CBD} > 0.3 \longrightarrow \text{Medicinal/Drug}$$

$$\frac{THC}{CBD} < 0.3 \longrightarrow \text{Fiber/ Seed/ Oil}$$

$$\frac{THC}{CBD} \simeq \frac{1}{1} \longrightarrow$$

Sativex®


Phenylalanine
PAL
Trans- cinnamic acid
C4H
Tyrosine
TAL
p-Coumaric acid
COMT
Ferulic acid
COMT
Sinapic acid
4CL
4CL
4C
p-Coumarcyl-CoA
COMT
Feruloyl-CoA
COMT
Sinapoyl-Co
3 malonyl CoA
CHS
Naringenin chalcone
P-Hydroxyphenyl lignin
CCR
CAD
Guaiacyl lignin
CC
CA
Syringy
Lignin biosynthesis
CHI
FS
F3'H
Luteolin
Apigenin
Flavonoid biosynthesis

CannOMICS: How to put cannabinoids on health and food basket

Iran Cannabis collection

CannOMICS: How to put cannabinoids on health and food basket








Iran Cannabis collection















Cannabis Genome Browser

C. sativa (*Cannabis*) Genome Browser Gateway

The UCSC Genome Browser was created by the Genome Bioinformatics Group of UC Santa Cruz.

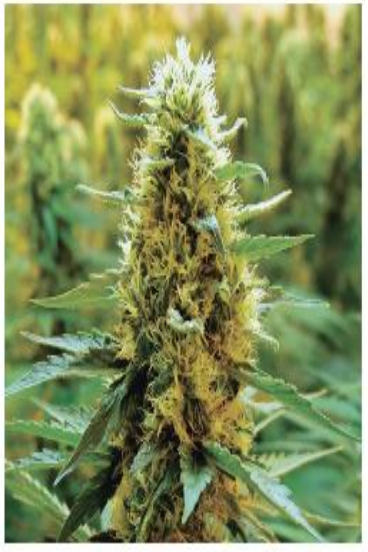
clade	genome	assembly	position or search term	
Plant	C. sativa	Purple Kush (canSat3)	scaffold19603:7,697-9,334	submit

Click here to reset the browser user interface settings to their defaults.

add custom tracks | configure tracks and display | clear position

About the C. sativa Purple Kush (canSat3) assembly (sequences)

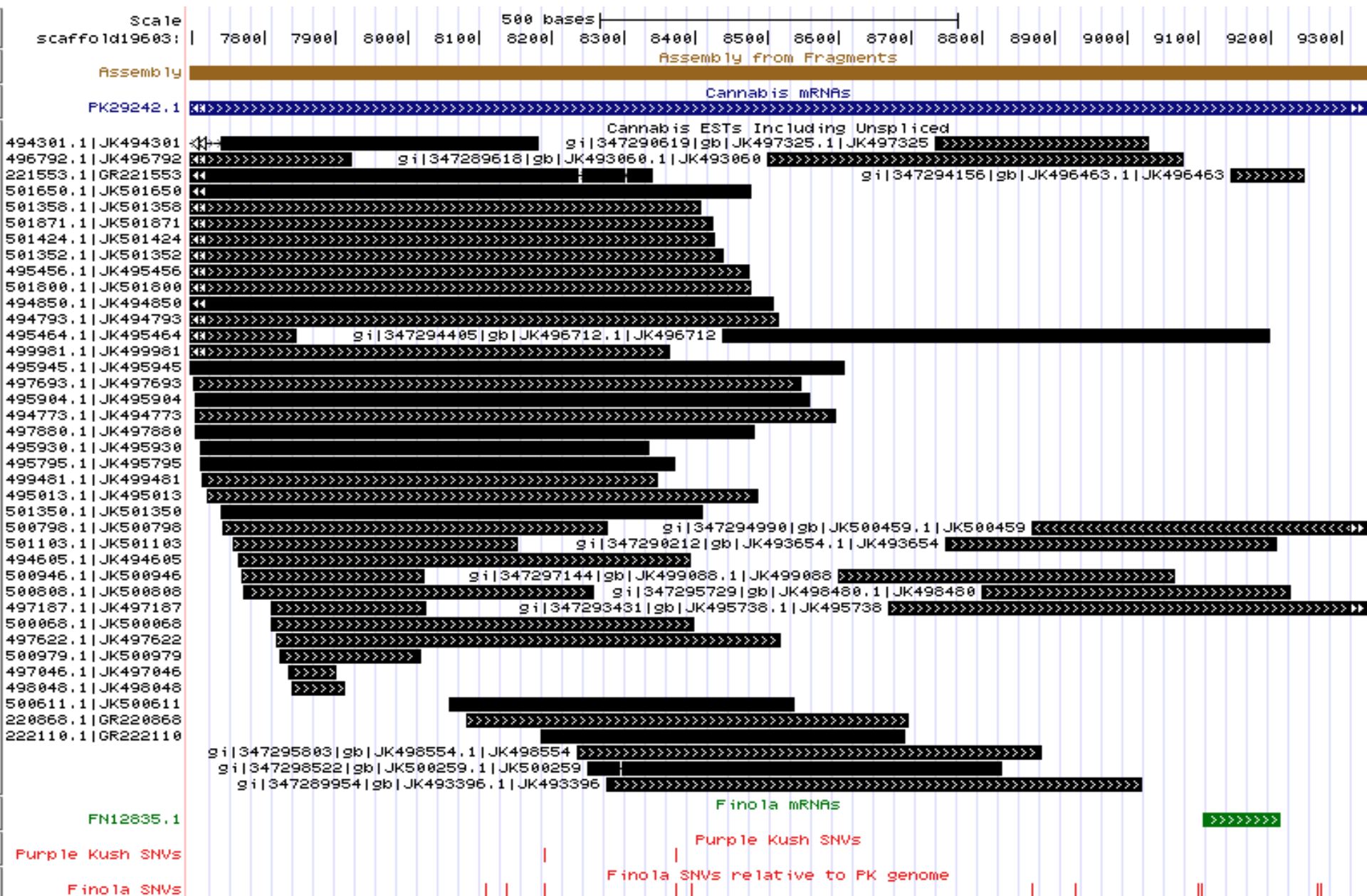
This project provides the assembled draft genome and transcriptome of *Cannabis sativa*. The high-potency medical marijuana strain Purple Kush was used for sequencing. The raw assembly data can be downloaded here.



