

# The Plant Science of *Cannabis sativa*



Peter Apicella

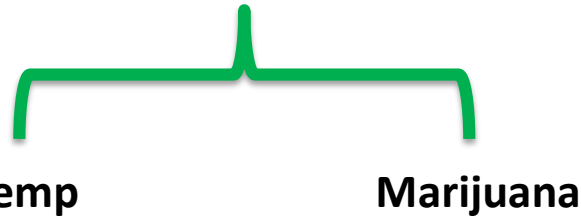
Dr. Gerald Berkowitz

# Key Terms

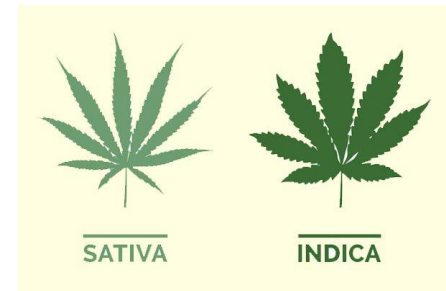
- The crop – cannabinoids – pharmaceutical components of cannabis
- There are many cannabinoids, but we will only focus on two of the most important ones:
  - Tetrahydrocannabinol (THC) – psychoactive
  - Cannabidiol (CBD) – non-psychoactive

# Cannabis Taxonomy

- One highly polymorphic species  
*Cannabis sativa*



- Hemp and Marijuana are members of the same species of *Cannabis sativa*
- There are different varieties of hemp
- My focus: CBD hemp and Marijuana



# What do you harvest?

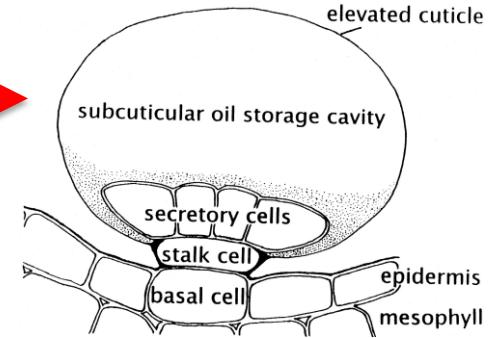


Unfertilized female flowers  
"sinsemilla"

Leaves not as densely  
covered with trichomes



Cannabinoids  
produced  
here



Flower bract densely  
covered in trichomes

Trichome close-up





# Harvest time!

Marijuana



- Marijuana is often grown indoors for harvesting multiple crops per year
- Allows for strict environmental controls
- Usually not more than 5 acres

Hemp



- Hemp is typically grown outdoors
- Only one harvest per year
- Little infrastructure allows for scalability
- Farms can be 100s of acres

# The Main Difference

- Hemp is classified as being  $\leq 0.3\%$  THC
  - 2018 Farm Bill
  - If flower from a hemp plant tests, 0.31% THC, it can be considered marijuana and its destruction can be legally mandated
- Hemp can be very high in another cannabinoid, cannabidiol (CBD), which does not cause a high when ingested
- Marijuana typically has lower concentrations of CBD

# Hemp or Marijuana?



Hemp



Marijuana

How do you tell the difference?

- Chemical component testing with:
  - High Performance Liquid Chromatography
- Instrument also used for ensuring there aren't any illegal pesticide residues on organic foods



High Performance Liquid Chromatography machine

# Schedule 1 Drugs

- Marijuana and its THC are schedule 1 drugs
  - Other Schedule 1 drugs include: heroin, ecstasy, and LSD
  - These drugs have no federally recognized medicinal value and have a high risk of abuse
- Disclaimer:
  - The scientific literature tells us that there are medical benefits of consuming Marijuana and its psychoactive chemical, THC



# Interesting implications for law enforcement

- Hemp looks, feels, and smells exactly like marijuana
- Testing is very costly
  - Independent labs charge \$70 per sample
  - Costly equipment and skilled labor
- Prosecutions getting dropped



# Cannabis Botany

- Member of the *Cannabaceae* family
  - Hops (*Humulus lupulus*) is a close relative
- Compound palmate leaves
- Varieties can be dioecious or monoecious
- Short-day plant

CBD hemp variety

Dioecious  
male plant



Dioecious  
female plant



Hops (*Humulus lupulus*)



