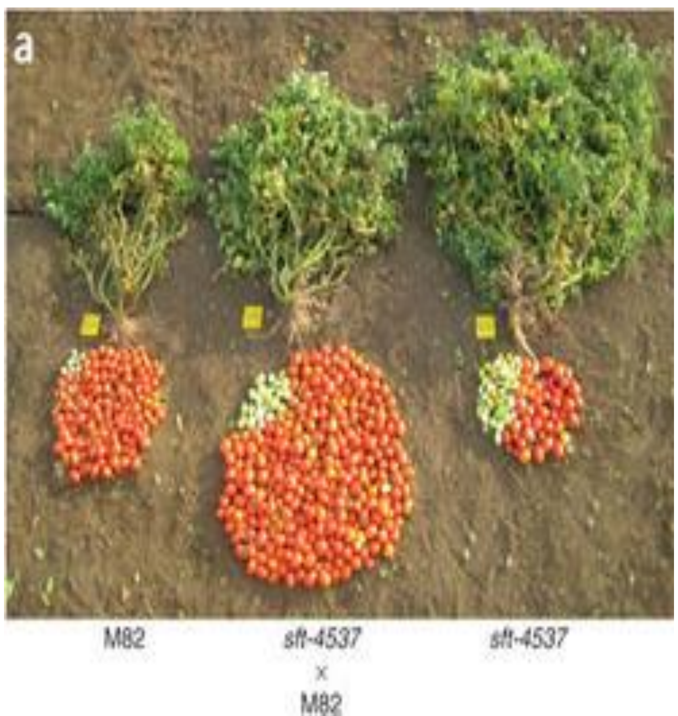
In the Name of God

Vegetable Seed Production and Breeding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P1
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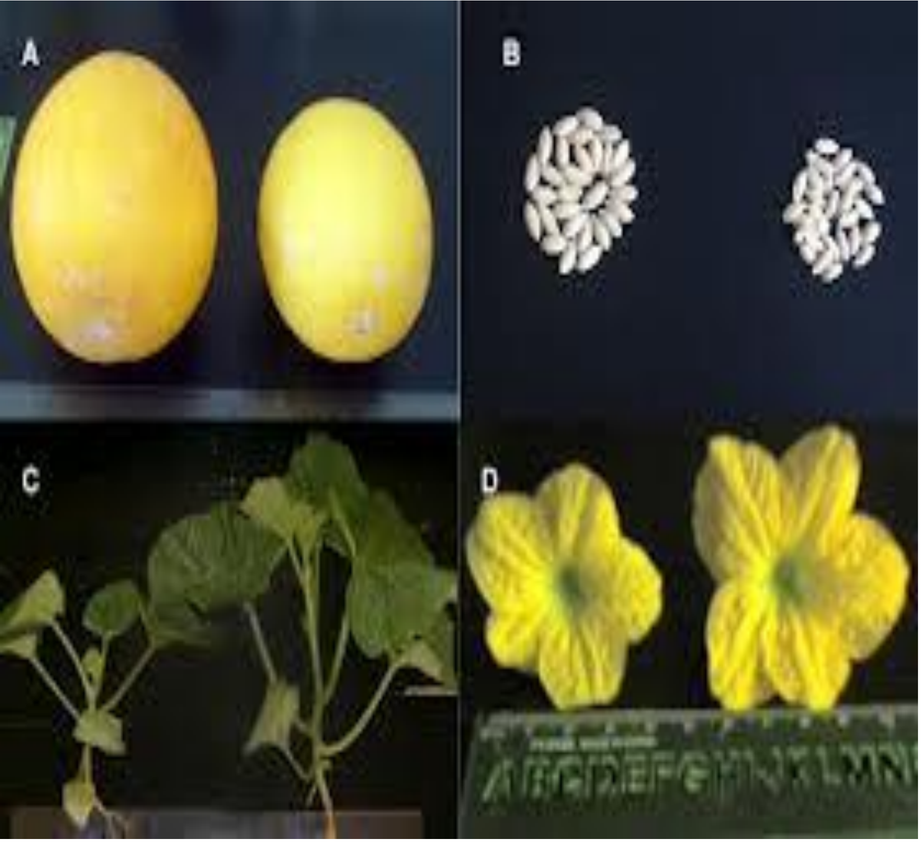
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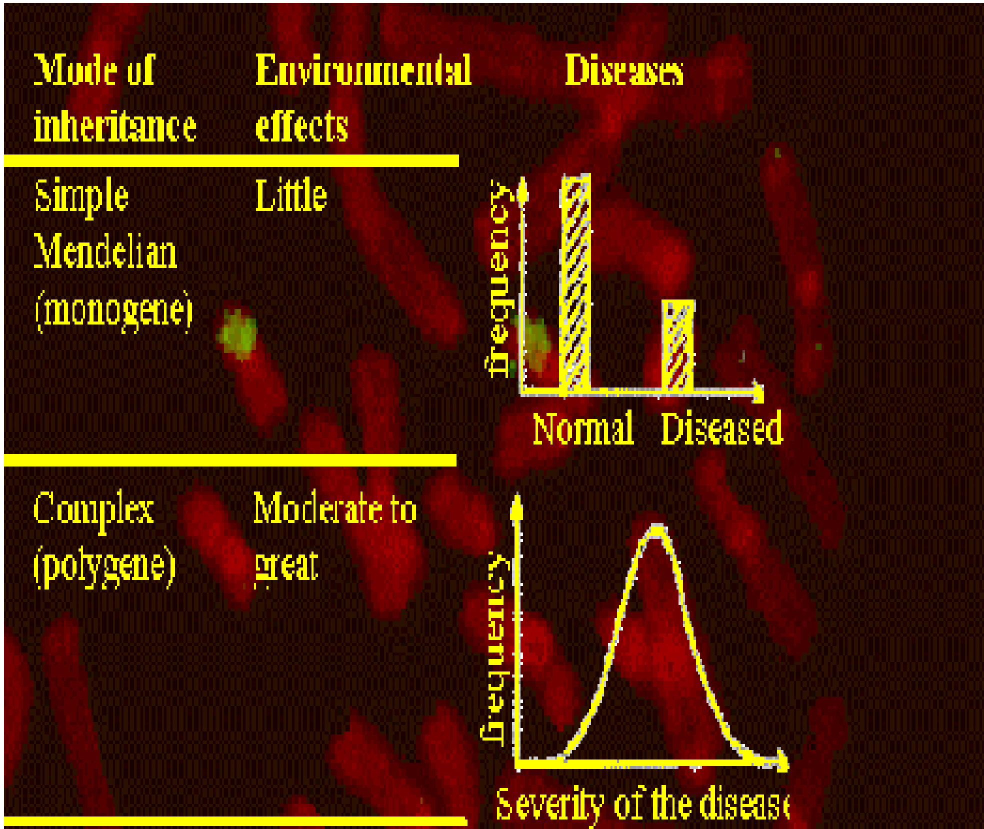

Mode of inheritance
Environmental effects
Diseases
Simple Mendelian (monogene)
Little
frequency
Normal
Diseased
Complex (polygene)
Moderate to great
frequency
Severity of the disease

هدف از اصلاح نژاد گیاهان ، ایجاد واریته های مطلوب است. برتری واریته های اصلاح شده هنگامی مشخص خواهد شد که بذرکافی از آنها تولید و در مناطقی که واریته تولید شده سازگاری دارد کشت شود.

استفاده از واریته های جدید با مشکلاتی روبرو است که نه تنها با توزیع اولیه بذر اصلاح شده بین زارعین پایان نمی پذیرد بلکه پس از توزیع باید کوشش نمود که واریته اصلاح شده را خالص نگه داشت تا زحمت هایی که درایجاد و تهیه آن آن کشید شده است از بین نرود.

مسئولیت مهم متخصصین اصلاح نژاد ایجاد واریته های جدید و افزایش بذر آنها در مقیاس محدود میباشد.

اهداف اصلاح نباتات

معمولاً در اصلاح گیاهان باغی یا زراعی چند هدف اصلی دنبال می شود که عبارتند از :

- افزایش عملکرد
- کیفیت محصول
- مقاومت به آفات و امراض
- مقاومت به استرس های محیطی(توسعه حوزه کشت)
- تغییر در نحوه رشد گیاه
- استفاده بهتر از فصل رشد
- تولید واریته های جدید و برتر

Rozi F1

Type: Single

Fruit description:
- Red, Flat Globe
- Green shoulders
- Good fruit Setting
- Good shelf-life
- Delicate taste
- Pleasant aroma
- Ave. fruit wt.: 180-250gr. (5-6 oz.)

Plant description:
- Strong vegetation
- Good coverage
- High yield potential
- 80 days to maturing variety
- 12-15000 plants/ha

Resistance:
- Fol I (HR)
- V (HR)

Betty F1

Type: Single

Fruit description:
- Dark red color with green shoulders
- Flat
- Extra large - Beef type
- Ave. fruit wt.: 180-250gr. (5-6 oz.)

Plant description:
- Good cover
- High vigor
- High yield
- Early

Resistance:
- V (HR)
- Fol I,2 (HR)

Perla F1

Type: Determinate (Bush)

Fruit description:
- A fresh market hybrid
- Dark red color
- Flat Globe
- Average weight: 120-140 gr. (4-5 oz.)
- Good fruit quality

Plant description:
- Strong vegetation
- Good fruit coverage
- High yield potential
- 80 days to maturing variety
- 30-40000 plants/ha

Resistance:
- V (HR)
- Fol I,2 (HR)

Tomato, Hybrids, Cherry

Lycopersicon esculentum

Esterina F1

F1 G C

Type: Cherry

Fruit description:
- Yellow cherry, slightly oval
- Multi-cluster type (about 1kg. ea.)
- 30-40 fruits/multi-cluster
- For single packing (10 gr. ea.)
- Dia.: 2.5x3cm. (1-1.5")
- Very sweet with high quality flavor

Plant description:
- Vigorous growth
- Huge continuous production
- 60 days to maturity
- Seed count: 440 seeds/gr.
- Thousand seed weight: 2.3gr.
- 20-25000 plants/ha

Resistance:
- TMV (HR)
- V (HR)

Sarina F1

F1 G C

Type: Cherry

Fruit description:
- Red Cherry
- Vine ripe, over 14-16 fruits/cluster
- Round shape, dia.: 2.5cm. (1")
- Firm fruits, 10gr. each
- Sweet with high quality flavor.

Plant description:
- Vigorous
- Highly productive
- 60 days to maturity
- Seed count: 450 seeds/gr
- Thousand seed weight: 2.2 gr.
- 20-25000 plants/ha

Resistance:
- TYLCV (HR)
- N (HR)
- FoII (HR)
- V (HR)
- TMV (HR)
- TSWV(SW5) (HR)

Negev F1
Type: Blocky

Fruit description:
- Excellent red color
- Large fruit size
- Good shelf-life

Plant description:
- Vigorous open plant with short nodes
- High continuous yield potential

Resistance:
- PMMV: 0, 1, 2, 3(L4) (HR)
- PMT (HR)
- TSWV (IR)

Atos F1
Type: Blocky

Fruit description:
- Dark red color
- Large fruit size

Plant description:
- Vigorous open plant with short nodes
- High continuous yield potential

Resistance:
- PMMV: 0, 1, 2, 3(L4) (HR)
- TSWV (IR)

Madonna F1
Type: Blocky

Fruit description:
- Pale yellow color
- Medium fruit size

Plant description:
- Vigorous growth
- Good leaf coverage
- High continuous yield potential

Resistance:
- PMMV: 0, 1, 2(L3) (HR)
- TSWV (IR)

Paprik

Type: Red Paprika

Fruit description:
- Red color turns dark red when dry
- High uniformity
- Size: 12x3cm. (4.5-1.2")
- Shape: Narrow cone

Plant description:
- Hardy and vigorous
- Very productive
- For open field production
- Direct sowing or transplants
- 90 days to ripening
- 120-150 days to dry
- Ave. seed /gr.: 126
- 35,000-40,000 plants/ha

Reports from trials in major paprika production areas:
- Small narrow cone fruit with small seed cavity
- Easy to dry
- Little rain-spot damage

Dulce

Type: Corno Di Toro

Fruit description:
- Sweet taste cone pepper
- Used for fresh roasting or stuffing
- Size: 20-25cm. (8-10") long
  4-5cm. (1.5-2") wide at shoulders
- Curved, tapering shape
- Color: green to yellow/orange or deep red

Plant description:
- Hardy & vigorous bushy plant
- Semi-determinate growing habit
- Heights: 60-80cm. (24-30")
- High yielding long continuous production
- Annual flowering in temperate climates
- Days to maturity: 75-85 days
- For Open field and Greenhouse production
- Ave. seed /gr.: 165
- Thousand seed weight: 6 gr.
- 35-40,000 plants/ha

Salsa

Type: Sweet Pimiento

Fruit description:
- Short cone shape
- Dark green turns to glossy red
- Size: 6-8cm. (2-3")
- Thick-walled with sweet tasty flesh
- For fresh salads, roasting or salsa.

Plant description:
- Hardy & vigorous bushy plant
- Height: 45-60cm. (18-24")
- Semi-determinate growing habit.
- Productive with high yield potential
- Long continuous uniform crop
- For open field, Greenhouse and containers
- 75 Days to maturity
- Ave. seed /gr.: 50
- Thousand seed weight: 6.6gr.
- 35-40,000 plants/ha

Raam

Type: Early Jalapeno

Fruit description:
- Color: Dark green turns red at maturity
- Size: 6x3cm. (3x1.5")
- Cylindrical cone-shape fruits with thick juicy walls
- Medium, SHU 4-5.000 units
- Usually eaten green, Excellent in salsa, stuffed or pickled
- Very high uniformity

Plant description:
- Hardy compact plant
- Medium size 50x50cm. (20x20")
- Determinate growing habit
- Very heavy yielding over long season
- Freshly picked when dark green
- Early 60 days green, 75 days red ripe,
- Easy to grow
- 35-40,000 plants/ha

Buda

Type: Hungarian Hot Wax

Fruit description:
- Slightly curved cone fruit with thick juicy walls.
- 15cm. (6") long X 2.5cm. (1") wide
- Initial color has light green, waxy shine.
- It turns into yellow, orange & red when ripe
- Mild, SHU 2,500 units
- Used in fresh salads, roasting, stuffing or pickled.

Plant description:
- Vigorous bushy plant
- Mainly for open field production
- Size: 40x40cm. (16x16")
- Extremely productive
- Long continuous yield
- Days to maturity: 75-80 days
- Ave. number of seeds/gr.: 170
- Thousand seed Weight 6gr.
- 35-40,000 plants/ha

Solero

Type: Ring-O-Fire; Cayenne

Fruit description:
- Color: Green turns to dark red at maturity
- Size: 10-15cm. (4-6") long x 1.5cm. (0.5") wide
- Shape: long, thin, tapered, twisted
- Very hot, SHU 30-50,000 units
- Usage: Dry for pepper flakes, fresh for salsa or salads
- High uniformity

Plant description:
- Hardy & vigorous bushy plant
- 50-60cm. (18-24") high; 50cm. (18") wide
- 75-85 days to mature
- Long continuous uniform production
- Extremely productive easy to grow plant
- For open field production
- Ave. number of seeds/gr.: 200
- Thousand seed weight: 4gr.

Michal F1
Type: Classic

Fruit description:
- Dark black shiny skin
- Uniform fruit shape
- Parthenocarpic fruit set, with few seeds
- Firm with good shelf-life
- Very tasty

Plant description:
- Hardy with strong & vigorous vegetation
- Very productive
- Early, 60-70 days from planting to harvest
- Adapted for year-round production (greenhouse or open field)
- Good performance against Botrytis

Piccolo F1
Type: Pickling

Fruit description:
- Glossy striped type
- Purple and white stripes
- Oval shape
- Ave. size: 8x10cm. (3x4")
- Firm with good shelf-life
- Great for stuffing & pickling

Plant description:
- 60-70 days from planting to harvest
- Vigorous growth habit
- High continuous production
- Partenocarpic fruit set
- Adapted for year round production
- Open field or greenhouse production
- 236 seed/gr.
- Thousand seed weight: 4.2 gr.
- 120,000 plants/ha

Bianca
Type: Snowy; Open pollinated

Fruit description:
- Ivory color with green calyx
- Elongated: 18X6 (7X2.5")
- Firm and meaty texture
- Delicate sweet flavor

Plant description:
- Hardy with vigorous vegetation
- Mainly for open field production
- Plant height: 50-60cm. (20-25")
- 60-70 days from planting to harvest
- High continuous yield
- Ave. seed count: 270/gr. (7540/oz.)
- Thousand seed weight: 4 gr. (0.141oz.)
- 20-30,000 plants/ha

Rosa Bianca
Type: Open pollinated

Fruit description:
- Rosy pink fruit with green calyx
- Unique color and shape
- Size: 10-15 X 6-8cm. (4-6 X 2.5-3")
- Mild, creamy taste, meaty texture
- Perfect for stuffing

Plant description:
- Height: 55-75cm. (21-30")
- 75-80 days from planting to harvest
- 12,000 plants/ha
- High yield in temperate zones
- Ave. seeds per gr.: 270 (7540 s/oz.)
- Thousand seed weight: 4 gr. (0.15 oz.)

Black Beauty
Type: OP; Most Popular variety

Fruit description:
- Glossy purple/black color, lobed shape
- Size: 15-20cm. (6-8") long
  10-12cm. (4-5") dia.
- Tasty rich flavor
- Popular for cooking, fried or stuffed

Plant description:
- Plant Height: 55-75cm. (21-30")
- 80 days from planting to harvest
- High continuous production, Easy to pick
- Adapted for year-round production
- 12,000 plants/ha
- Ave. seeds/gr.: 270 (7600s/oz.)
- Thousand seed wt.: 3.7gr. (0.13oz.)

Manny F1

Type: Greenhouse; Beit-Alpha; Autumn, Winter, Spring

Fruit description:
- Uniform fruit size
- Fruit of top quality
- 18-20cm. long; Dia.: 25-35mm.
- Dark color
- Smooth skin
- 1-2 Fruits per node

Resistance:
- PM (IR)
- CVYV (IR)

Adam F1

Type: Greenhouse; Beit-Alpha; Autumn, Winter, Spring

Fruit description:
- Uniform fruit size
- Fruit of top quality
- 16-18cm. long; Dia.: 25-35mm.
- Dark color
- Smooth skin
- 1-2 Fruits per node

Resistance:
- PM (IR)
- CVYV (IR)

Eve F1

Type: Greenhouse; Beit-Alpha; Autumn, Winter, Spring

Fruit description:
- Dark green, smooth skin
- Excellent taste
- 1-2 fruits/ node
- Early maturing 45-50 days
- 16-18cm. (6-7") long, Dia 2.5cm. (1")
- Ave. 40 seeds/ gr. (1120 seeds/ oz.)
- Thousand seed weight: 25gr. (1oz.)