Assembly overview

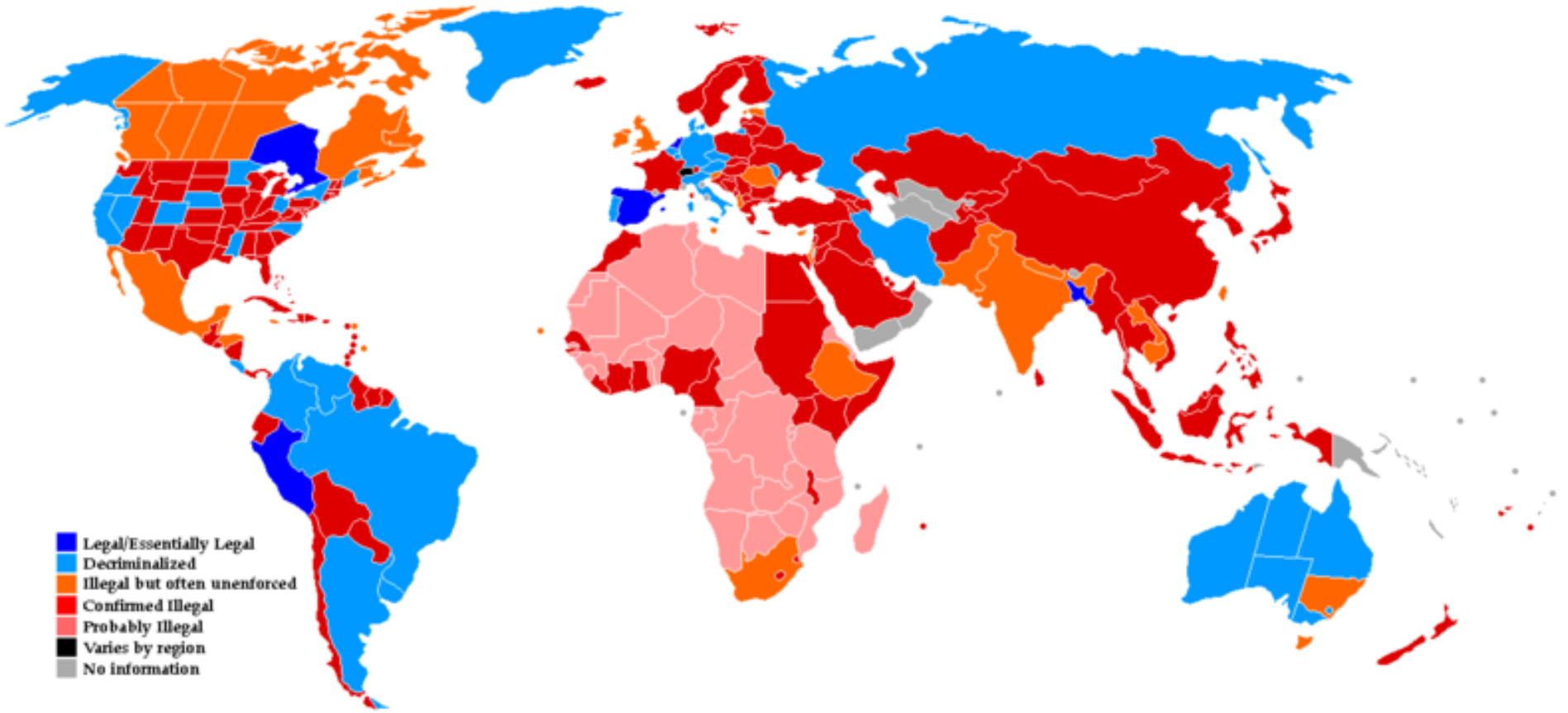
Minimum scaffold size:	400 bp
Total bases (+gaps)	787.3 Mb
Total bases (-gaps)	534.7 Mb
N50	16.2 kb
Maximum scaffold size:	565.9 kb
Number of scaffolds:	136,377