Pollen sacs

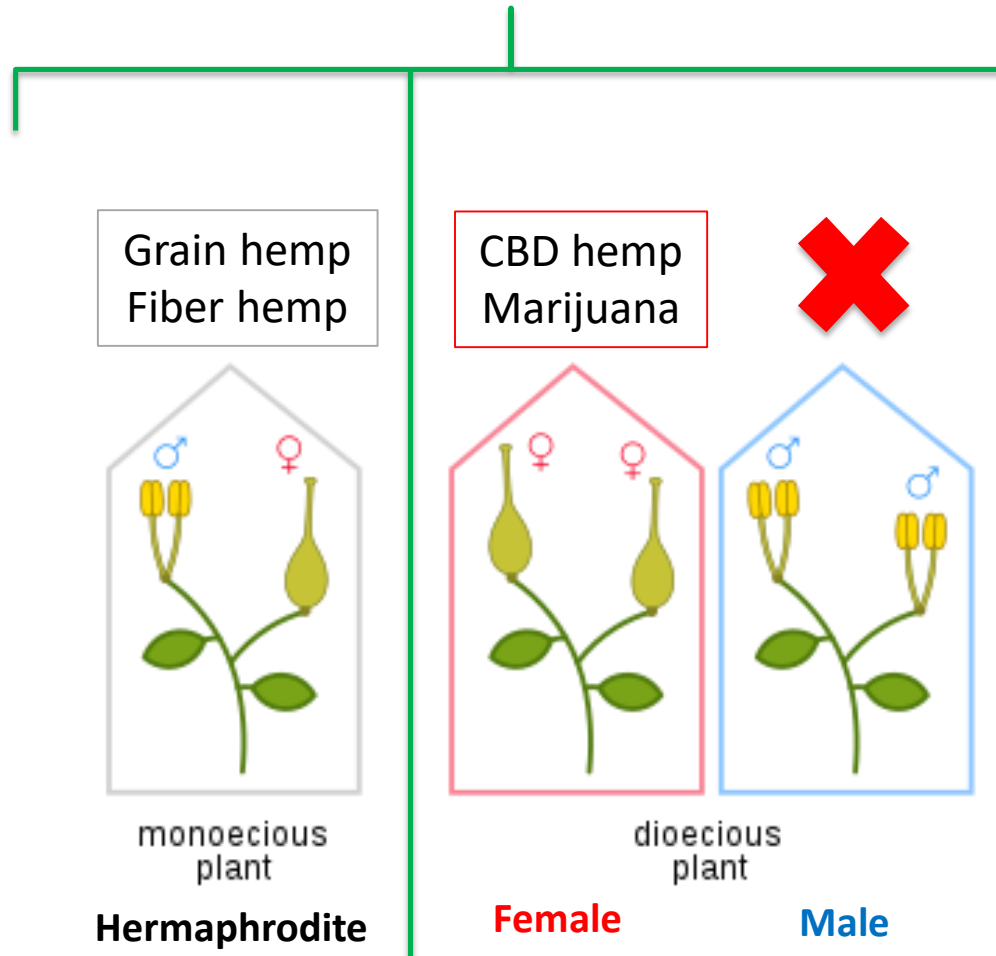


Pistils

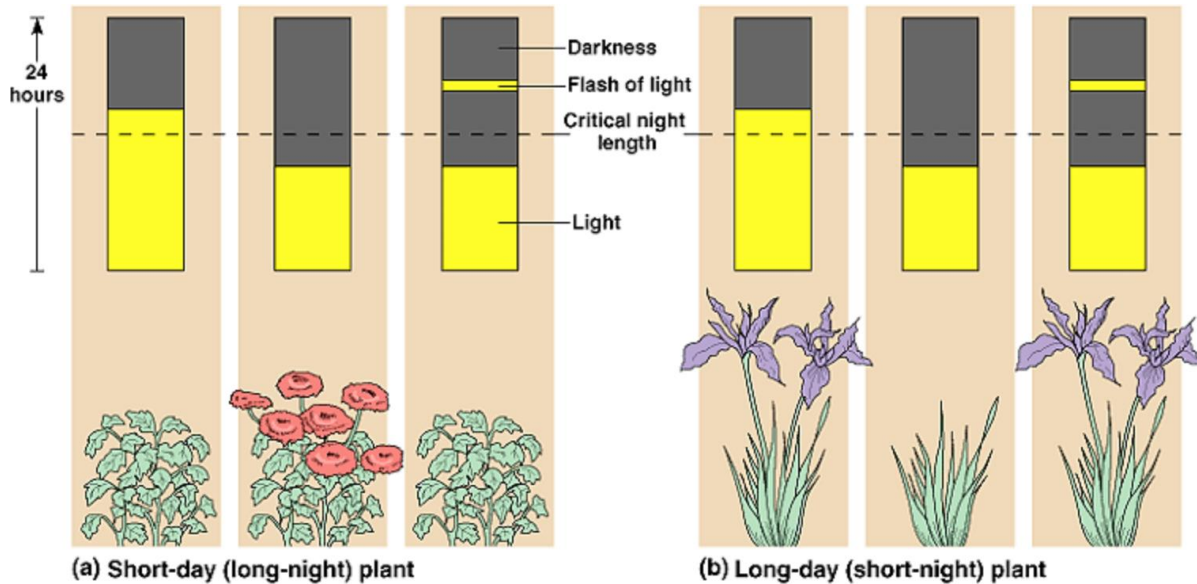


# Monoecy and Dioecy

*Cannabis sativa*



# The Importance of Photoperiod



- *Cannabis*, like chrysanthemums, requires short days in order to produce flowers
  - Mums and Cannabis are only in season once per year
- Growing *Cannabis* indoors allows you to control the photoperiod by using artificial lights
  - Therefore, you are not constrained by the time of the year

# Cannabis Plant Development

Vegetative growth – 16 h light