Resistance:
- PM (IR)
- CVYV (IR)

Green 18 F1

Type: Open Field; American Slicer

Fruit description:
- Straight dark green fruit with spines
- High uniformity, excellent taste
- Size: 20-22cm. (8-9")
- Female flowers, Needs 10% pollinator
- Early, 55-60 days
- Ave. 40 seeds/gr (1120 seeds/oz.)
- Thousand seed weight: 25 gr. (1 oz.)

Resistance:
- CMV (IR)
- PM (IR)
- DM (IR)

Sivan F1

Type: Cantaloupe/Charantais

Fruit description:
- Good fruit setting, round uniform shape
- Strongly netted ribbed skin
- Small seed cavity
- Fragrant & Sweet Orange Flesh
- Average Wt.: 1-1.2 Kg.(2-2.5 lb.)

Plant description:
- Days to Maturity: 75-80 days
- Hardy & Vigorous
- Good Leaf Cover
- Greenhouse (Trialling & Open Field).
- Suitable for year round production
- High yield potential: 45-55 Ton/ ha.
- 20,000-28,000 plants/ha

Resistances:
- PMT (IR)
- Fom (IR)

Dona F1

Type: Galia

Fruit description:
- Size: 1-1.5 kg. (in early crop)
- Very good fruit setting
- Round Uniform Shape
- Good Netting
- Light Green Flesh, Small Seed Cavity
- Very Good Shelf-Life
- High T.S.S
- Aromatic

Plant description:
- Vigorous
- Production: Bush growth in greenhouse, walking-in tunnel and low tunnel.
- Suitable for year-round Production
- 80-90 days early maturing variety,
- 10,000-12,000 plants/ha

Resistances:
- MNSV (HR)
- PMT (IR)
- Fom 0,1,2 (HR)

Rona F1

Type: Galia

Fruit description:
- Size: 1.5-2.5 kg.
- Round Uniform Shape
- Good Netting
- Light Green Flesh
- Small Seed Cavity
- Good Shelf-Life
- High T.S.S
- Aromatic

Plant description:
- Vigorous
- Production: Open-Field
- 80-90 days maturing variety,
- 10,000-15,000 plants/ha

Resistances:
- Fom 0,1,2 (HR)
- PMT (IR)

Diploid F1

Type: Tiger Stripe; With seeds

Fruit description:

- Oval shape
- Tiger-stripe rind pattern with green background
- Red flesh
- Average weight: 3-5Kg.

Triploid F1

Type: Tiger Stripe; Seedless

Fruit description:

- Round-to-oval shape
- Tiger-stripe rind pattern with medium green background
- Red flesh
- Average weight: 3-5Kg.

Watermelon breeding

The organic breeding in watermelon program consists mainly of :-

- Mid-size fruit (3-5Kg. (7-11lb.)
- Red flesh and green rind with dark green stripes (Tiger stripe)
- Experimental varieties, seedless (Triploid) and with seeds (Diploid), being tested in Murcia and Almeria (Spain).
- New varieties for semi-commercial plots will be available in the year 2012.

Plant Description:

- Open field growth and under cover
- Suitable for early spring-summer production

Primadonna

Type: Iceberg

Head description:
- Medium with crisp head
- Weight: 800-900gr. (2lbs)
- Pre packer type with good density
- Size: 20-30cm. (8-12")
- Light green, flat type
- Crunch and crisp

Plant description
- Year round production
- Good tolerence to tipburn and heat
- Does well in cool temperatures.
- Indoor and open field production
- 80-90 Days to maturity

Resistance:
- LMV tested

Migdal

Type: Romaine/ Cos Plain Leaf

Head description:
- Sweet and crisp
- Medium (0.8-1Kg.-1.5-2lb.)
- Light green color
- Very high uniformity

Plant description:
- Adapted to indoor & outdoor production
- Relatively slow bolting
- 50-55 days to maturity
- 70,000-90,000 plants/ha
- 1183 seed/ gr. (33,000 seed/ oz.)
- Thousand seed weight: 1gr. (1/28oz.)

Resistance:
- LMV tested

Tari Green

Type: Curled leaf

Head description:
- Medium size
- Green curled leaf
- Tasty and crisp
- High head uniformity

Plant description:
- 30-40 days to maturity

Resistance:
- LMV tested

Gilaad (LRY)

Type: Plain Leaf; Romaine

Head description:
- Glossy deep dark red
- Full size head: 1-1.5Kg.(2-3lb.)
- Excellent eating quality
- Sweet and Crisp
- Romaine-shaped leaf
- High uniformity

Plant description:
- Adapted to indoor & out door production
- 50-55 days from planting to harvest
- 70,000-90,000 plants/ha

Resistance:
- LMV tested
- H (IR)
- TB (IR)
- BO (IR)

Gloria

Type: Double Curled Leaf; Red Lola Rosa

Head description:
- Dark red
- 53 Days
- Darker in the cool season

Resistance:
- LMV tested

Red Coral

Type: Red Salad Bowl; Oak-Leaf

Head description:
- Red & green curled oak leaf
- Big head: 1-1.2Kg (2-3lb.)
- Darker in the cool season
- Not sensitive to tip burn

Resistance:
- LMV tested

کاربرد علم ژنتیک در اصلاح نباتات

کروموزوم ها حاوی ژن ها هستند و به مجموعه آنها ژنوم اتلاق میگردد . سلول های هاپلوئید دارای یک ژنوم و سلول های دیپلوئید دارای دو ژنوم و .... می باشند.

نه تنها هسته بلکه سیتوپلاسم هم در امر وراثت اهمیت فوق العاده دارد. مجموعه قسمتهائی از سیتوپلاسم که در وراثت دخالت دارند **Plasmon** نامیده می شوند.

از اجزاء سیتوپلاسم که در انتقال صفات ژنتیکی دخالت دارند می توان پلاستید ها و میتوکندیها را نام برد. پس بطور کلی در هر سلول گیاهی دو نوع ژنوم یافت میشود.

– ژنوم هسته ای **Nuclear Genome**
– ژنوم ارگانلی **Organellar Genome**

کاربرد علم ژنتیک در اصلاح نباتات

- کار متخصصین اصلاح نباتات مدیریت تنوع ژنتیکی درگیاهان است
- متخصصین اصلاح نباتات هم با صفات کمی سر وکار دارند هم با صفات کیفی
- اکثر صفات مطلوب اقتصادی جزء صفات کمی هستند
- تنوع یا تغییر ژنتیکی Genetic Variability از موتاسیون، هیبریداسیون و تفکیک ژن ها حاصل می شود

کاربرد علم ژنتیک در اصلاح نباتات

- ژن ها که واحد نهائی درتفکیک صفات هستند از یک سری قوانین خاص وراثتی **Inheritance** و یا رفتاری **Behaviour** بعد از هیبریداسیون تبعیت می کنند
- چون اثرات ژن ها روی یکدیگردر یک مکان ژنی و یا در مکان های ژنی مختلف متفاوت است.ژن ها بعد از بیان شدن ایجاد فنوتیپ های جدید می کنند.

کاربرد علم ژنتیک در اصلاح نباتات

- قوانین وراثتی و رفتاری در یک جمعیت گیاهی برای صفات تک ژن (صفات کیفی) ساده تر از صفات پلی ژن (صفات کمی) می باشند
- چون صفات کمی توسط چند ژن کنترل میشوند به مقدار زیادی تحت تاثیر عوامل محیطی قرار می گیرند.

ژن های تشکیل دهنده هر ژنوم (Genome) درگیاه بوجود آورنده فنوتیپ و ژنوتیپ آن می باشند

کاربرد علم ژنتیک در اصلاح نباتات

- ژن ها Expression صفات را به عهده دارند
- این صفات ممکن است مورفولوژیک ، آناتومیک ، آگرونومیک ، فیزیولوژیک و یا بیوشیمیایی باشند
- ظهور Appearance نسل اوّل یک هیبرید منطبق بر Interaction یا اثر متقابل ژن هائی است که از والدین مختلف می آیند و یا در ژنوم های آن گیاه وجود دارند

نحوه تولید مثل و روش های اصلاح نباتات

مکانیسم تولید مثل (**Mechanism of Reproduction**) و همچنین نحوه وراثت صفات (**Mode of Heredity**) هر گیاه تعیین کننده انتخاب روش اصلاحی مناسب برای آن گیاه است .

پدیده های مرتبط با مکانیسم تولید مثل مانند **گرده افشانی**، **لقاح** ، **باروری** و **روابط ناسازگاری** پیش نیاز روشهای اصلاحی هستند از این رو شناخت صحیح ازنحوه تولید مثل گیاه به درک بهتر مکانیسم وراثتی آن کمک می کند.

بنابراین ضروری است که **Breeder** قبل از انتخاب روش مناسب برای اصلاح گیاه از چگونگی تعدادی از عوامل کلیدی مرتبط با نحوه تولید مثل آن آگاهی کافی داشته باشد.

Plant Reproductive Biology

What is it?

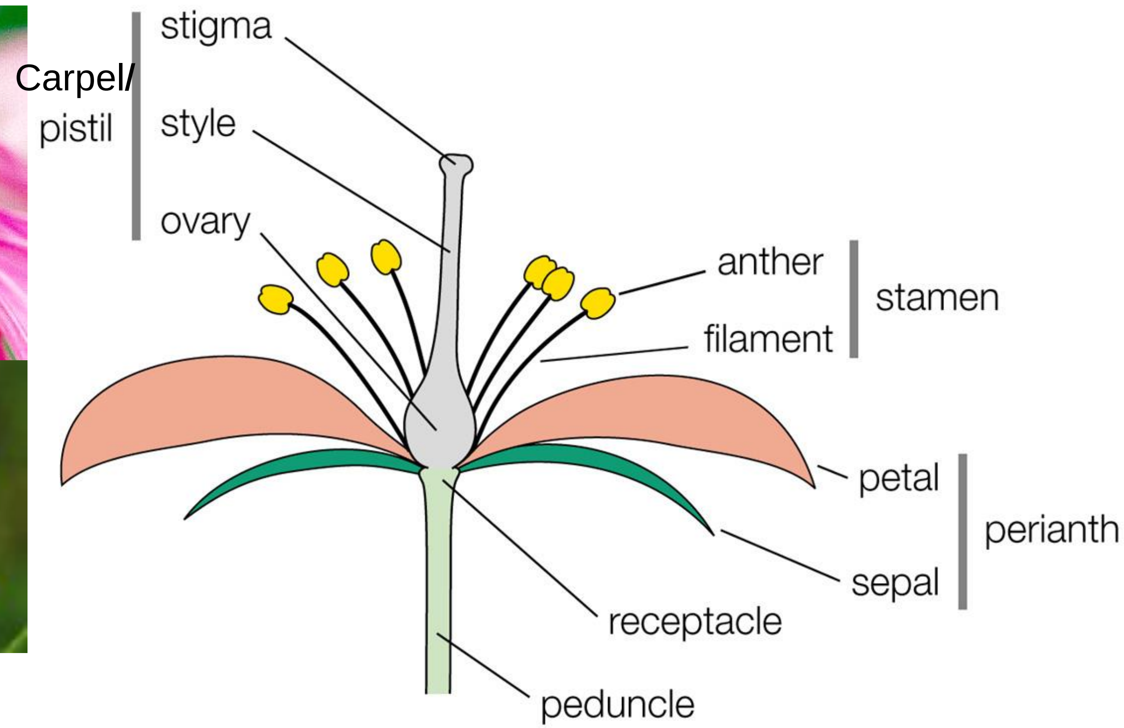
- Study of sexual and asexual reproduction
  - Pollination mechanisms
  - Gene flow
  - Genetic variation
  - Propagule dispersal

Why study it?

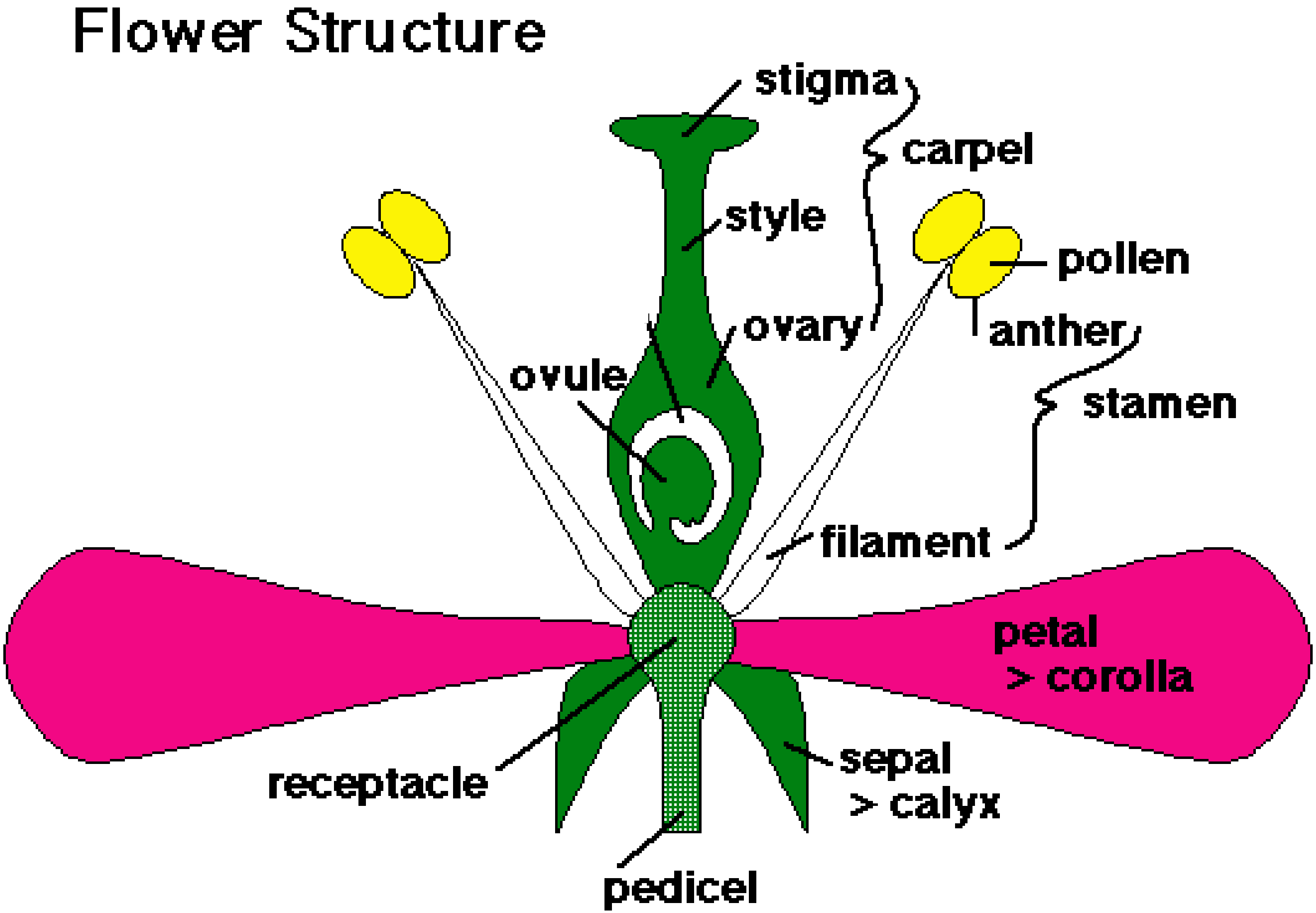
- Insight into adaptive significance & homology of systematic characters
- Insight into delimitation of species and subspecies.

Function of flower

- To attract pollinators with colorful petals, scent, nectar and pollen

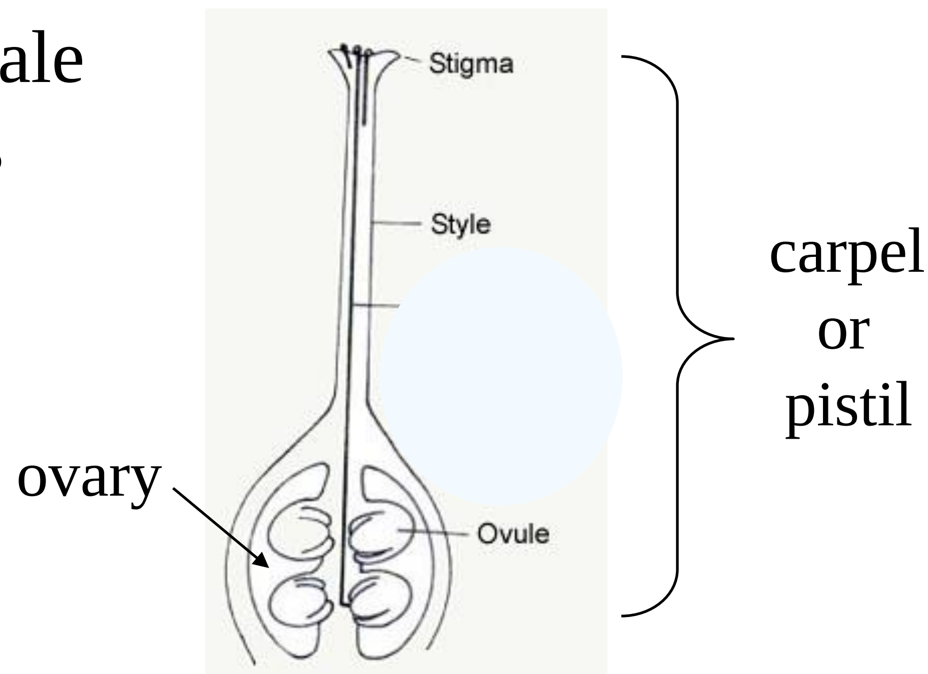


Overview of floral organs



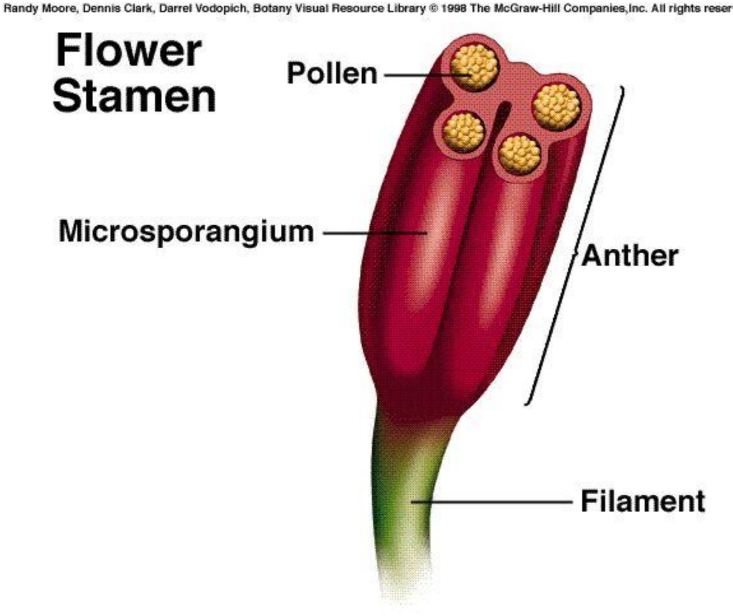
Reproductive floral organs: female

- **Carpel** or **pistil** – female reproductive organs; contains:
- **Stigma –** is where pollen sticks to
- **Style** – is the long tube that connects stigma to ovary
- **Ovary** – enlarged structure at the base of carpel/pistil where the ovules are located; it will become the fruit.
- **Ovules** – contains female gametophyte, becomes the seed
- Plants have style!