Genome Browser on *C. sativa* Purple Kush (canSat3) Assembly



Genome Browser on *C. sativa* Purple Kush (canSat3) Assembly

World Cannabis Laws




C.indica_Pakistan
CAN37-M
CAN-37-97
921298-M
CAN37-F
891385-M
921298-F
891385-F
CAN18-M
CAN_23_99
VIR_569
CAN_39_98
Ard-01-F
PCA1
PCA2
-0.3
-0.2
-0.1
0.0
0.1
Type
Hemp
Marijuana
Orginal from Canada
Orginal from Iran

CannOMICS: How to put cannabinoids on health and food basket

1- Establish a core gene bank of cannabis in Iran (Done)

2- Study the diversity of Cannabis populations collected from different regions of Iran using morphological, phytochemical, ISSRs, SSRs markers as well as GBS (Done).

3- Whole genome sequencing (WGRS) of selected Iranian cannabis beside Purple kush and Finola (Ongoing)

4- Whole transcriptome analysis (RNA-Seq) and Small RNA Sequencing in cannabis (Ongoing)




CannOMICS: How to put cannabinoids on health and food basket

5- Genetic diversity and phytochemical analysis of Cannabis populations collected from different regions of the world (We are doing GBS analysis on hundreds of accessions were collected from different regions of the world).

6- Differential expression of THCAS and CBDAS in different tissues and different developmental stages of drug and non-drug type of Cannabis (Done).

7- Silencing of Cspds and CsTHCAS genes in Cannabis using VIGS: Optimizing silencing of key genes involved in cannabinoid biosynthesis pathway (Done).

8- Stable transformation of Cannabis to overexpress a few selected genes (Done).



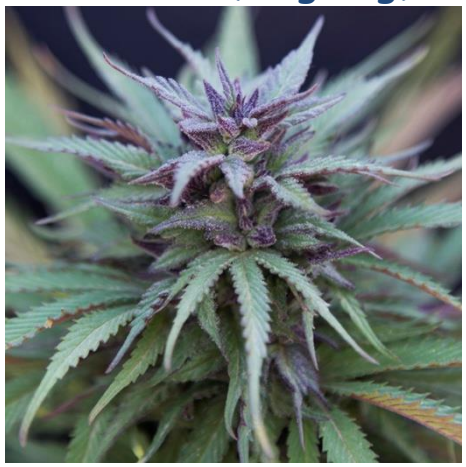

CannOMICS: How to put cannabinoids on health and food basket

9- Embryogenesis, organogenesis, suspension cell culture and hairy root culture in *Cannabis sativa* (Done).

10- Effect of abiotic (UV, TiO_2, wounding, salinity, drought and cold) and signaling elicitors (Salicylic acid, GA3, GABA, MtJA, Ascorbic acid) on metabolite synthesis in drug type cannabis (Done).

11- Study of polymorphisms, structure, expression and function of key genes involved in Cannabinoids biosynthetic pathway in drug and fibre type of Cannabis (Done).

12- Genetics of sex determination in *Cannabis* and discovery the markers linked to sex in Cannabis (Ongoing)




13- Anti microbial and anti oxidative effects of selected Cannabis chemotypes on human, animal and plant diseases as well as the first round of medical cannabis clinical trials (Ongoing):

Alzheimer

Alcoholism clinical trials

Pediatric Brain Cancer and Adult Brain Cancer

Childhood Epilepsy

Chronic Pain

PTSD - Anxiety

MS

Skin diseases




CannOMICS: How to put cannabinoids on health and food basket

14- Phytochemical fingerprinting and genomics of unknown metabolic pathways in Cannabis (Ongoing)

15- Regulatory engineering of cannabinoids pathway: Engineering towards High-THC and THC-free Cannabis (Ongoing)

16- Genetic regulatory network in the development of trichomes in Cannabis: characterization of Cannabis glandular trichome transcriptome using RNASeq (Ongoing)

17- Medical cannabis and Hemp breeding (Ongoing)




CannOMICS: How to put cannabinoids on health and food basket

18- Breeding of selected lines for cannabis oil/fiber/drug … (Ongoing)

19- Establish an experimental phase select and grow varieties high in CDB and low in THC and vice versa.

20- The chemical phenotyping (cannabinoids and terpenoids) of different cannabis strains in my lab together with genomic/genetic analysis.