Flowering – 12 h light



- Plants must be grown to an adequate size before changing the photoperiod from long days to short days
- Can be achieved indoors and outdoors too, if timed properly



# Cannabis Cultivation: “Veg” and Flower Rooms

“Veg” or vegetative room



- Long days
  - At least 14 hours of light
- No flowers
- Achieve adequate size for ample flower production

Flower room



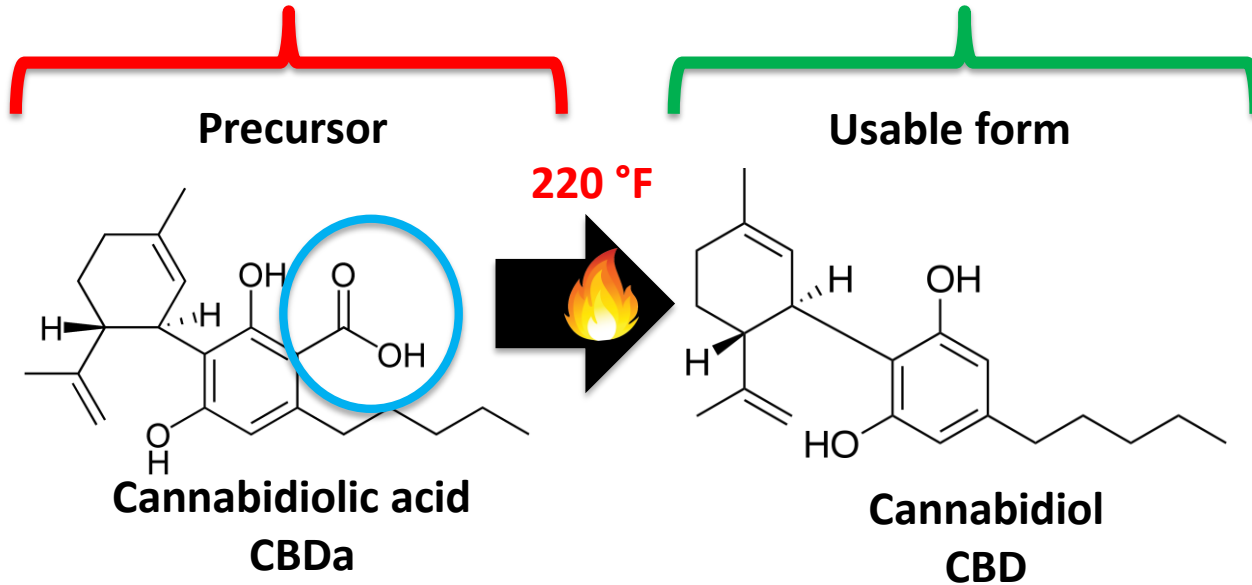
- Short days
  - 12 hours of light
  - 12 hours of uninterrupted darkness
- Flower production
- 6-8 weeks until harvest