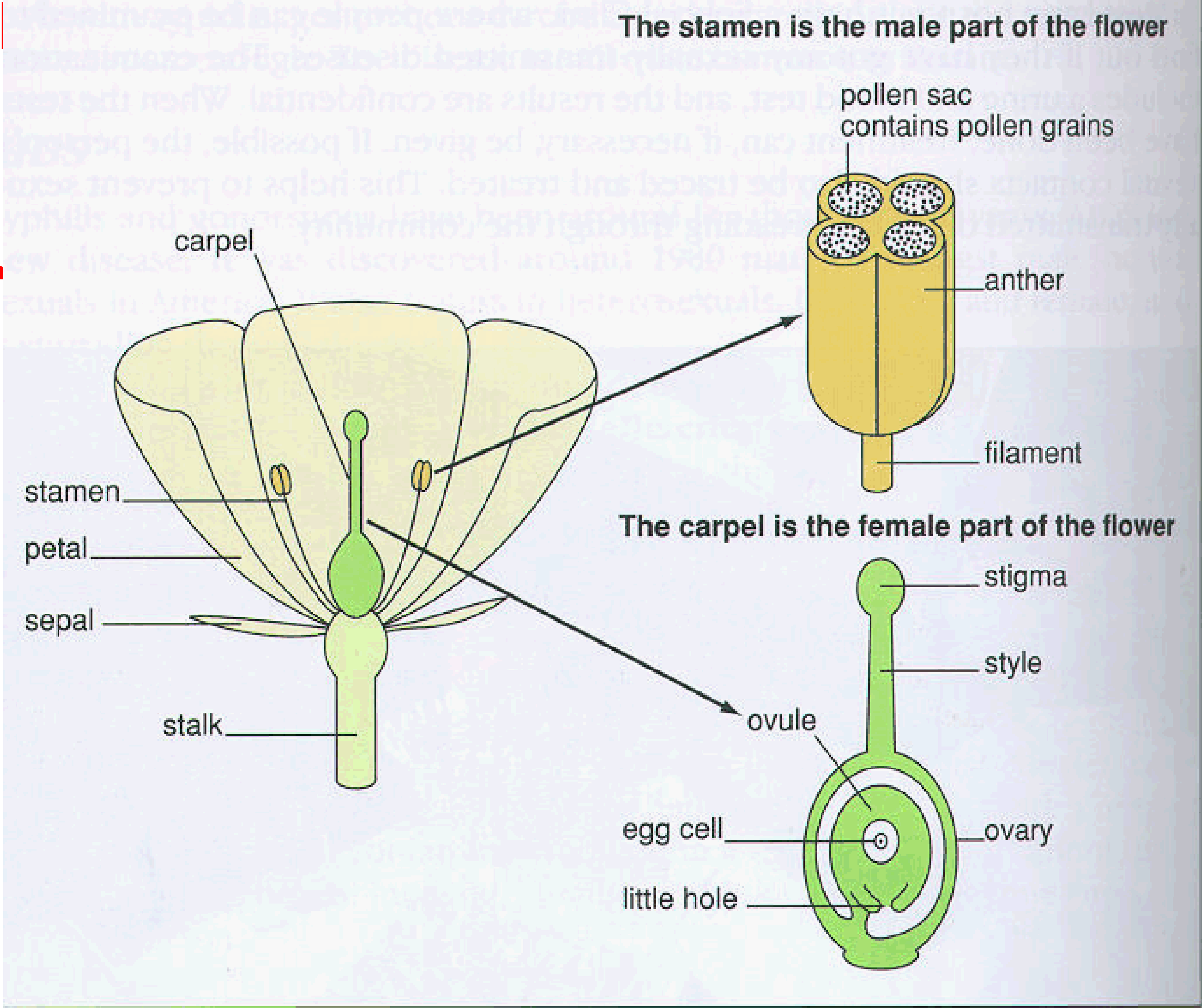


Reproductive floral organs: male

- **Stamen** – male floral organ, consists of:
- **Anther** – part of the stamen that produces pollen
- **Filament** – stalk-like structure that holds anther
- **Pollen** – immature male gametophyte

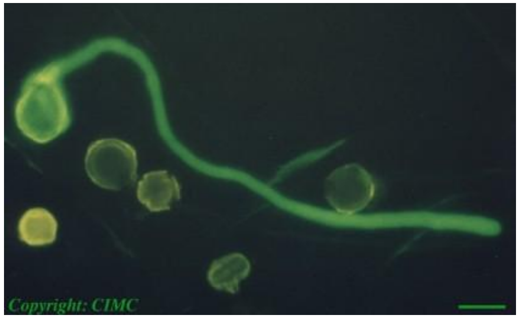


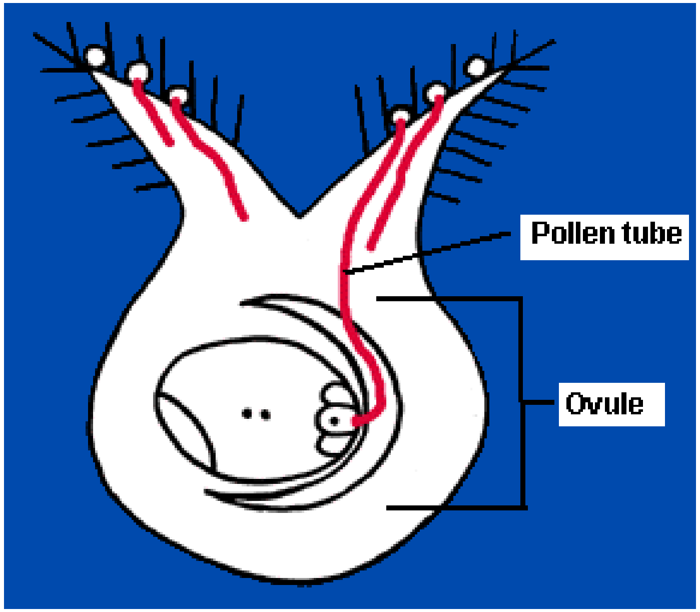
Sexual parts of a flower



Pollination and Fertilization

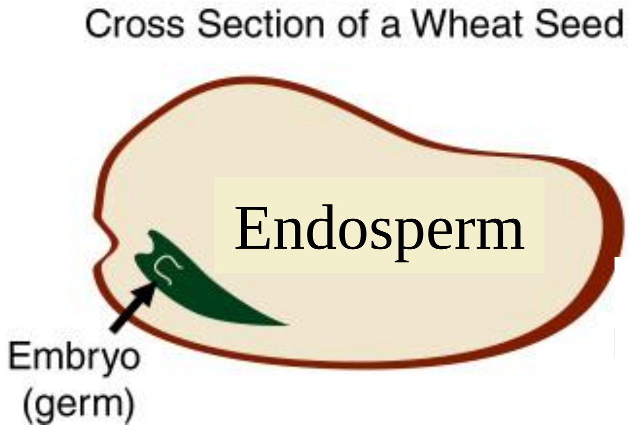
- For pollen sperm to successfully fertilize the egg, there must be **pollination**: a method to get the pollen from the male anther to the stigma.
- Pollen sticks to the stigma, starts growing a pollen tube
- **Fertilization** begins when tube begins to grow toward the egg

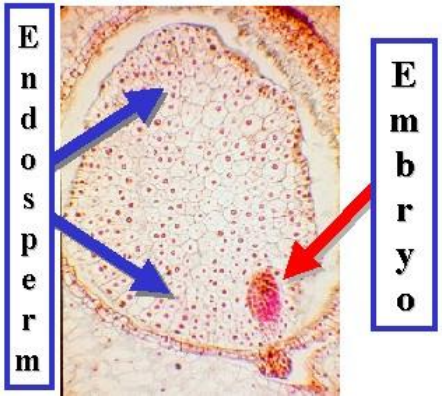




Double Fertilization

- **Double fertilization** occurs: One sperm nucleus (1n) fertilizes the egg, producing a **zygote** (2n) → which becomes the plant **embryo** inside the seed
- Another sperm nucleus fuses with the polar nuclei, resulting in a triploid **endosperm** (3n)
- Endosperm is a source of food for the young embryo.





POLLINATION

- What is pollination?
  - To reproduce sexually, you need to fuse a male sex cell (gamete) with a female sex cell (gamete).
  - The male gamete must be brought to the female gamete. In animals, there is the mating process.
  - How about for plants? They can't move from place to place!
  - They need an external agent and since it is the male gametes which are contained in the pollen grains that gets transferred , the process of transferring the pollen grains from the male part of the flower to the female part is known as pollination.
  - Pollination must occur before fertilisation can occur.

Pollination Mechanisms

INSECT (entomophily)

Bees (melittophily/hymenopterophyly

fls. showy, colorful, fragrant, with:

nectar guides

landing platforms

Butterflies (psychophily):

fls showy, colorful, fragrant

no nectar guides

long tubes or spurs

Pollination Mechanisms

Moths (phalaenophily):

large, white, fragrant

no nectar guides

usually tubes or spu

Pollination Mechanisms

Flies (sapromyiophily)

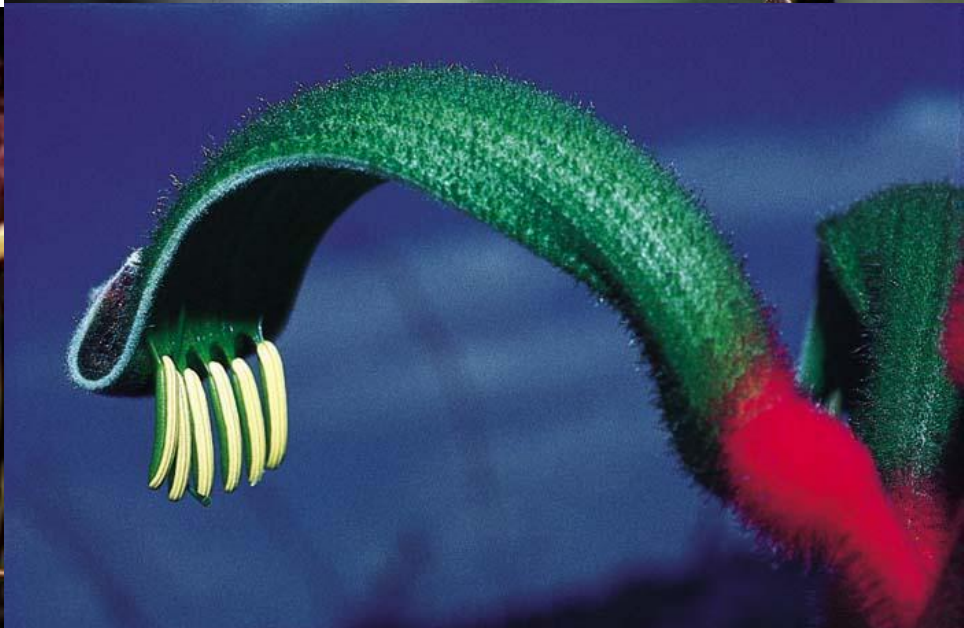
- **maroon / brown** in color
- **foul smelling** (like rotting flesh)

Pollination Mechanisms

Birds (ornithophily):

red (often, not always)

tubular (often)



Pollination Mechanisms

Bats (cheiropterophily):

- **nocturnal anthesis**
- **large**, colorful or white
- produce **copious nectar or pol**

Pollination Mechanisms

Wind (anemophily):

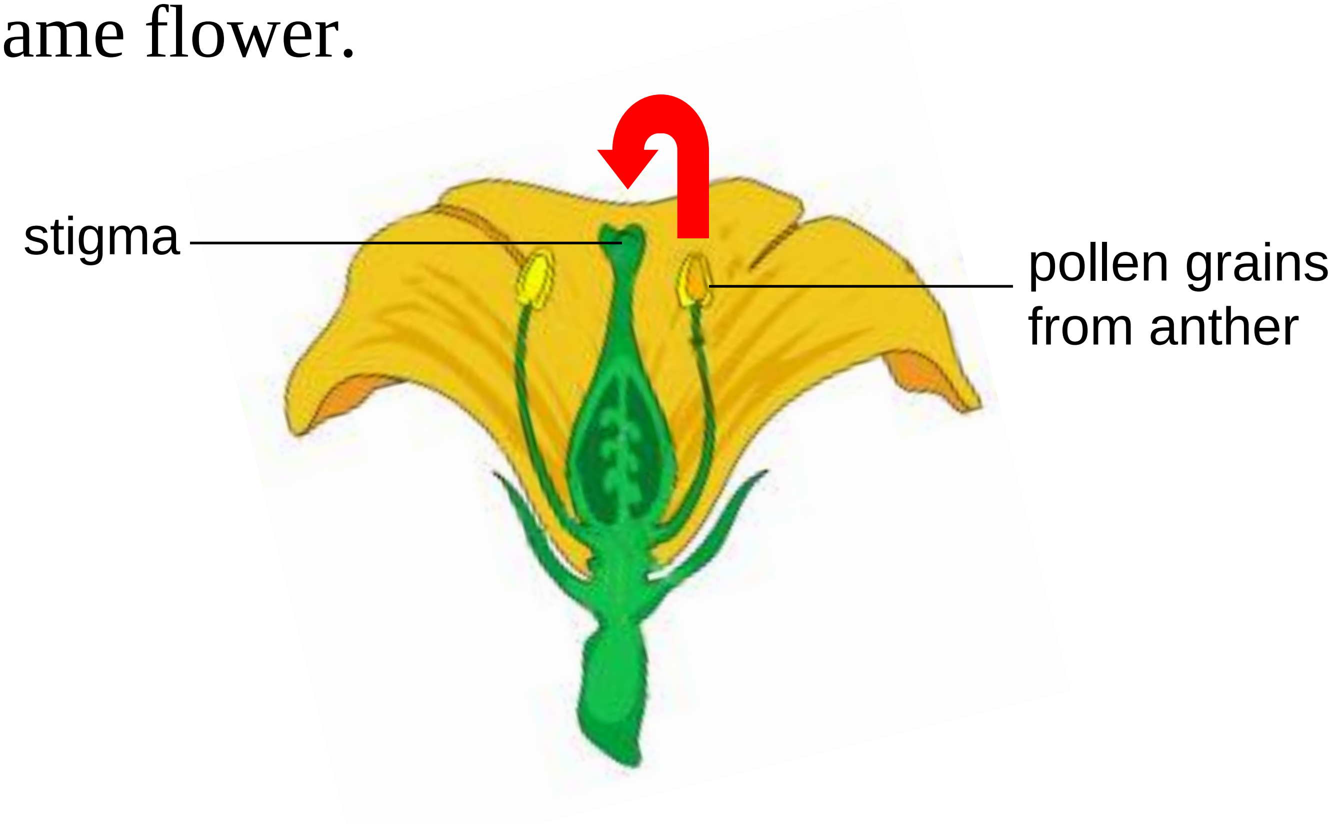
- **flowers small**, numerous, often unisexual
- **perianth absent or non-showy**
- flowers often produced **in mass**

Pollination Mechanisms

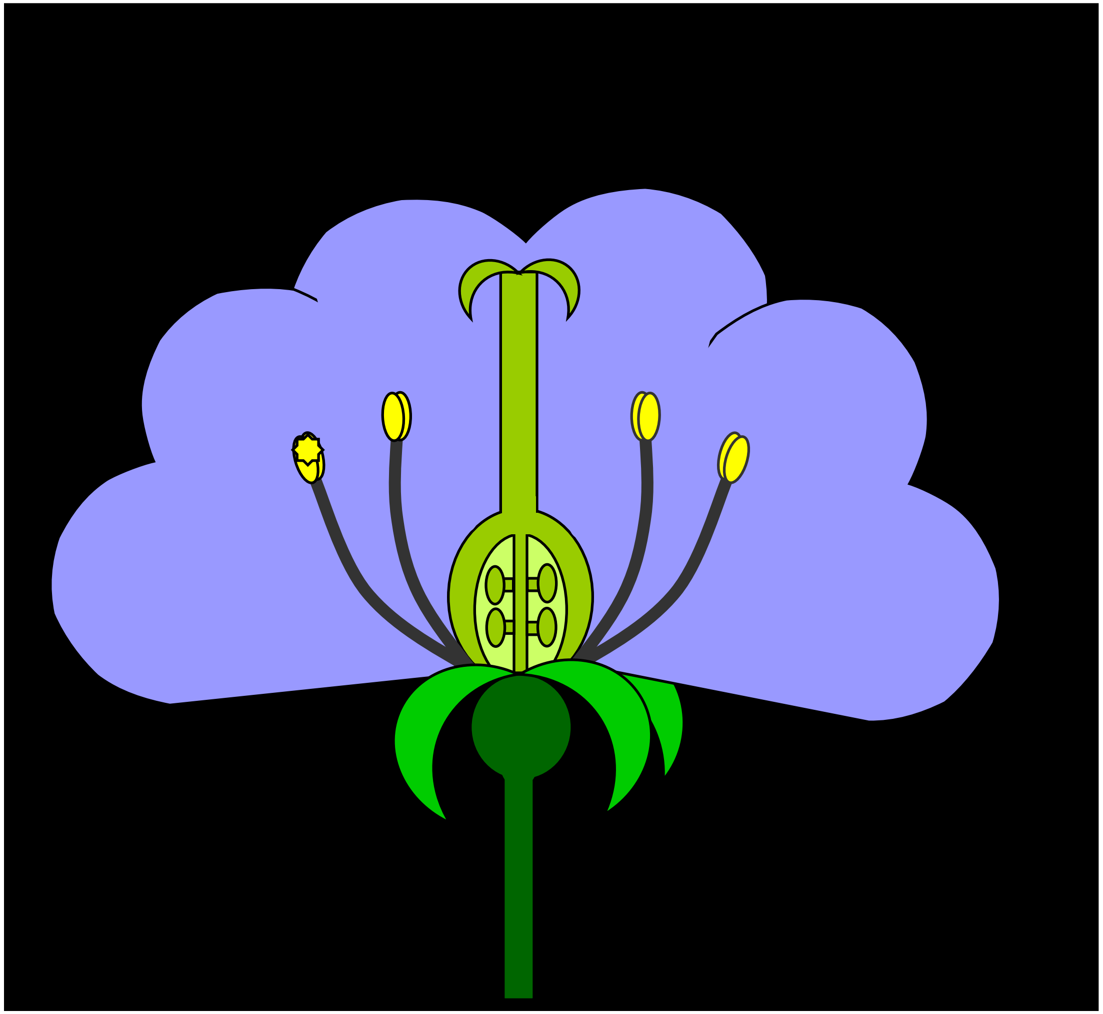
Water (hydrophily):

Pollination

- **Pollination** is the transfer of pollen grains from the anther to the stigma of a flower.
  - The pollen grains can be transferred within the same flower.