Research Site 1

Research Site 2


E1B

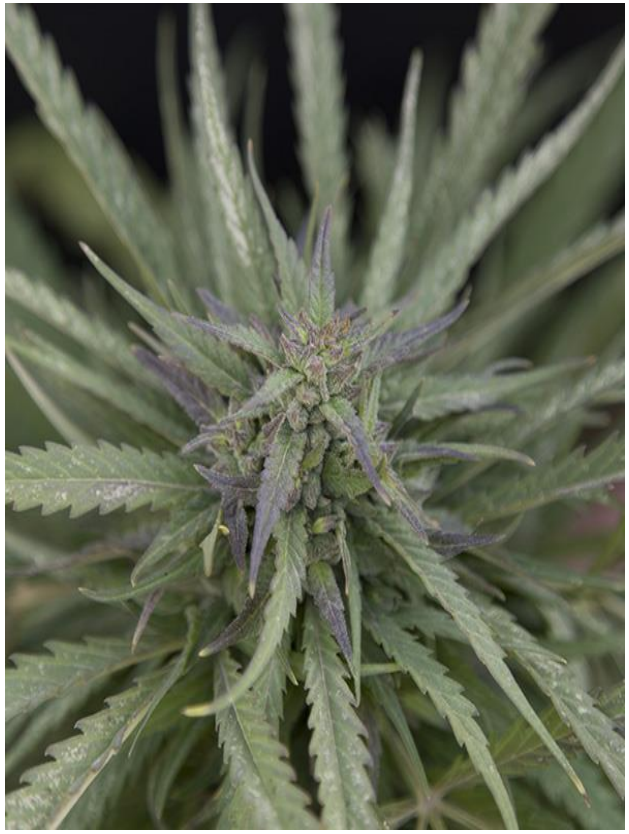

E2B

THC: 2.99%
CBD: 1.87 %
Height : 164
Time to flowering: 122
THC/CBD: 1.59

THC: 3.03 %
CBD: 0.73 %
Height: 158.5
Time to flowering: 116
THC/CBD: 4.12

THC: 22.74 %
CBD: 23.92 %
Height: 109.6
Time to flowering: 123
THC/CBD: 0.95

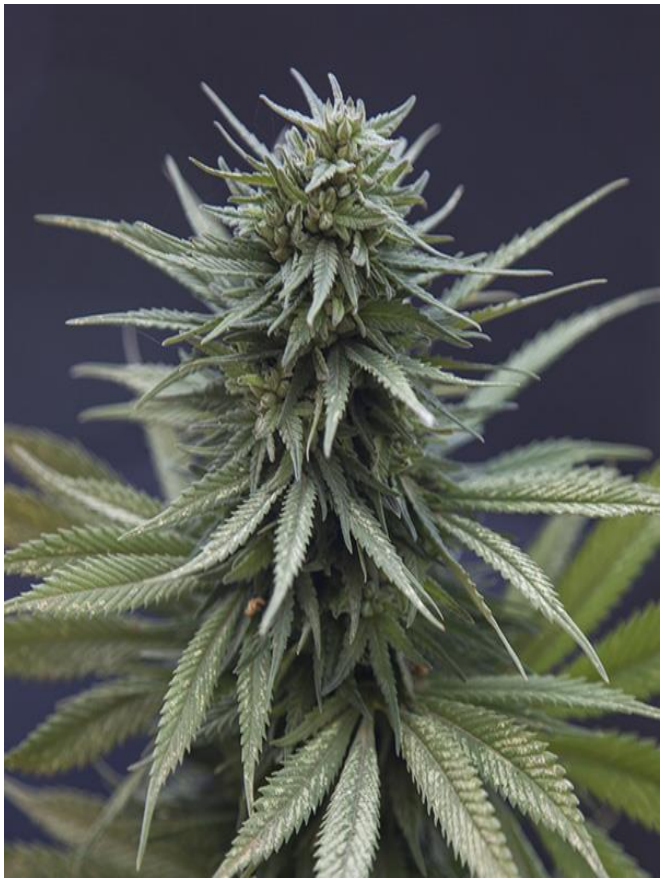
THC: 17.72 %
CBD: 27.70 %
Height: 151
Time to flowering: 120
THC/CBD: 0.63