# Cannabinoid Science

- Produced in the plant
- Cannot be utilized by humans

- Produced via combustion
- Can be utilized by humans

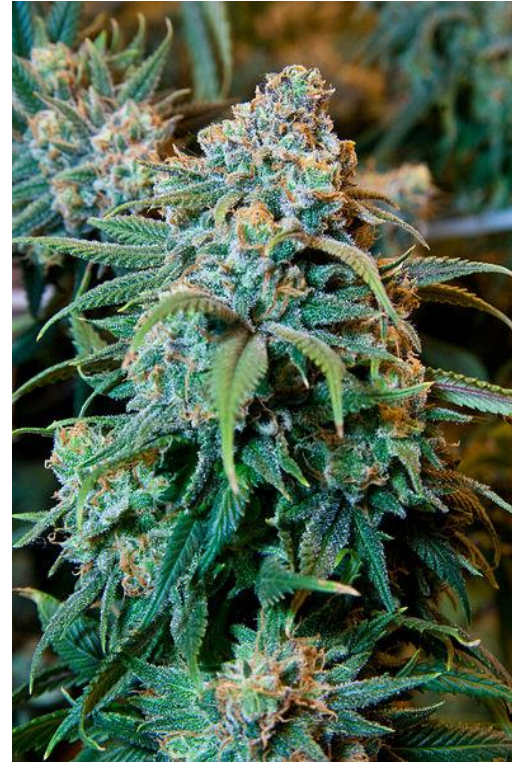


The cannabis flower must be **heated** to **220 °F** before ingesting or smoking to acquire the therapeutic benefits of its compounds  
The average lighter burns at over 500 °F

# What about male plants?



Male plant with dozens of pollen sacs



Female flower

- Males are essential for seed (grain) production
- Males are necessary for breeding of hemp and marijuana
- Males have a significantly lower cannabinoid content

# No Males Allowed

- You do not want males in a field or greenhouse of CBD Hemp or Marijuana
- Male plants will pollinate the female plants
  - The pollination will cause the female flowers to develop seeds
  - Cannabinoid yield will drop precipitously
- Propagating female cuttings from a female “mother plant” ensures that all of your plants will be female



Indoor Marijuana cultivation



# Hemp Uses



**Grain**



**Human  
consumption**



**Fiber**



**Industrial materials  
Textiles  
Building materials**



**CBD oil**



**Pharmaceuticals  
Supplements  
Cosmetics  
Food and  
beverages**

# What does science tell us about benefits of using THC or CBD?

## THC therapeutic benefits

- Chronic pain treatment
- Treatment of chemotherapy induced vomiting and nausea
- Improving some symptoms of multiple sclerosis

## CBD therapeutic benefits

- Pediatric seizure treatment
  - FDA approved Epidiolex in 2016
- Opioid addiction and anxiety mitigation

There are many claims made by companies about what CBD can do, but the ethics of this practice is questionable



Epidiolex, an FDA approved purified CBD isolate

Generic CBD oil

# What's that smell?

- Terpenes
- Chemicals are abundant in the Plantae kingdom
- Cannabis provides a smorgasbord of these aromatic chemicals



**Limonene**



**Pinene**

Camphene	3-Carene	B-Ocimene	Trans-Nerolidol	Caryophyllene
beta-Pinene	Cymene	gamma-Terpinene	Guaiol	alpha-Humulene
beta-Myrcene	Limonene	Terpinolen	alpha-Bisabolol	Nerolidol



# UConn Research



**Dr. Jessica Lubell**

- Breeding for improved CBD hemp varieties
- Feminized seed development techniques
  - Seed that is 99.9% female instead of 50% male and 50% female



**Dr. Gerald Berkowitz**

- Molecular genetics of cannabinoid biosynthetic pathways
  - Determine genetic barriers to greater cannabinoid production
- Hemp genetic engineering

# Thank you!

- Dr. Berkowitz
- The Berkowitz laboratory
  - Dr. Yi Ma
  - Steve Jepsen
  - Gair Laucius
  - Sarah Parzych
- Metro Hort Group