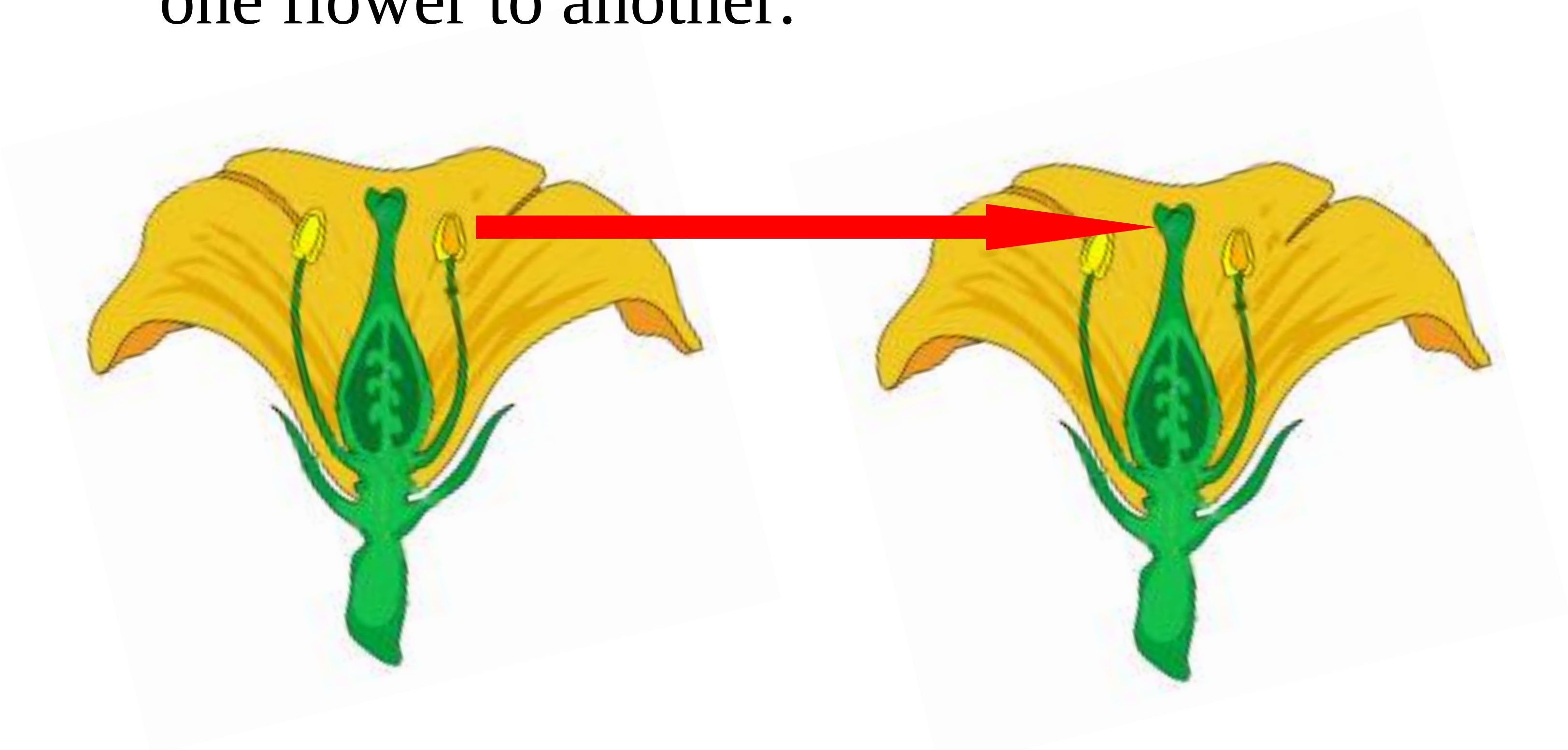
Self-pollination occurs when pollen falls from the anther onto the stigma of the same flower



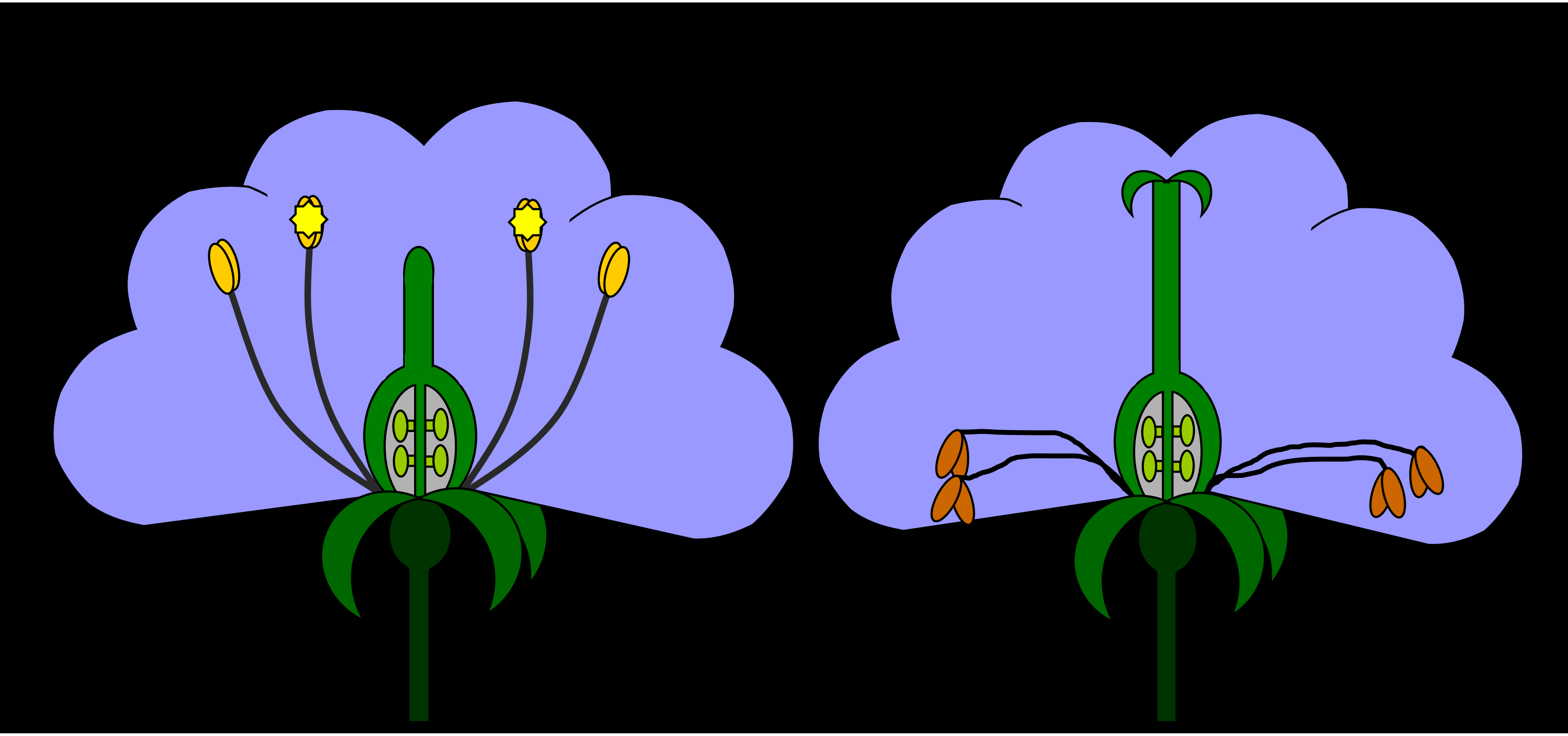
- Self-pollination is not desirable as it reduces variation

Pollination

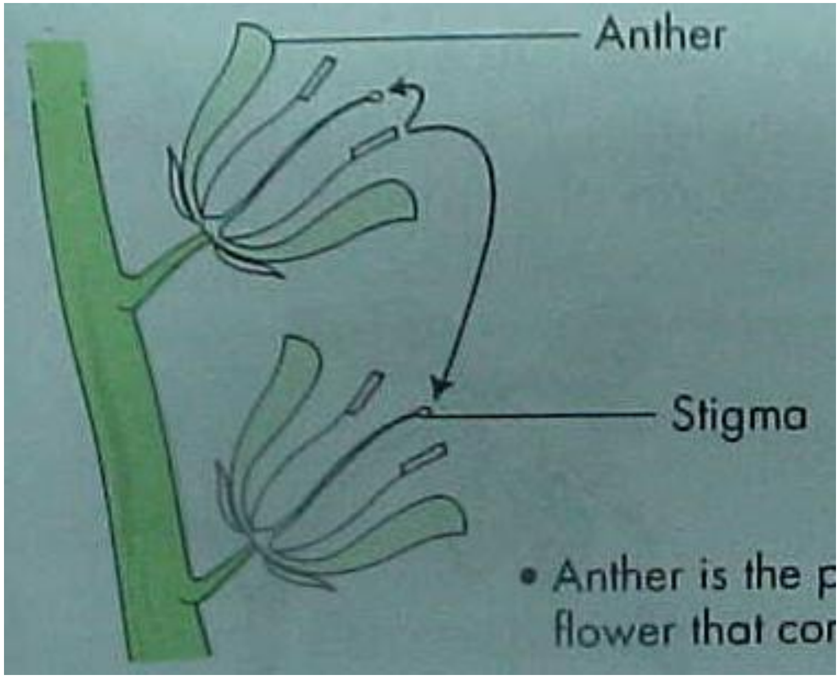
- **Pollination** is the transfer of pollen grains from the anther to the stigma of a flower.
  - The pollen grains can also be transferred from one flower to another.



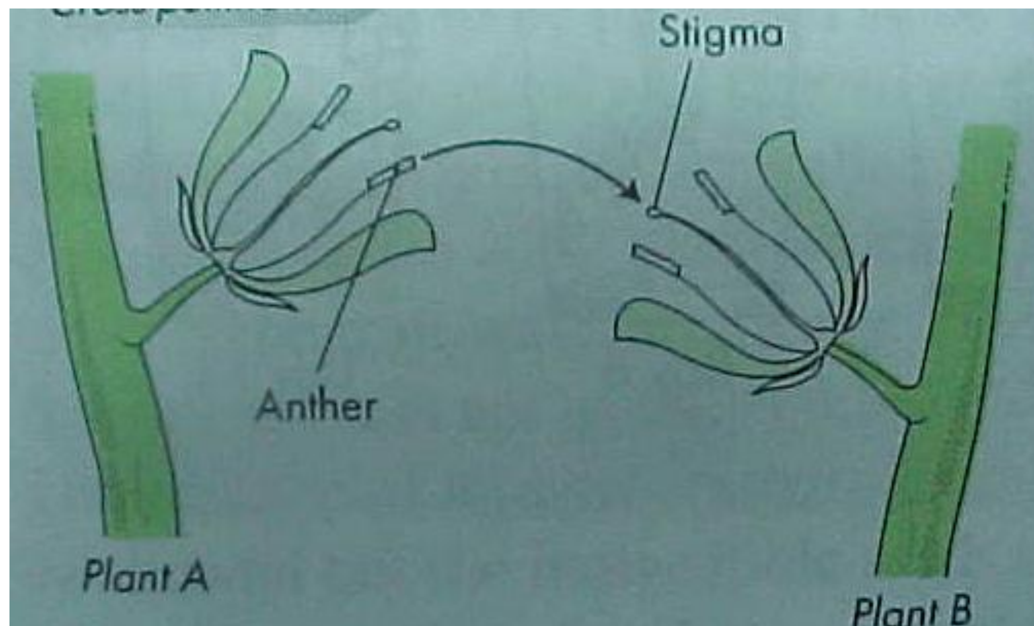
Pollination is the transfer of pollen from the anther to the stigma



- This is an example of **cross-pollination** as the pollen travels from one flower to a different flower. This is desirable in plants as it promotes variation.



Self-pollination vs
Cross-pollination



Self-Pollination vs Cross Pollination

- SELF-POLLINATION
  - Pollen grains falling on the stigma of the same flower or of a different flower but of the same plant
  - less adaptable to changes in the environment.
  - Analogy : Marrying within same family
  - If parent plant has a genetic disease, it will be passed on to offspring.

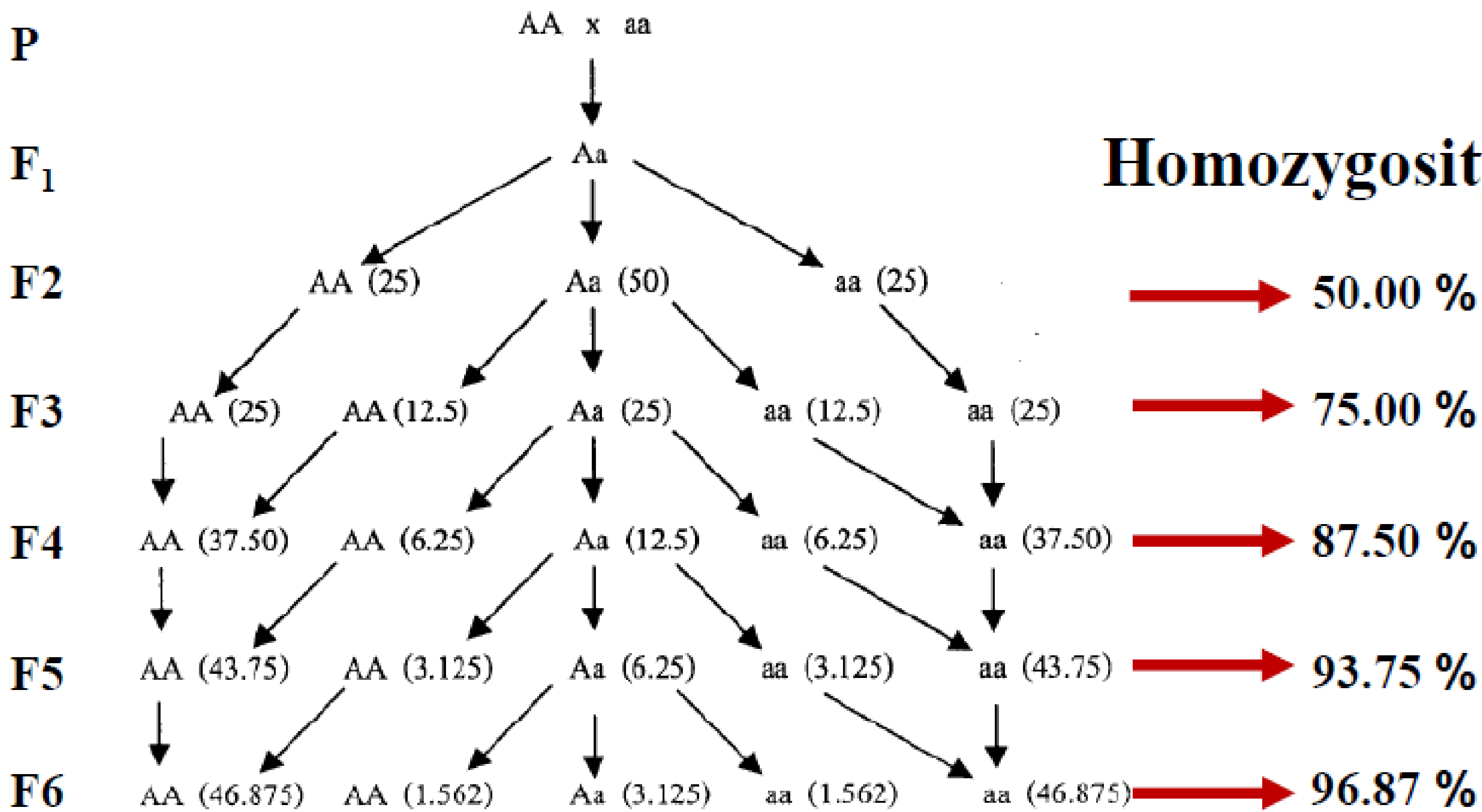
- CROSS-POLLINATION
  - Pollen grains falling on the stigma of another flower of the same kind but on a different plant
  - offspring has more variety. → Genetic variation.
  - Offspring inherit traits from both parents → can be good, but can be a bad thing too! E.g. genetic defect, disease, etc.

Self pollinated plants

- Self pollination is the phenomenon in which pollen grains are transferred from anthers to stigma of the same flower or another flower of same plant.
- Self pollinated species are naturally inbred and tend to be homozygous.

Self pollinated plants

Crossing



Mechanisms facilitating self pollination

1. Cleistogamy

- This mechanism prevents foreign pollens to reach the stigma of flower. In this case flowers never open.
- Examples – Some varieties of wheat, barley and oat, some grasses, etc.

2. Chasmogamy

- Flowers will be opened after the completion of pollination.
- Example – rice

Mechanisms facilitating self pollination

3. Hidden Stamen and Stigma

- Some floral organs do the job to hide or cover the reproductive organs, to avoid cross-pollination.
- Examples – legumes like pea, black gram, mung bean, soybean.

4. Anther position

- Stigmas remain densely and closely surrounded by anthers.
- Example – tomato

Mechanisms facilitating self pollination

5. Homogamy

- Anthers and stigma of a flower mature at the same time only ~ 4% of flowering plant species are dioecious – so how do they avoid inbreeding depression?