THC: 33 %
CBD: 15.75 %
Height: 102.8
Time to flowering: 118
THC/CBD: 2.09

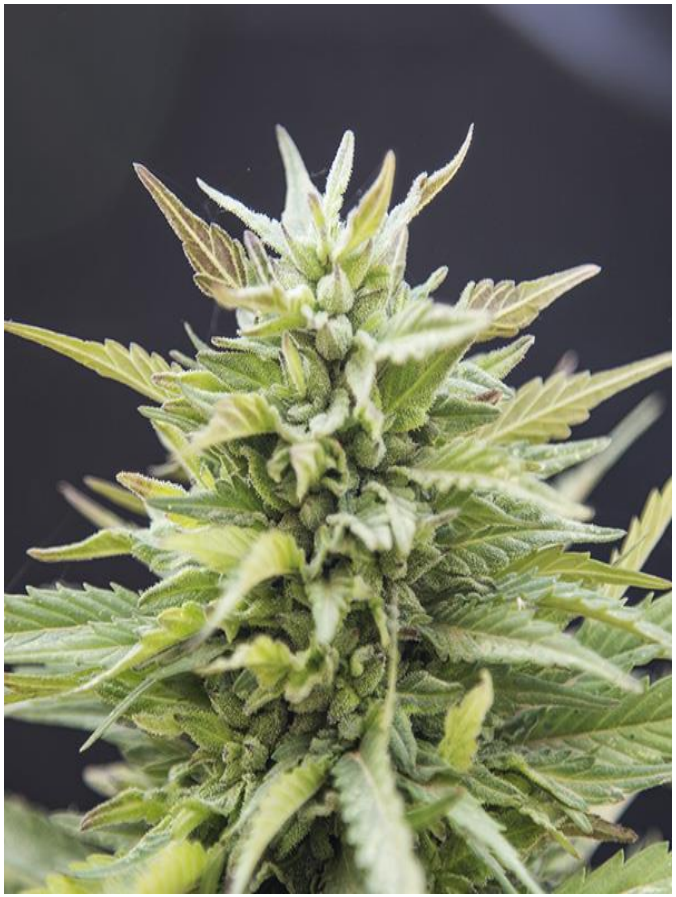
THC: 0.75 %
CBD: 1.16 %
Height: 105.2
Time to flowering: 121
THC/CBD: 0.64

THC: 3.66 %
CBD: 1.46 %
Height: 173.5
Time to flowering: 121
THC/CBD: 2.50



THC: 1.59 %
CBD: 2.54 %
Height: 129
Time to flowering: 130
THC/CBD: 0.62

THC: 0.3 %
CBD: 2.4 %
Height: 186
Time to flowering: 128
THC/CBD: 0.14

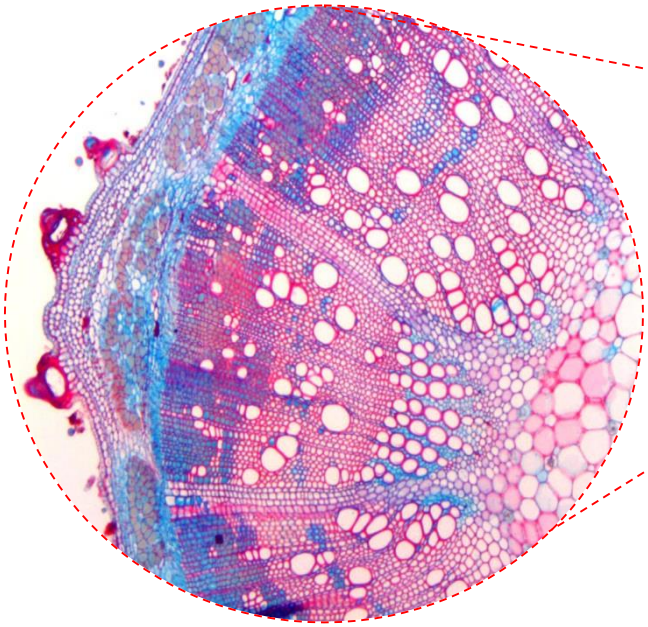


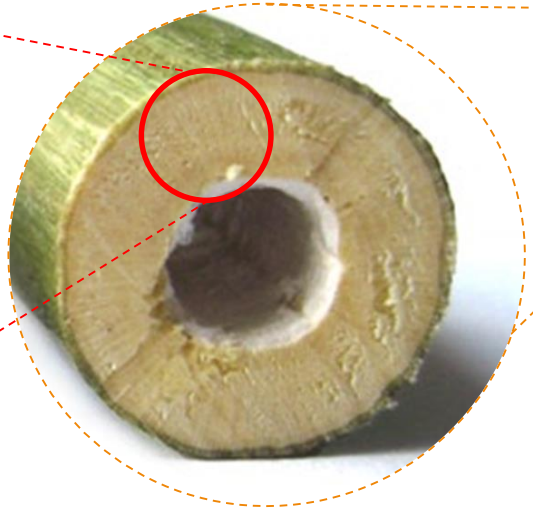
THC: 1.75 %
CBD: 1.38 %
Height: 86.75
Time to flowering: 116
THC/CBD: 1.2