Means of Promoting Outcrossing

1) Spatial and temporal differences between flowers and stamen/pollen

    -Heteromorphic flowers

    -Dichogamy (timing)

        -Protogyny

        -Protandry

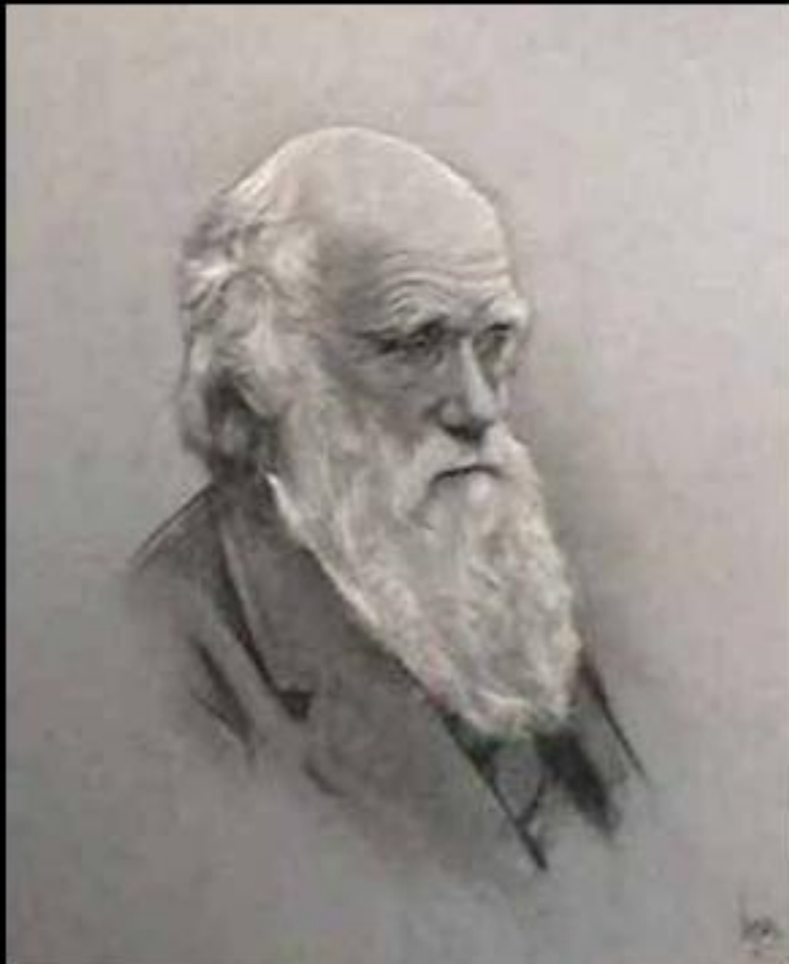
2) Self-incompatibility genes

    Gametophytic and sporophytic

3) Sexual expression

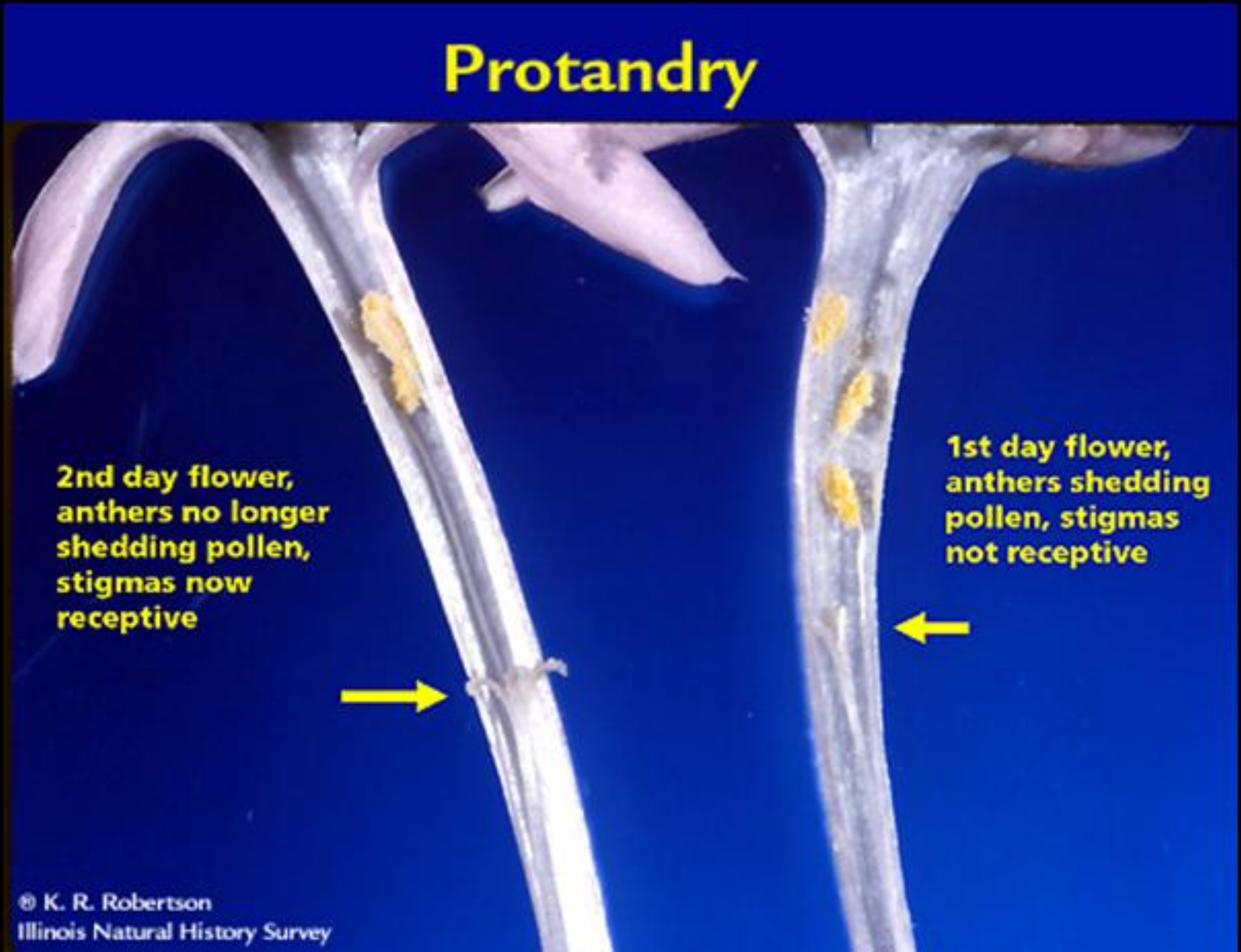
    Monoecy and Dioecy

HETEROMORPHIC FlOWERS



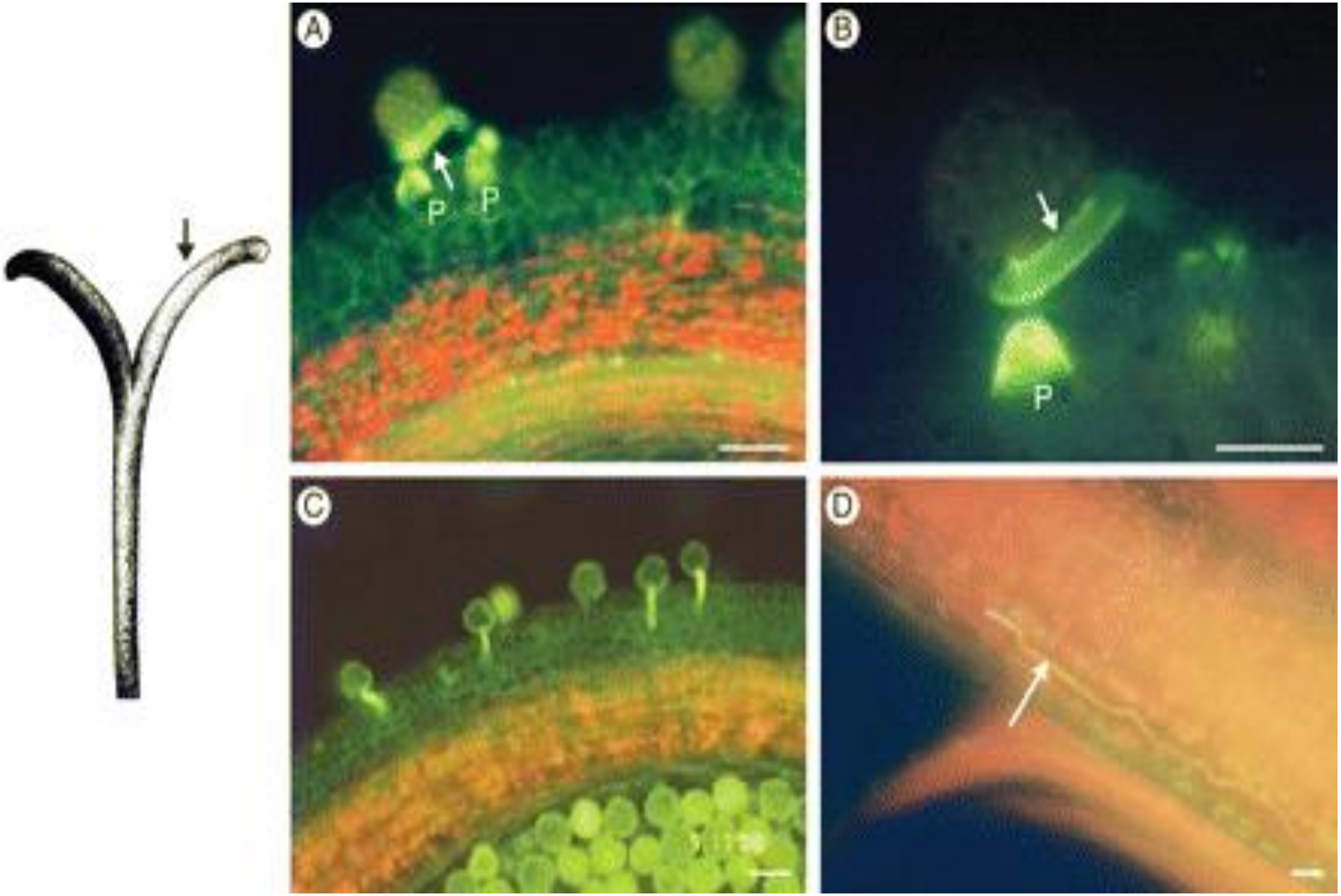
Darwin, C. 1893. *The different forms of flowers on plants of the same species.* New York, D.

Dichogamy I


Protandry
2nd day flower, anthers no longer shedding pollen, stigmas now receptive
1st day flower, anthers shedding pollen, stigmas not receptive
® K. R. Robertson
Illinois Natural History Survey

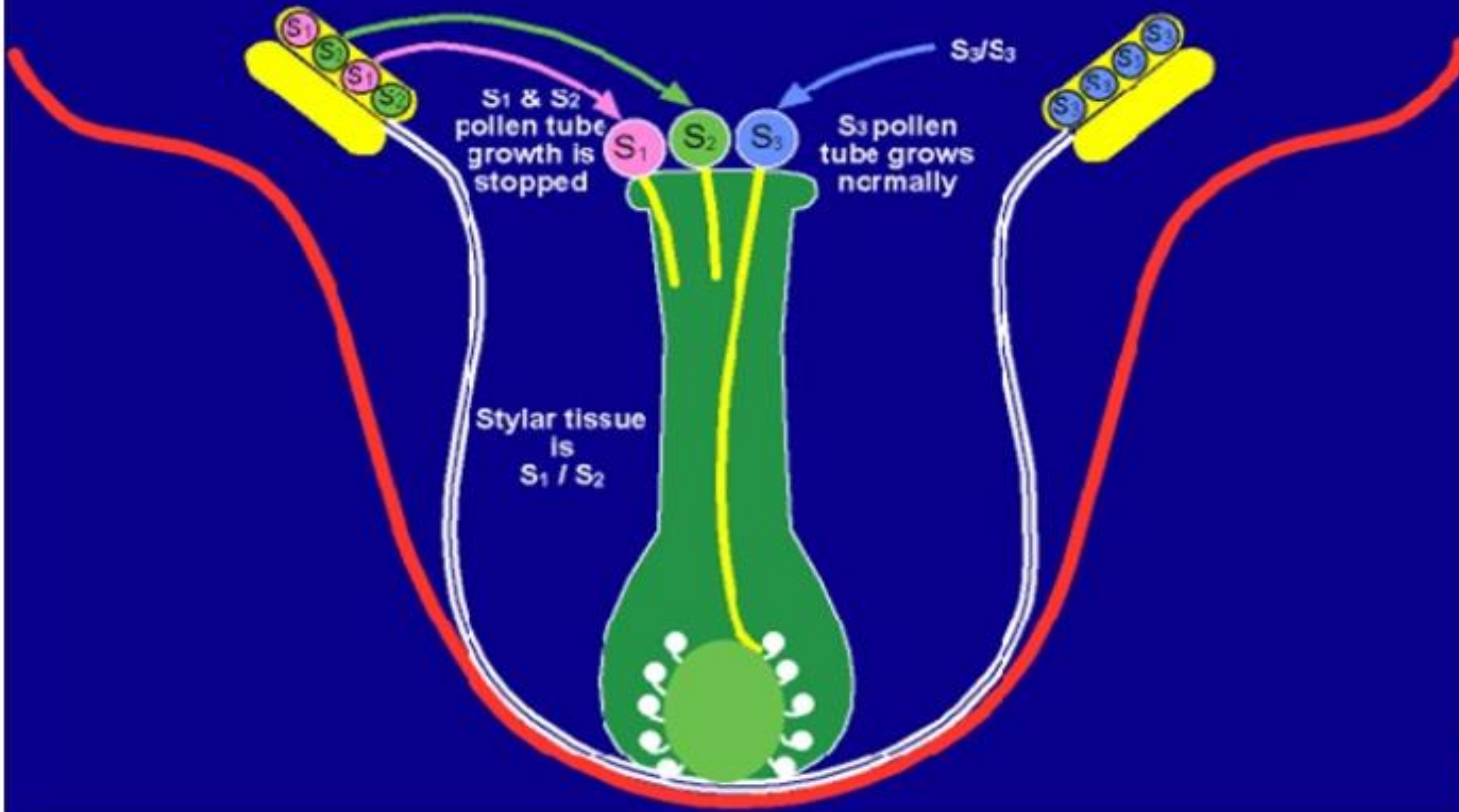
Dichogamy II

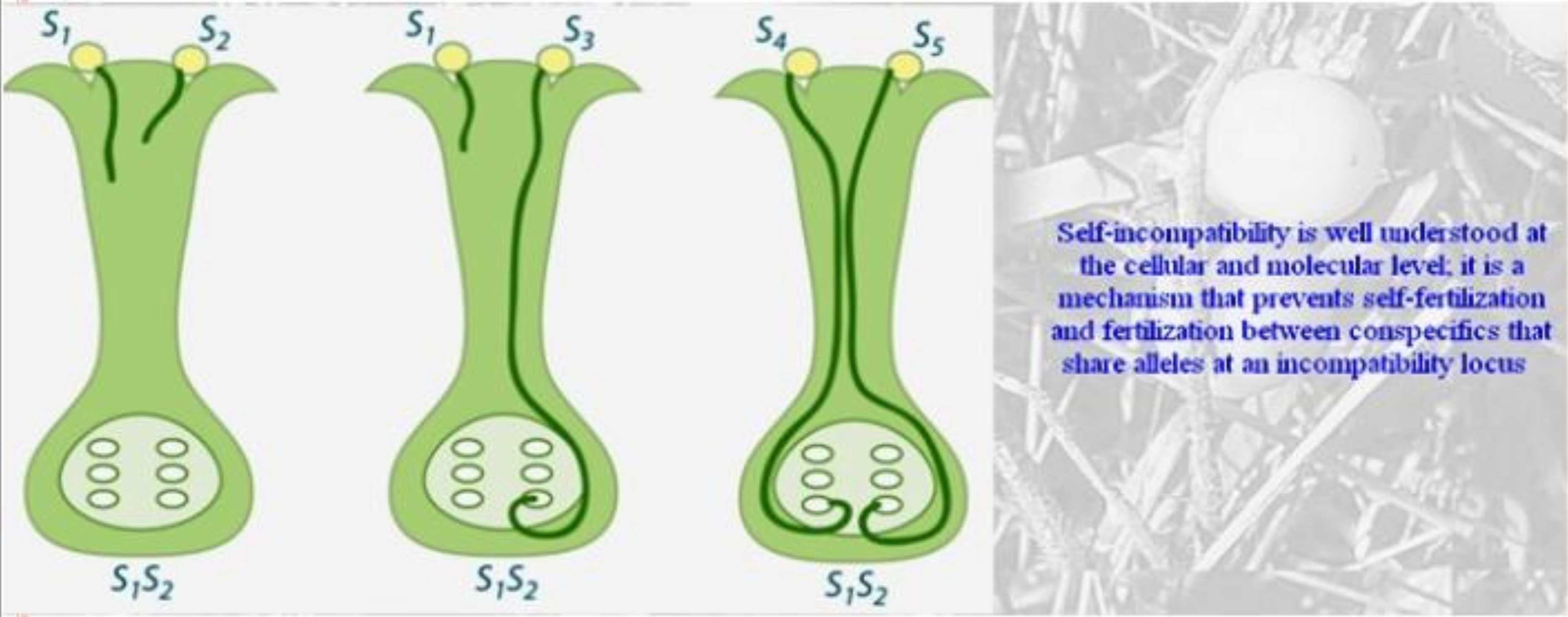
Protogyny – extremely obvious here, stigma out before the flower even opens



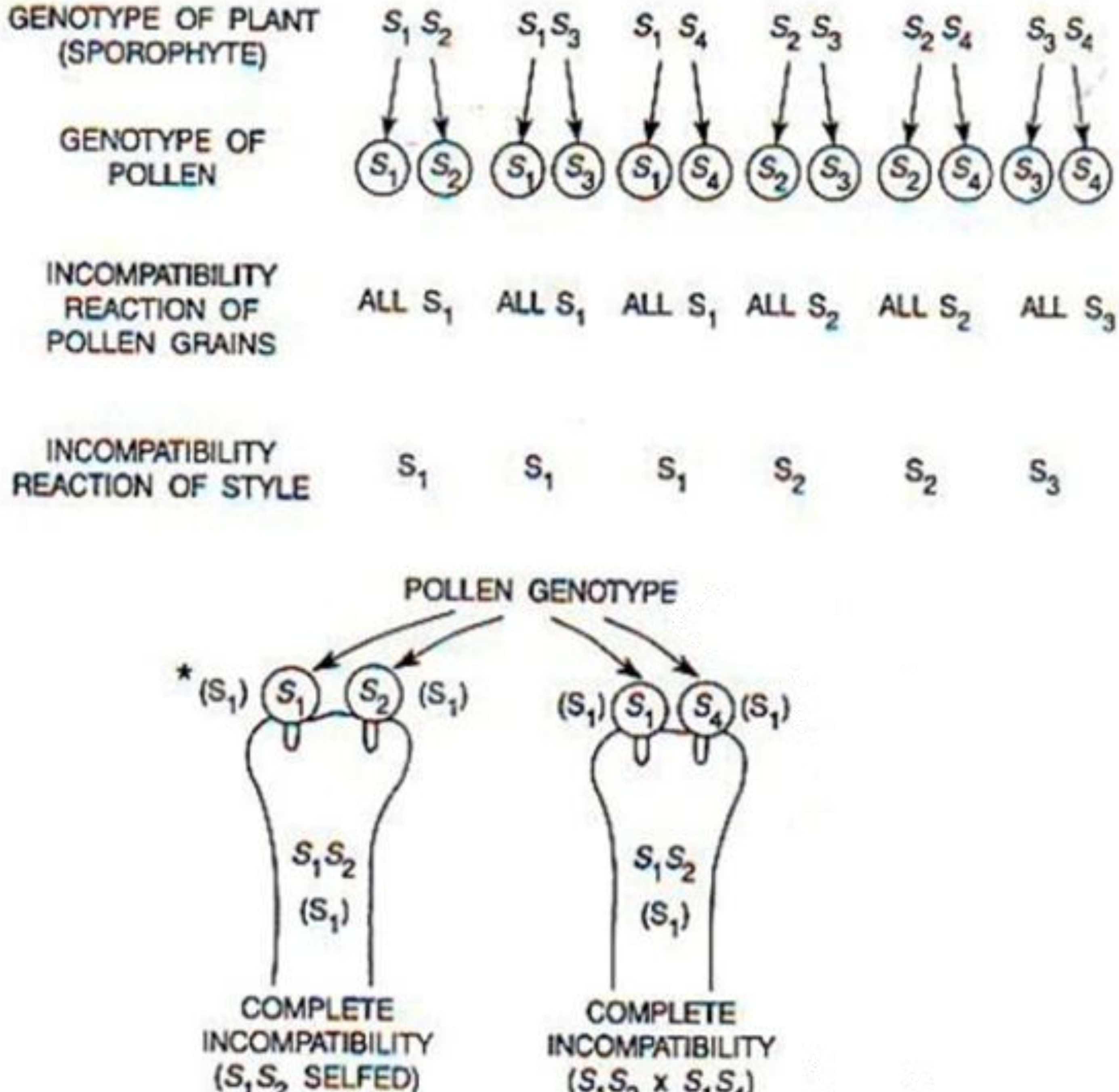
Incompatible and compatible pollinations in *Senecio squalidus.* Squash preparations of stigmas stained with aniline blue and viewed under UV light. (A,B) Incompatible pollination; pollen tube (arrow) blocked from entering papillae (P). (C) Compatible pollination; pollen tubes penetrating stigma tissue. (D) Compatible pollen tube growing through transmitting tissue (arrow). Scale bars = 0·25 µm.

GAMETOPHYTIC SELF-INCOMPATIBILITY



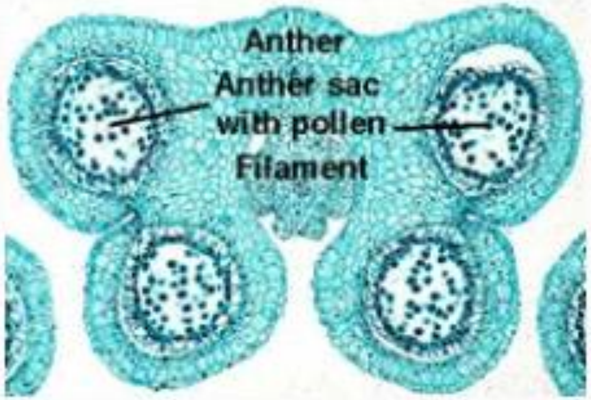


Gametophytic incompatibility

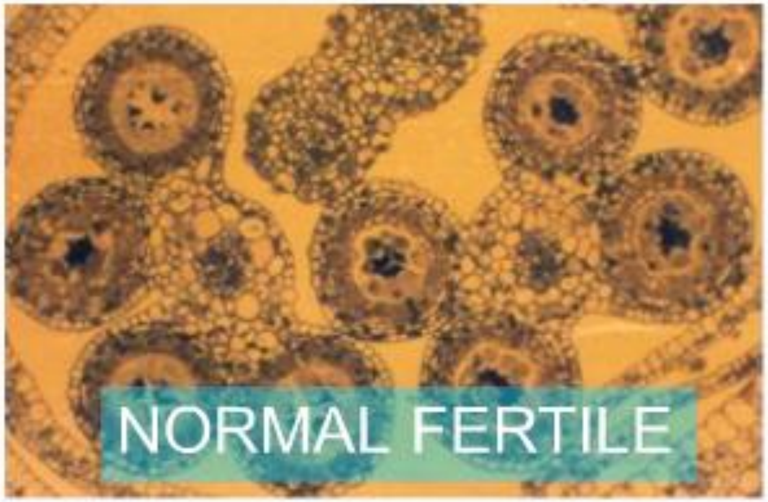


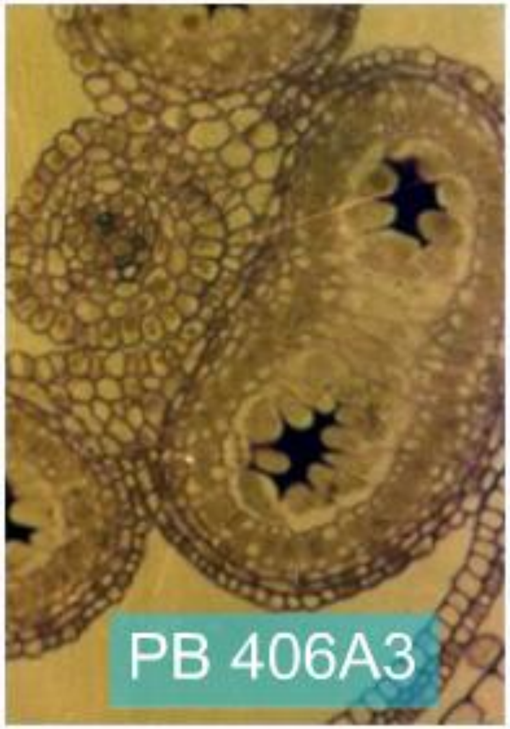
GENOTYPE OF PLANT (SPOROPHYTE)
$S_1 S_2$ $S_1 S_3$ $S_1 S_4$ $S_2 S_3$ $S_2 S_4$ $S_3 S_4$
GENOTYPE OF POLLEN
S_1 S_2 S_1 S_3 S_1 S_4 S_2 S_3 S_2 S_4 S_3 S_4
INCOMPATIBILITY REACTION OF POLLEN GRAINS
ALL S_1 ALL S_1 ALL S_1 ALL S_2 ALL S_2 ALL S_3
INCOMPATIBILITY REACTION OF STYLE
S_1 S_1 S_1 S_2 S_2 S_3
POLLEN GENOTYPE
* (S_1) S_1 S_2 (S_1)
$S_1 S_2$
(S_1)
COMPLETE INCOMPATIBILITY ($S_1 S_2$ SELFED)
(S_1) S_1 S_4 (S_1)
$S_1 S_2$
(S_1)
COMPLETE INCOMPATIBILITY ($S_1 S_2 \times S_1 S_4$)

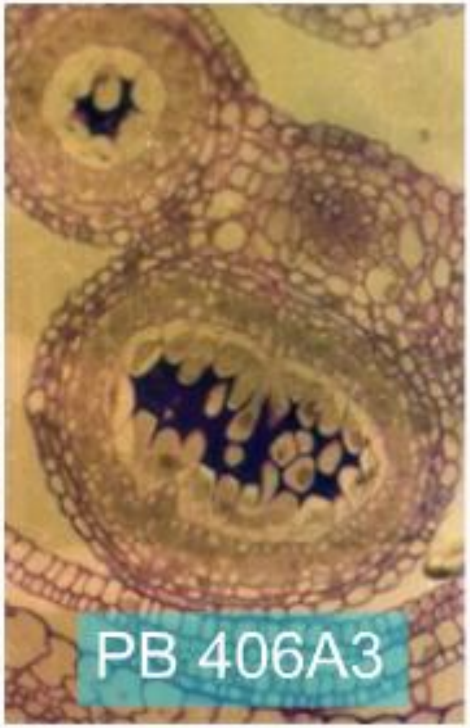
Phenotypic expressions of MS



- Absence , atrophy or malformation of androecium
- Lack of normal anther sac or anther tissues
- Inability of the pollen to mature or to be released from anther sac
- Inability to develop normal microspores or pollen

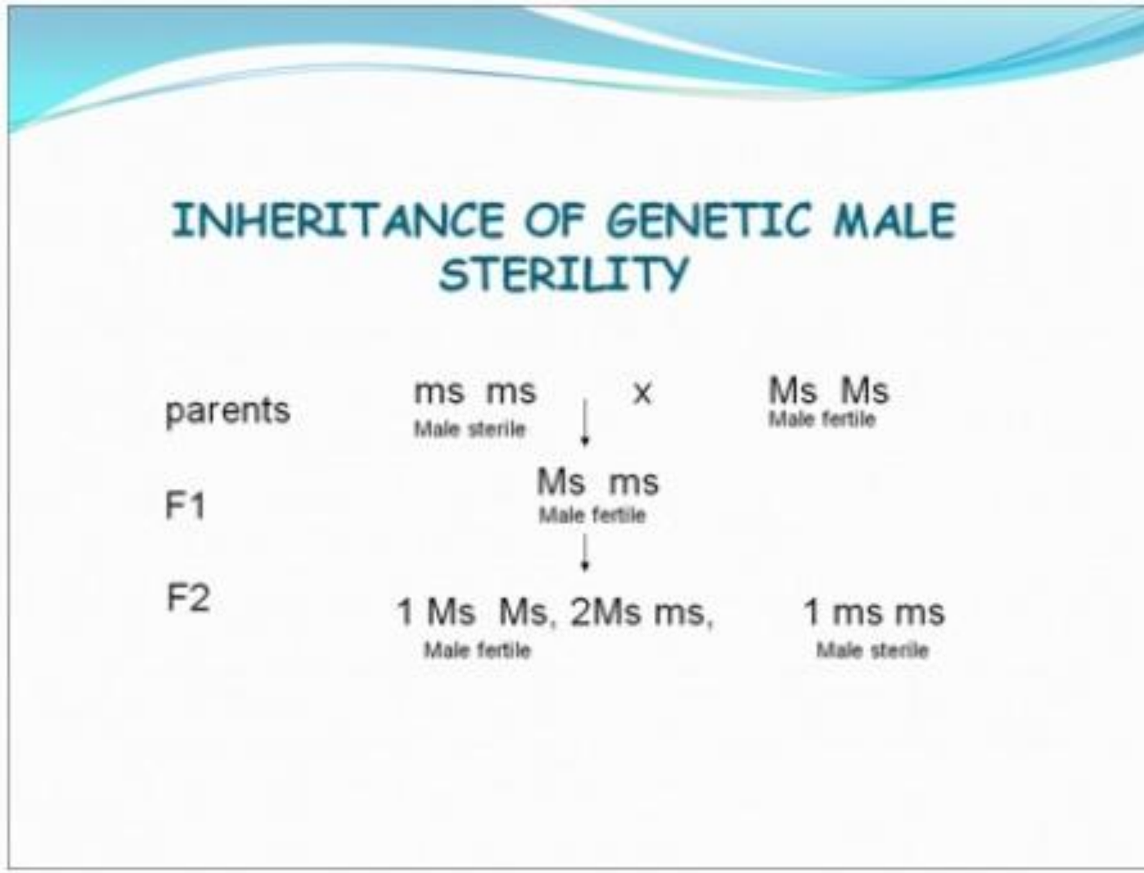




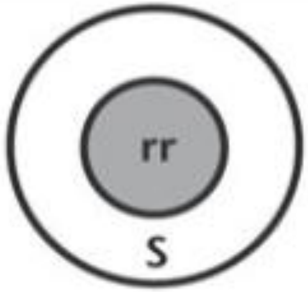


Genetic Male Sterility

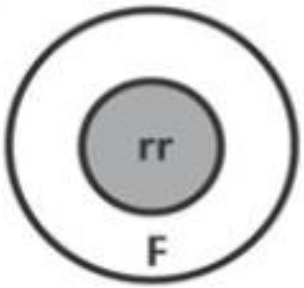
- Ordinarily governed by single recessive gene but sometimes by dominant genes e.g. Safflower
- Alleles arise spontaneously by mutation or may be artificially induced by use of mutagens
- MS x MF = MF in F_1 while a ratio of 3(MF):1(MS) in F_2



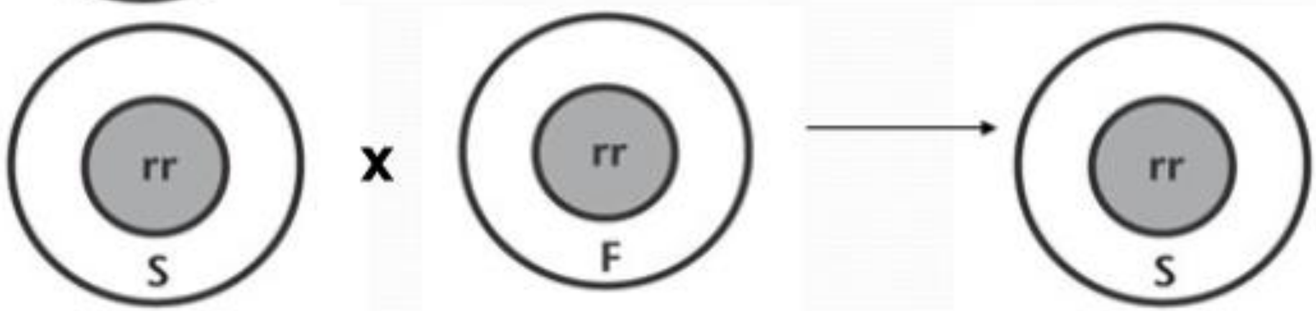
CYTOPLASMIC MALE STERILITY



Cytoplasmic sterile nuclear gene non restorer



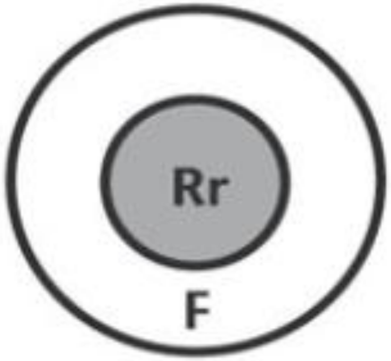
Cytoplasmic fertile nuclear gene non restorer