منابع جایگزین

توسعه پایدار

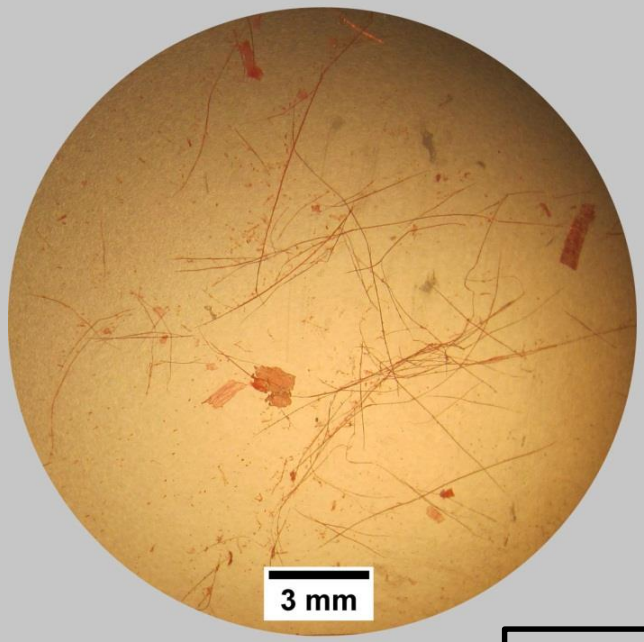
(*Cannabis sativa* L.)