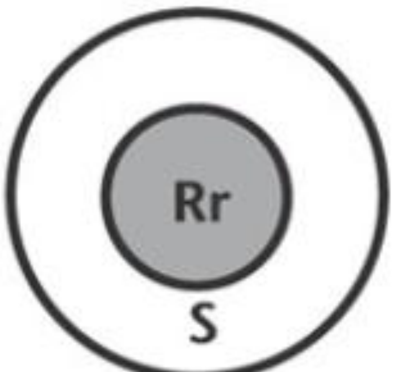
Male sterile Male fertile Male sterile

CYTOPLASMIC - GENETIC MALE STERLITY

Male fertile

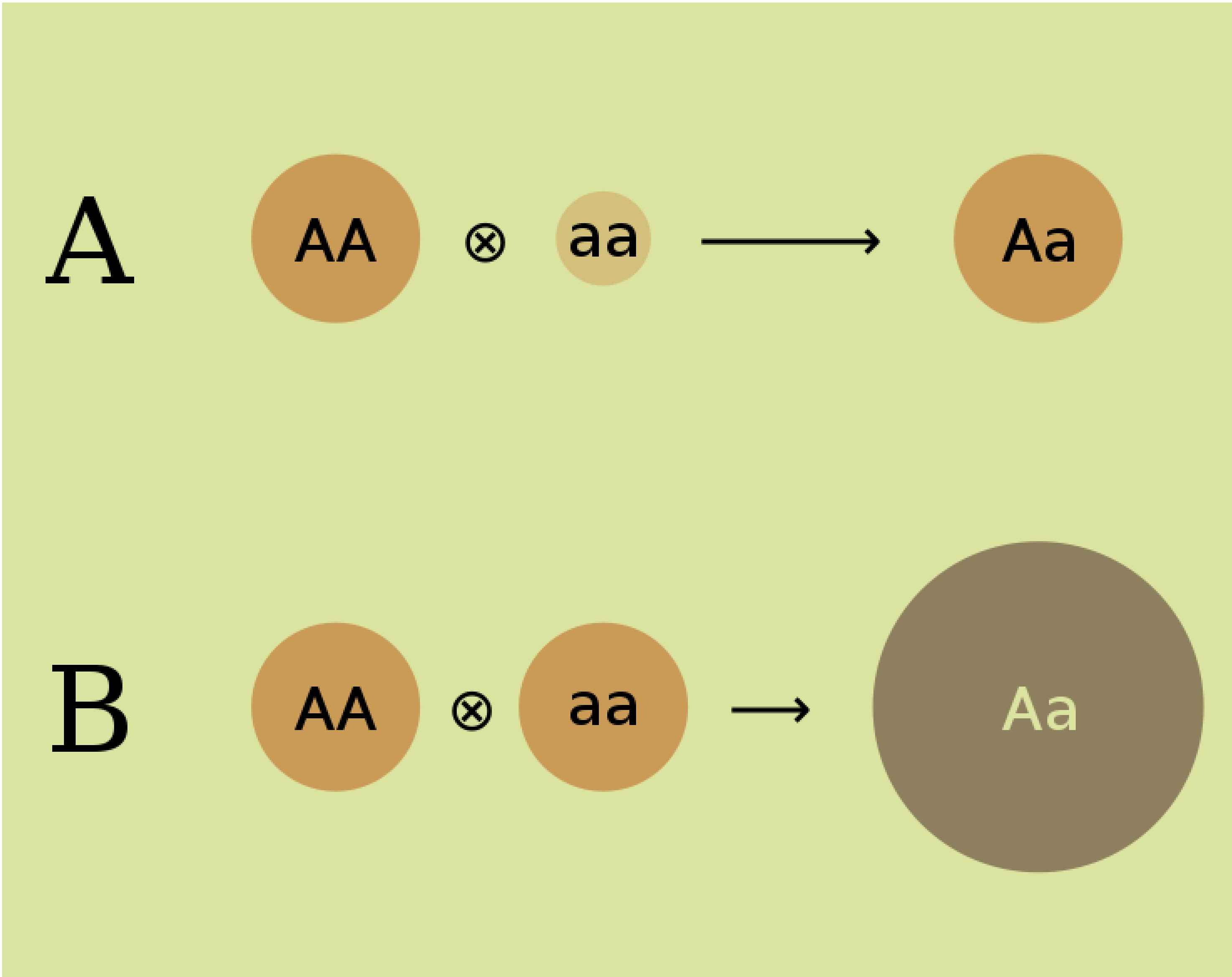


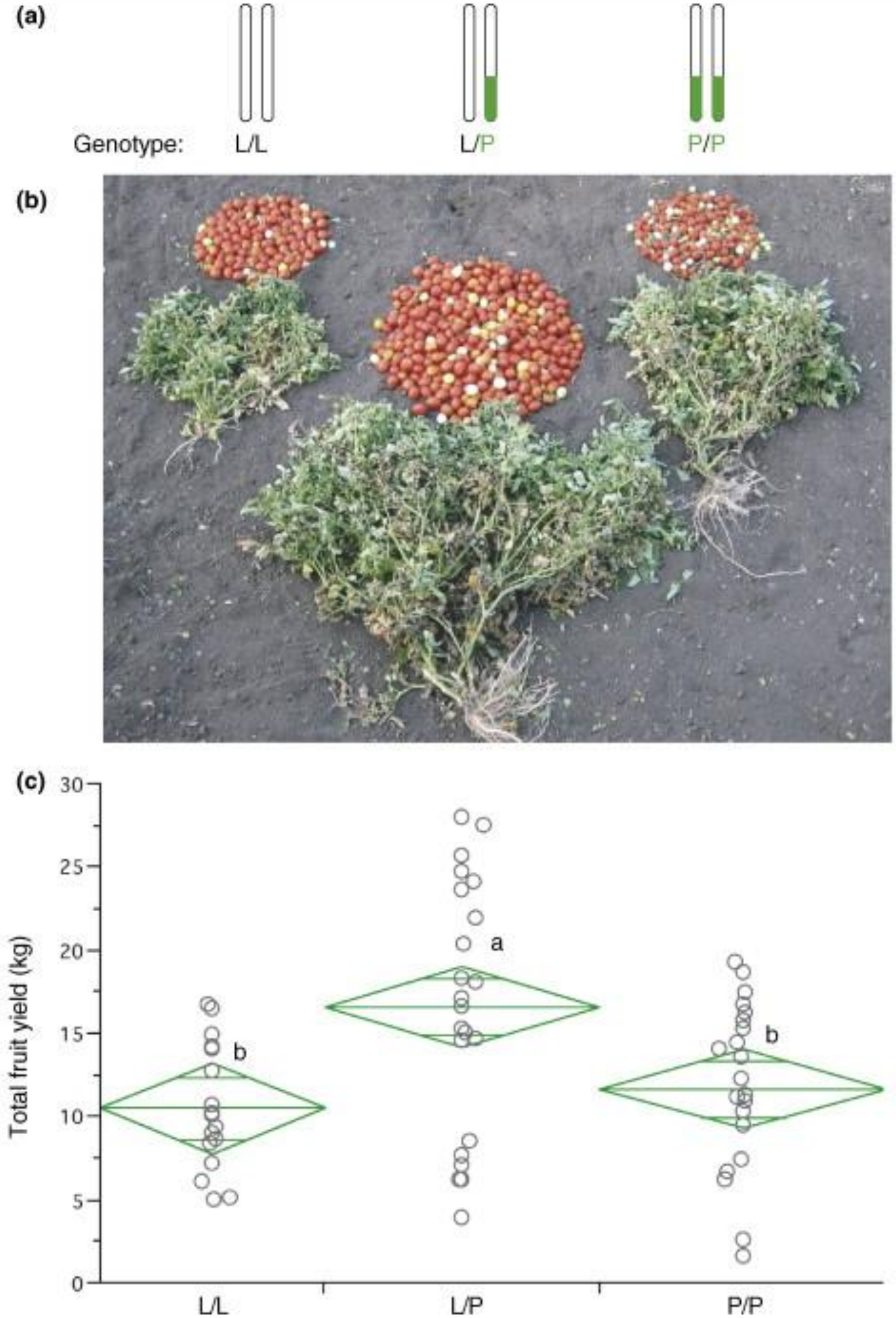
Male fertile



Male fertile

Heterosis





TRENDS in Genetics

Breeding methods of self pollinated crops

- Plant introduction
- Selection
- Hybridization

Breeding methods of self pollinated crops

Selection

- Pure line selection
- Mass selection

Breeding methods of self pollinated crops

Hybridization

- Pedigree selection
- Bulk population breeding
- Single seed descent
- Back cross breeding

Mass selection

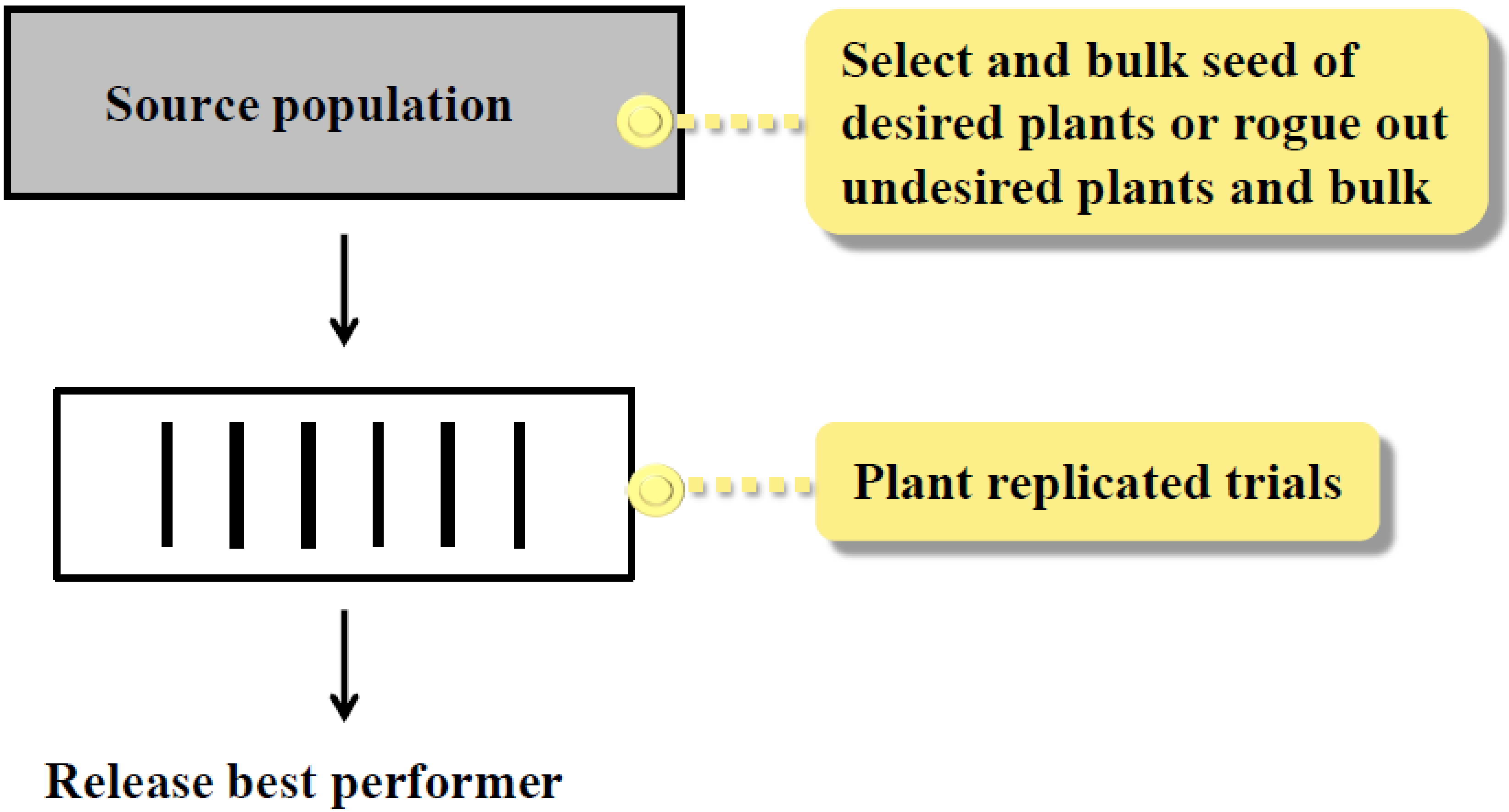
Mass selection

- Mass selection is often described as the oldest method of breeding self pollinated plant species.
- Mass selection is an example of selection from a biologically variable population.
- Selection is based on plant phenotype.

Objectives of Mass selection

- Purify a mixed population with differing phenotypes
- Develop a new cultivar by improving the average performance of the population

Generalized steps in breeding by mass selection for cultivar development



Advantages

- It is a rapid and simple method.
- It is an inexpensive to conduct.
- The cultivar is phenotypically fairly uniform.

Disadvantages

- Without progeny testing, heterozygotes will segregate in the next generation.
- Phenotypic uniformity is less than in cultivars produced by pure-line selection.

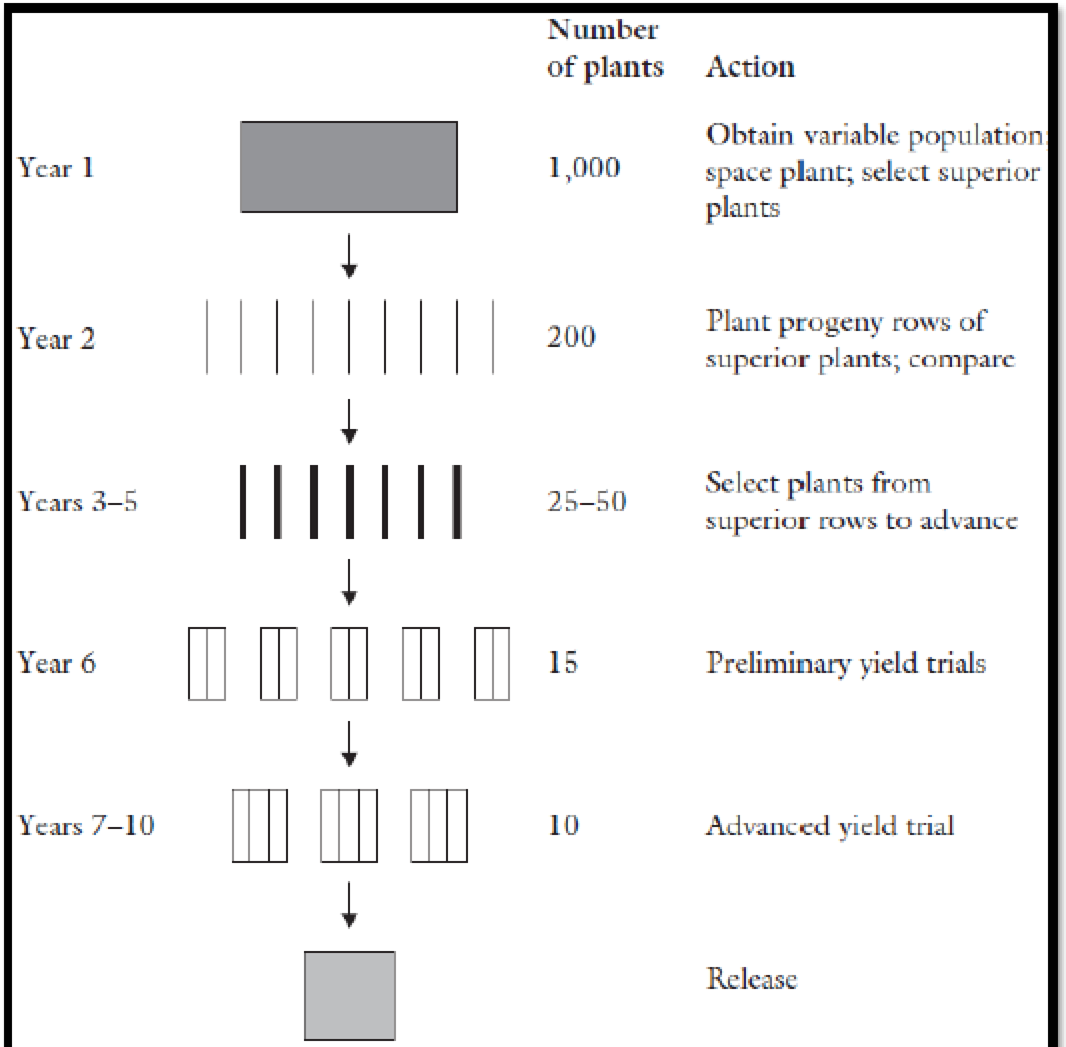
Pure line selection

Pure line Selection

- Pure line selection is a procedure for isolating pure line(s) from a mixed population.

- Genetic improvement using pure line breeding is limited to the isolation of the best genotypes present in the mixed population.

Generalized steps in breeding by pure line selection



Disadvantages

- The purity of the cultivar may be altered through admixture, natural crossing with other cultivars, and mutations.

- The cultivar has a narrow genetic base and hence is susceptible to devastation from adverse environmental factors.

- The method promotes genetic erosion.

Pedigree selection

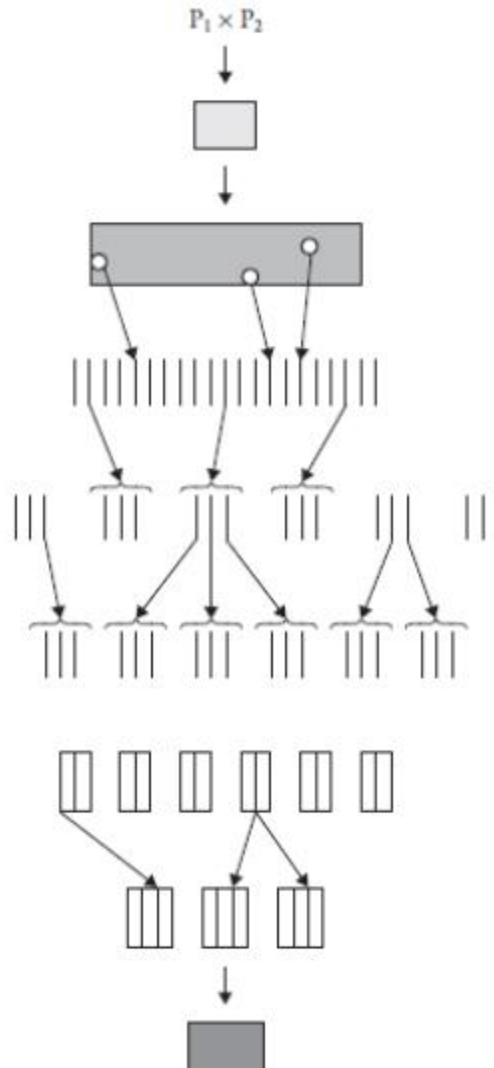
Pedigree selection

- Pedigree selection is a widely used method of breeding self pollinated species.
- In this method superior types are selected in successive segregation, and a record is maintained of all parent-progeny relationship.
- Individual plant selection continued till the progeny become virtually homozygous, and no phenotypic segregation.

Pedigree selection

- Essentially a plant to row system is used to develop pure lines.
- This method and its variants require a lot of record keeping.

Generalized steps in breeding by pedigree selection



	Generation	Number of plants	Action
Year 1			Select parents and cross
Year 2	F_1	50–100	Bulk seed; space plant for higher yield
Year 3	F_2	2,000–5,000	Space plant for easy visual selection
Year 4	F_3	200	Select and plant in spaced rows
Year 5	F_4	100	Identity superior rows; select 3–5 plants to establish family in progeny rows
Years 6–7	F_5–F_6	25–50	Establish family progeny rows; select individual plants to advance each generation
Year 8	F_7	15	Conduct preliminary yield trials; select individual plants to advance
Years 9–11	F_8–F_{10}	5–10	Conduct advanced yield trials with more replications and over locations and years
		1	Cultivar release

Advantages

- Inferior types are discarded in the individual plant phase and before strain testing.
- This is an effective method for selecting superior lines from among segregating plants.
- A high degree of genetic purity is produced in the cultivar.

Disadvantages

- Record keeping is slow, tedious, time consuming, and expensive.

- This method can't be used in environments where genotypic variation of interest is not express.

Bulk population breeding

Bulk population breeding

- The bulk method applies pure-line theory to segregating populations to develop pure-line cultivars.

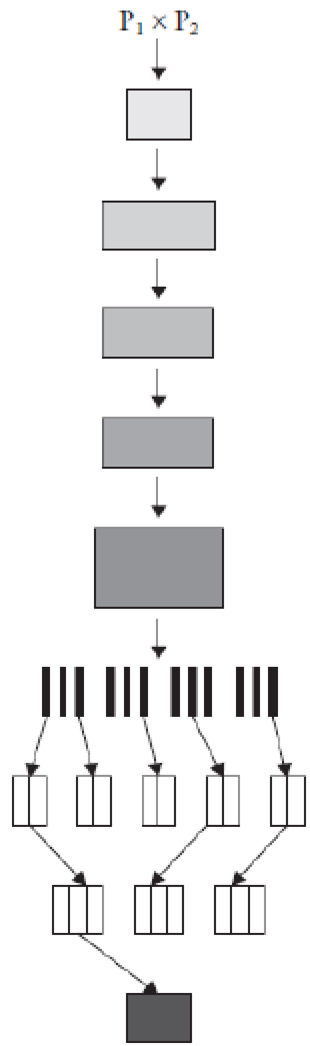
- The bulk method of breeding differs from the pedigree method primarily in the handling of generations following hybridization.

Bulk population breeding

- The rationale for delaying artificial selection is to allow natural selection pressure to eliminate or reduce the productivity of less fit genotypes in the population.

- Seeds harvested in the F_1 through F_5 generations are bulked without selection.

Generalized steps in breeding by bulk selection



	Generation	Number of plants	Action
Year 1			
Year 2	F_1	50–100	Bulk and space plant F_1
Year 3	F_2	2,000–3,000	Bulk and plant at commercial seeding rate
Year 4	F_3	2,000–3,000	Bulk and plant at commercial seeding rate
Year 5	F_4	2,000–3,000	Bulk and plant at commercial seeding rate
Year 6	F_5	3,000–5,000	Space plant; select superior plants
Year 7	F_6	300–500	Select and establish family rows from plants or heads
Year 8	F_7	30–50	Conduct preliminary yield trials
Years 9–11	F_8–F_{10}	10	Conduct advanced yield trials
		1	Cultivar release

Advantages

- It is less labor intensive and less expensive in early generations.
- Natural selection may increase frequency of desirable genotypes by the end of the bulking period.
- Bulk breeding allows large amounts of segregating materials to be handled.
- The cultivar developed would be adapted to the environment, having been derived from material that had gone through years of natural selection.