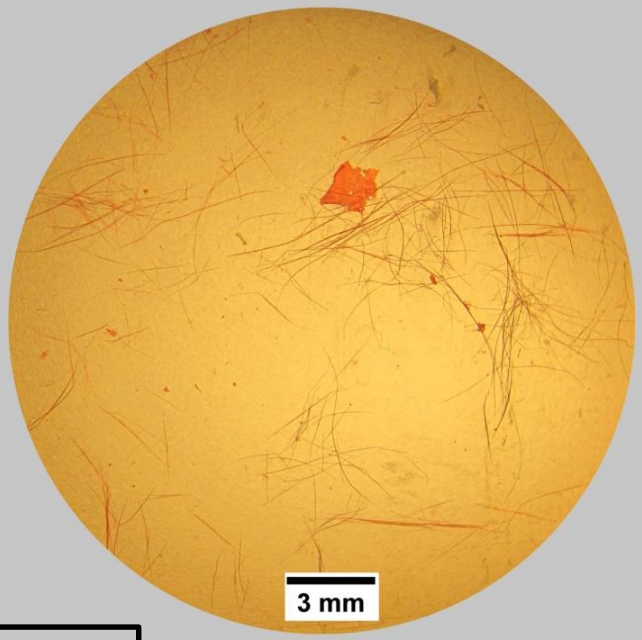




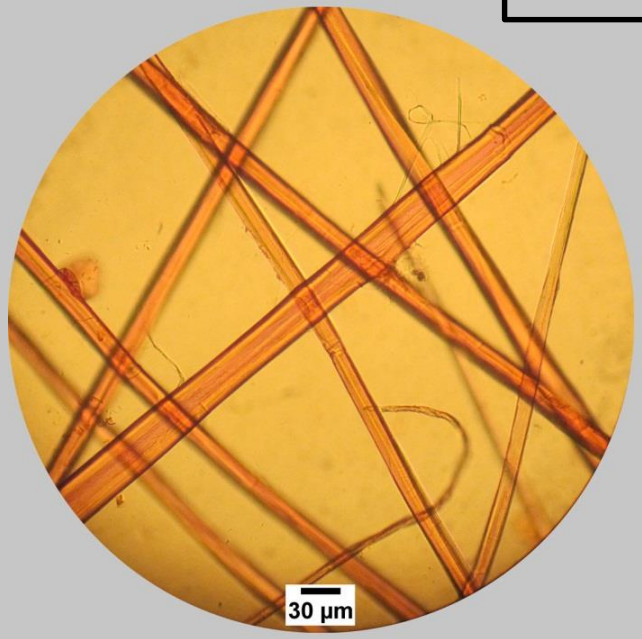
30-60 mm

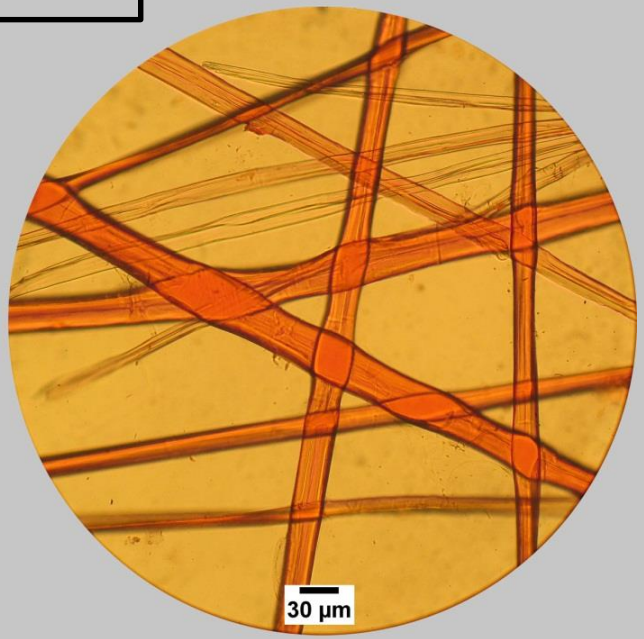
1-5 m

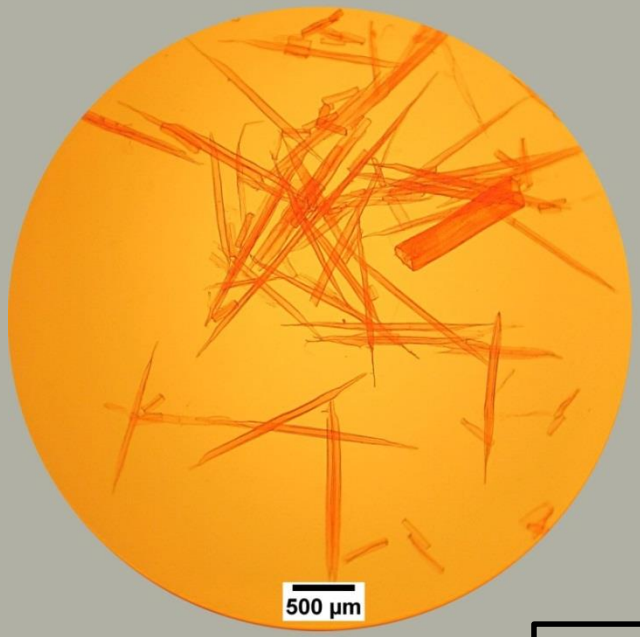


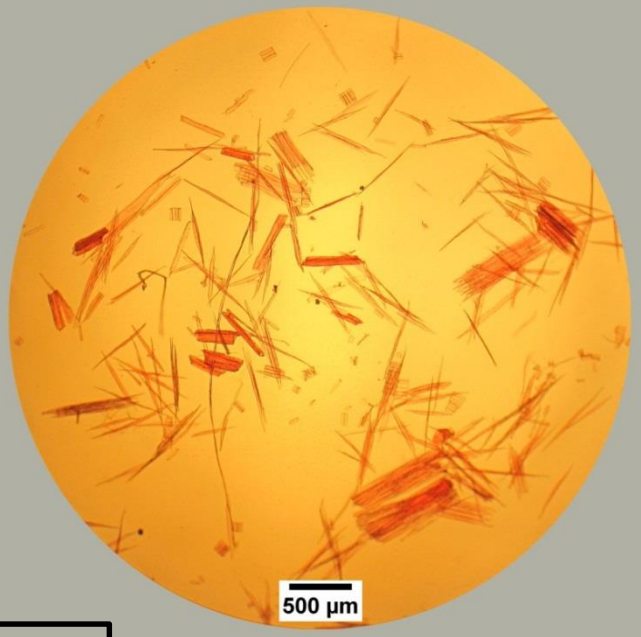


Bark fiber

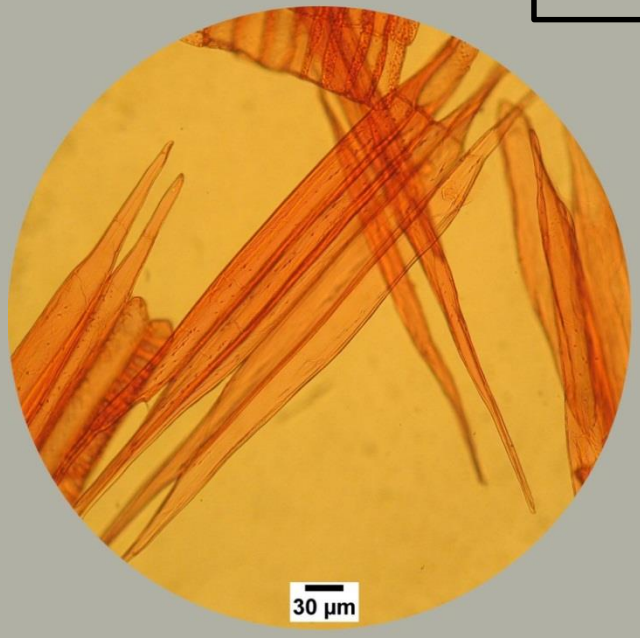


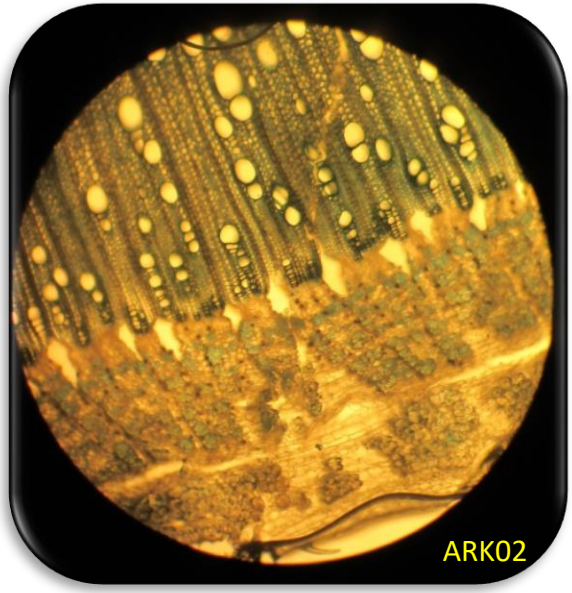


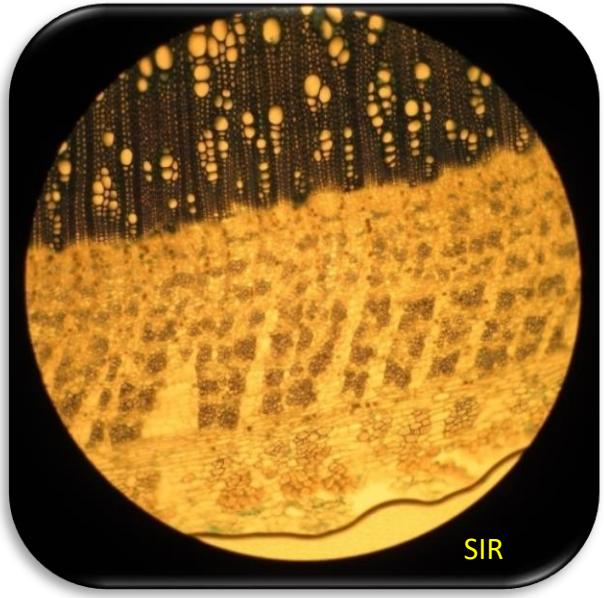




Wood fiber




ARK02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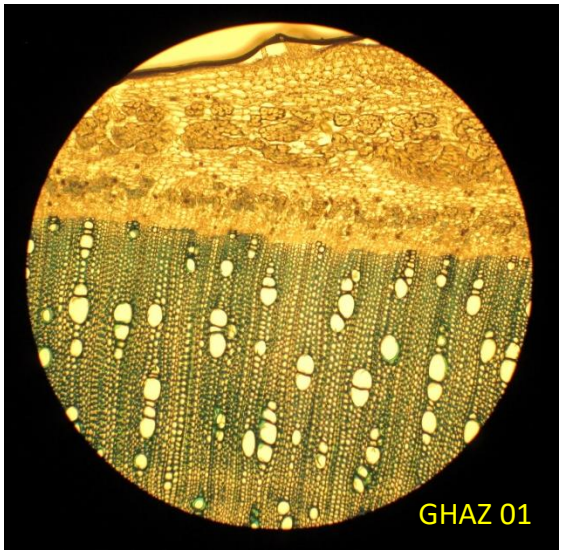
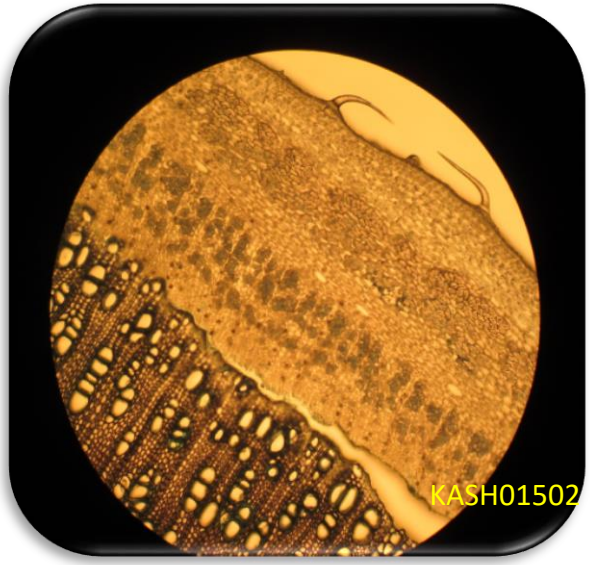

GHAZ 01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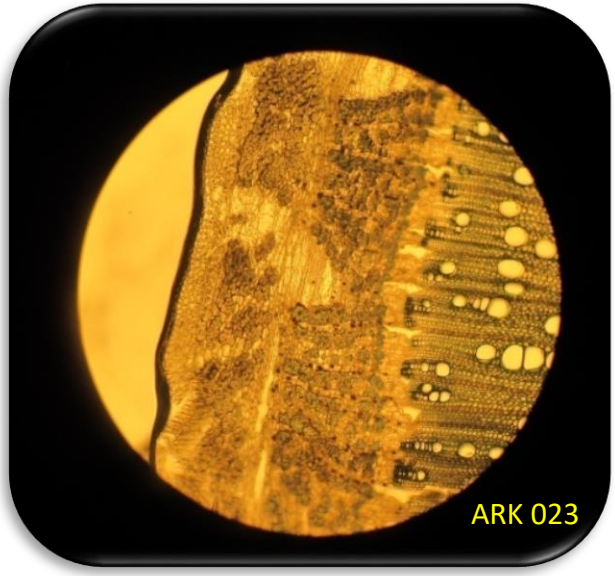
ARK 023


MAH 012

Data and Resources are everything…