Disadvantages

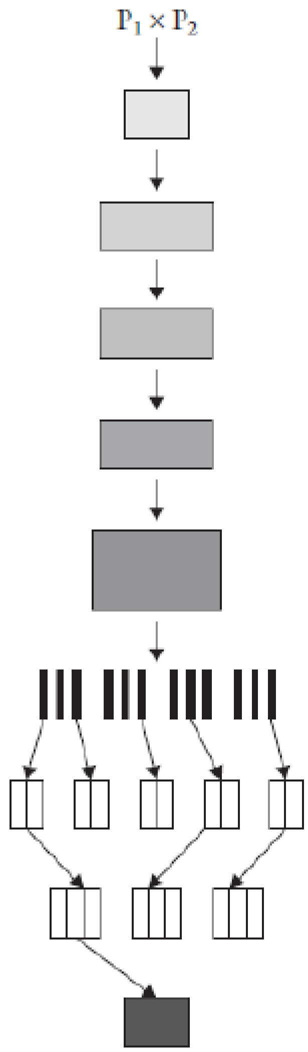
- Environmental changes from season to season so adaptive advantages shift
- Final genotypes may be able to withstand environmental stress, but may not be highest yielding.
- Not useful in selecting plant types at a competitive disadvantage (dwarf types).

Single seed descent

Single seed descent

- Single seed descent is a modification of bulk method.
- This is the classic procedure of having a single seed from each plant, bulking the individual seeds, and planting out the next generation.
- With this procedure one or two seeds are collected from each F_2 plant and then bulk to grow F_3 generation.

Generalized steps in breeding by bulk selection



	Generation	Number of plants	Action
Year 1			
Year 2	F_1	50–100	Grow F_1 plants and harvest all F_2 seeds per plant.
Year 3	F_2	2,000–3,000	Grow F_2 population, harvest one seed per plant
Year 4	F_3	2,000–3,000	Grow F_3 population, harvest one seed per plant
Year 5	F_4	2,000–3,000	Grow F_4 population, harvest one seed per plant
Year 6	F_5	3,000–5,000	Space-plant to grow F_5, select best single plants
Year 7	F_6	300–500	Grow F_5 derived plant rows in the F_6 generation
Year 8	F_7	30–50	Yield trial in F_7-F_{10}
Years 9–11	F_8–F_{10}	10	
		1	The most superior line is increased in the F_{11} and F_{12} as a new cultivar

Advantages

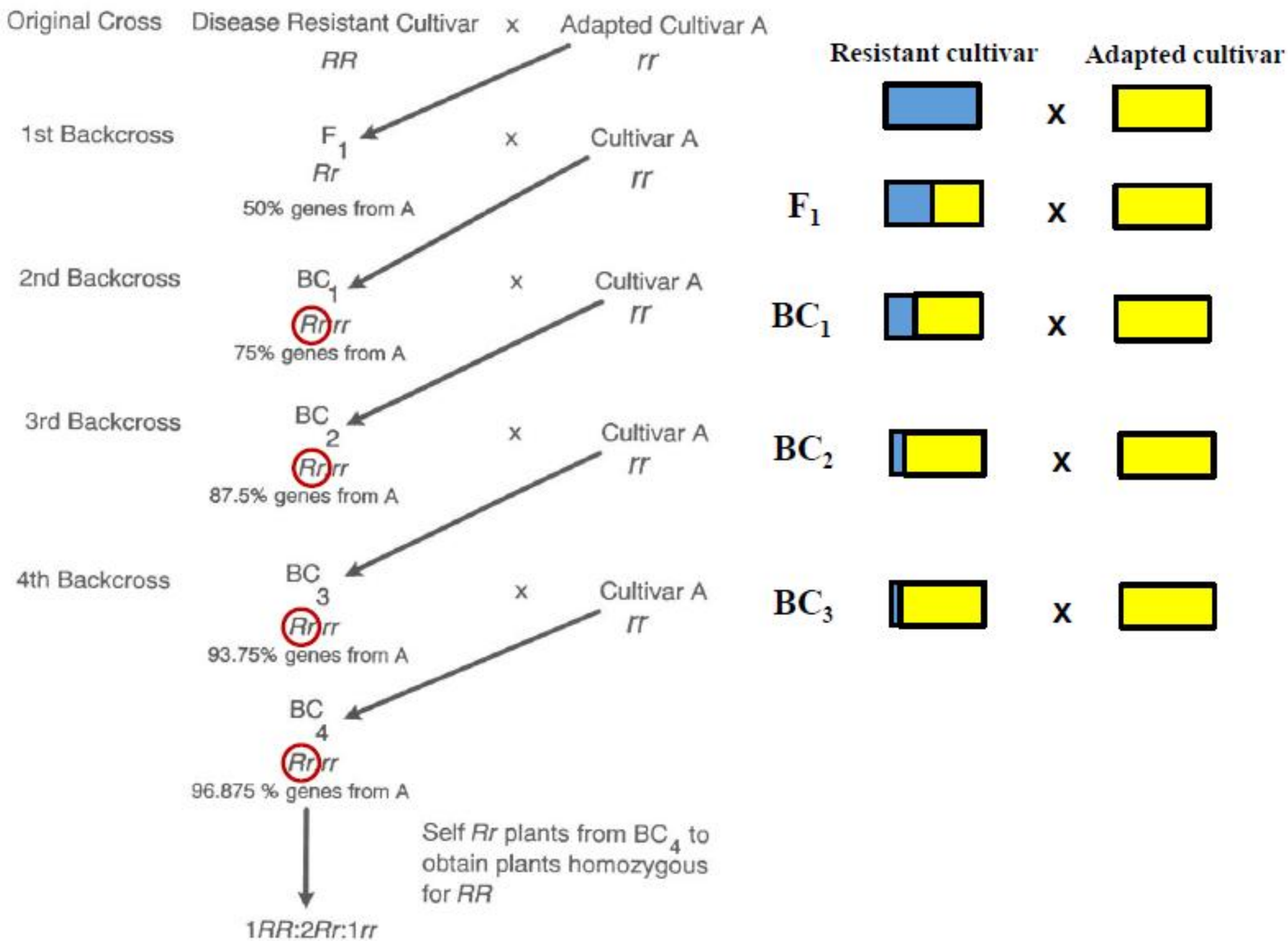
- It is an easy and rapid way to attain homozygosity.
- Small spaces are required in early generations to grow the selections.
- The duration of the breeding program can be reduced by several years by using single seed descent.

Disadvantages

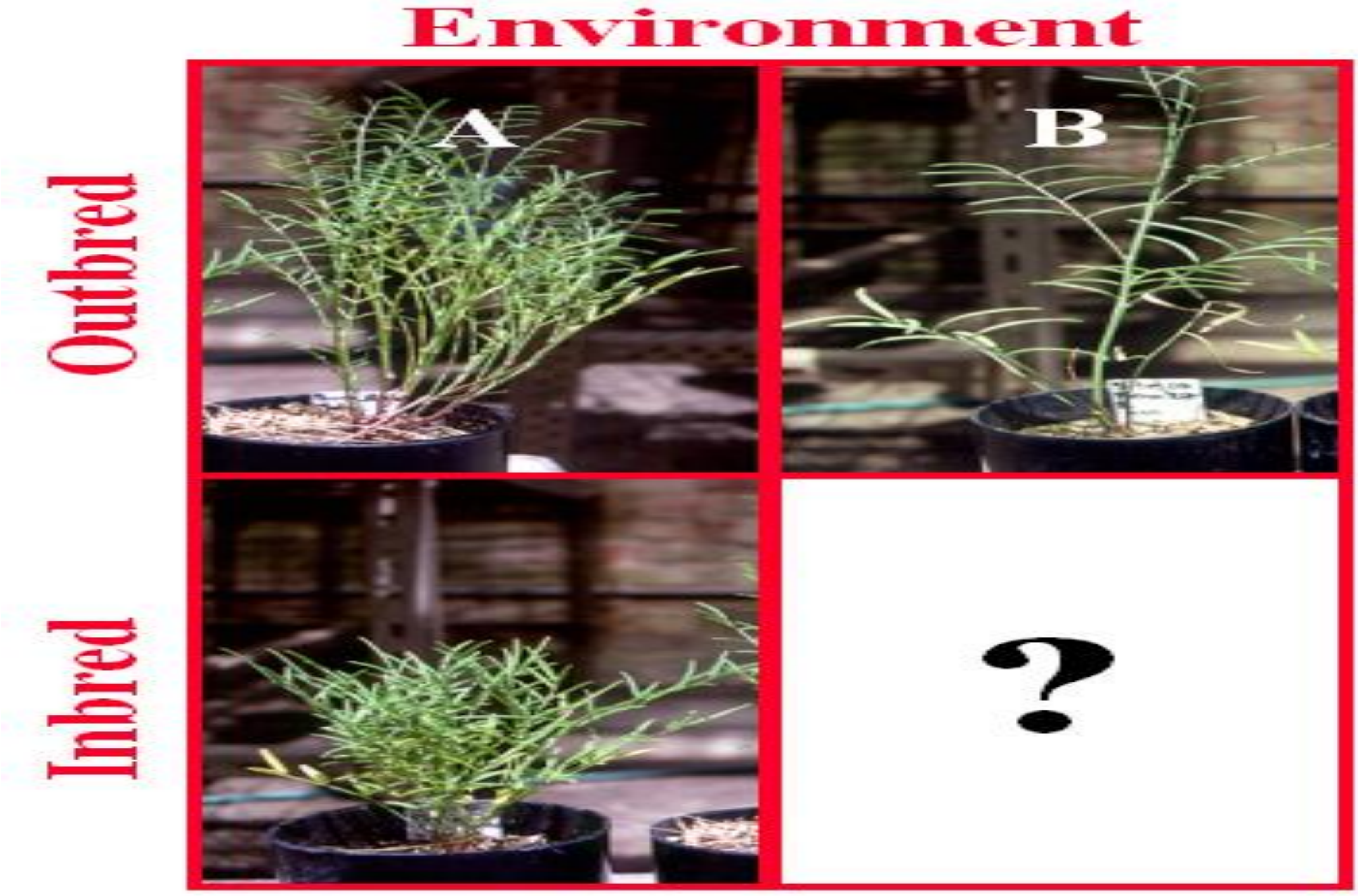
- Natural selection has no effect.
- An inability of seed to germinate or a plant to set seed may prohibit every F_2 plant from being represented in the subsequent population.
- Selecting a single seed per plant runs the risks of losing desirable genes.

Backcross breeding

Steps in breeding a dominant trait by the backcross method



Inbreeding



Inbreeding depression in white clover (non-inbred on left, inbred on right)

The plant at the far left is non-inbred, the plant second from left was produced by one generation of self-pollination, and the two plants on the right were produced by two generations of self-pollination.

Inbred plant B73 (left), inbred plant Mo17 (middle), and hybrid plant B73 x Mo17 (right). (University of Nebraska-Lincoln, 2004)

B73 ear (left), B73 x Mo17 hybrid ear (middle), and Mo17 ear (right)

Crosses types in cross pollinated plants

Inbreeding

Top cross

Polycross

Diallel cross

Breeding Methods in Cross-Pollinated Crops

- Mass Selection
- Recurrent Selection
- Reciprocal Recurrent Selection
- Synthetic Cultivars
- Hybrids

Breeding Methods in Cross-Pollinated Crops

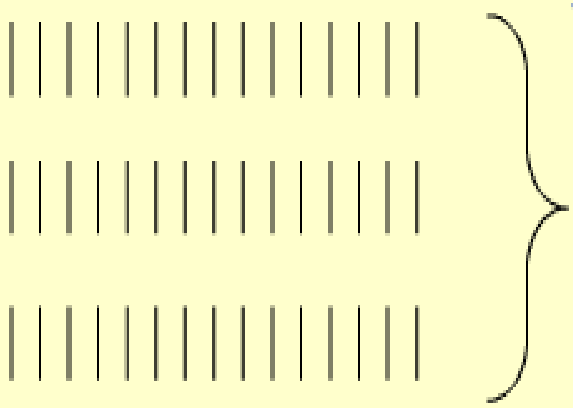
- Mass Selection
  - Same form as with self-pollinated crops
  - essentially a form of maternal selection since no pollination control
    - select desirable plants
    - bulk seed
    - repeat cycle
      - with strict selection breeder will reduce popul. Size
      - slow genetic gain since lack pollination control
      - must be able to ID superior phenotypes

- Recurrent Selection (Cycle 1)

Year 1

x	**x**	**x**	x	x	**x**	x	x	x	**x**
x	x	x	**x**	x	x	**x**	x	**x**	x
x	x	**x**	x	**x**	x	x	**x**	x	x

x = selfed; **x = selected at maturity** (superior performing plant)



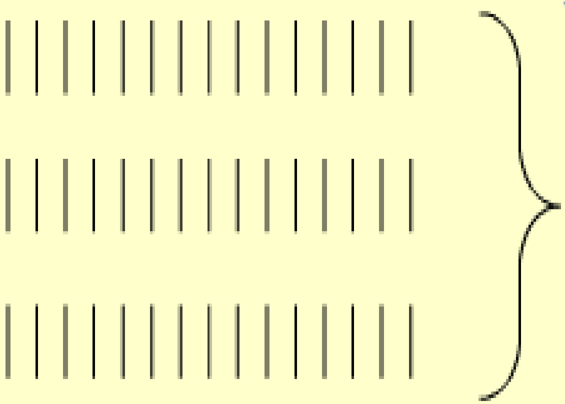
Year 2: Plant in an intercross block and allow intermating to re-establish HWE

- Recurrent Selection (Cycle 2)

Year 3

x	x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x	x

x = selfed; x = selected at maturity (superior performing plant)



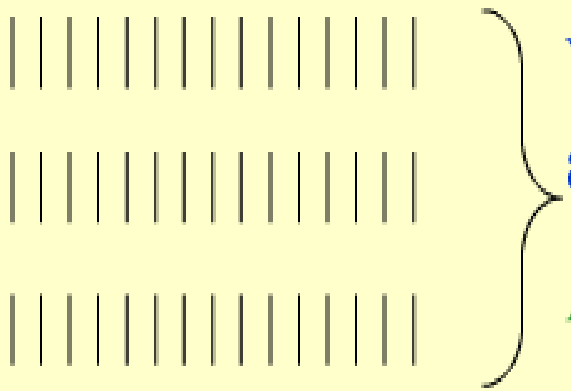
Year 4: Plant in an intercross block and allow intermating to re-establish HWE

- Recurrent Selection (Cycle n of continuing cycles)

Year n

x	x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x	x

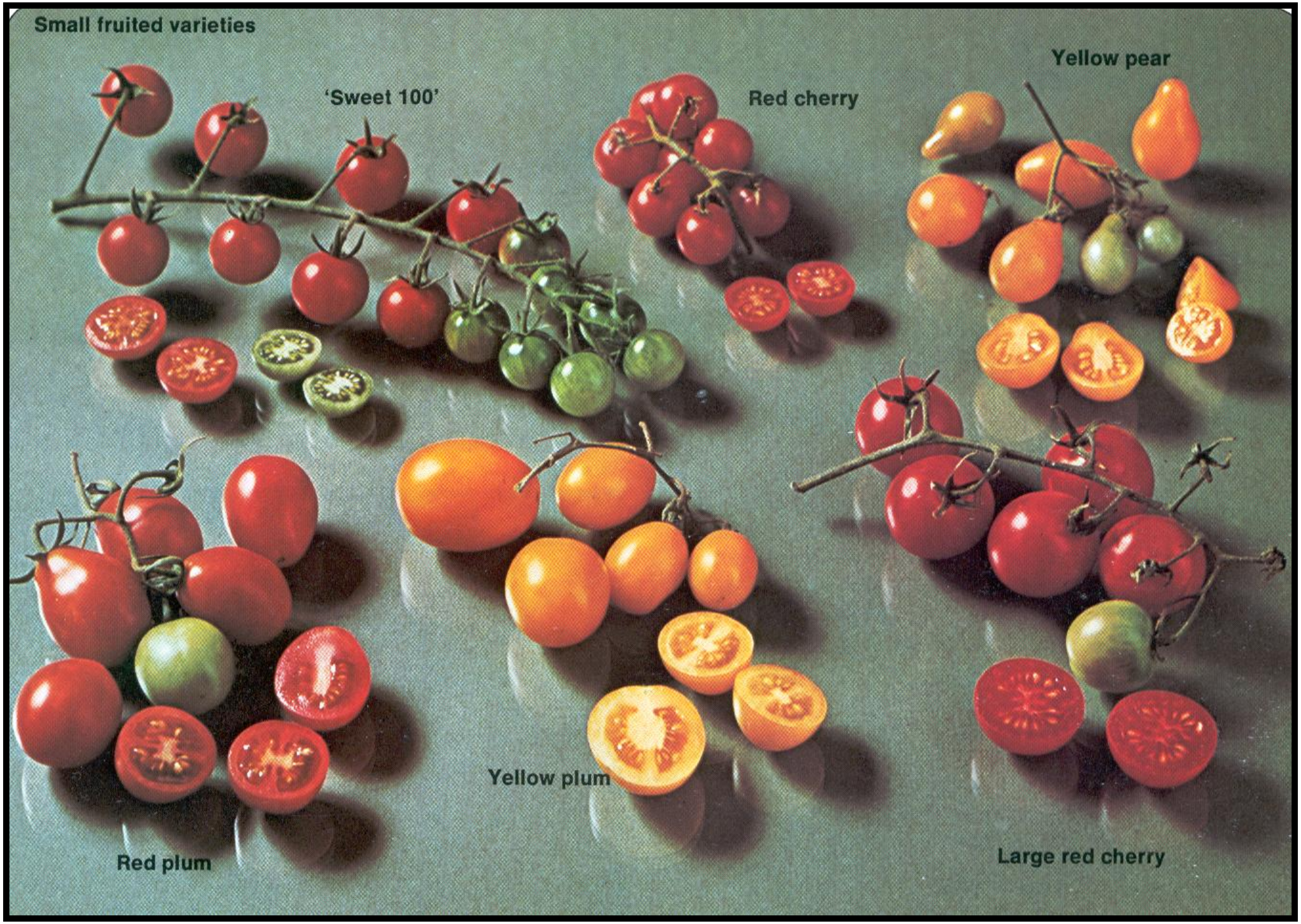
x = selfed; x = selected to initiate inbred line development;
MAY self and cross with a tester.



Year n+1: Plant in an intercross block and allow intermating to re-establish HWE

AND performance test hybrids

Tomato Breeding



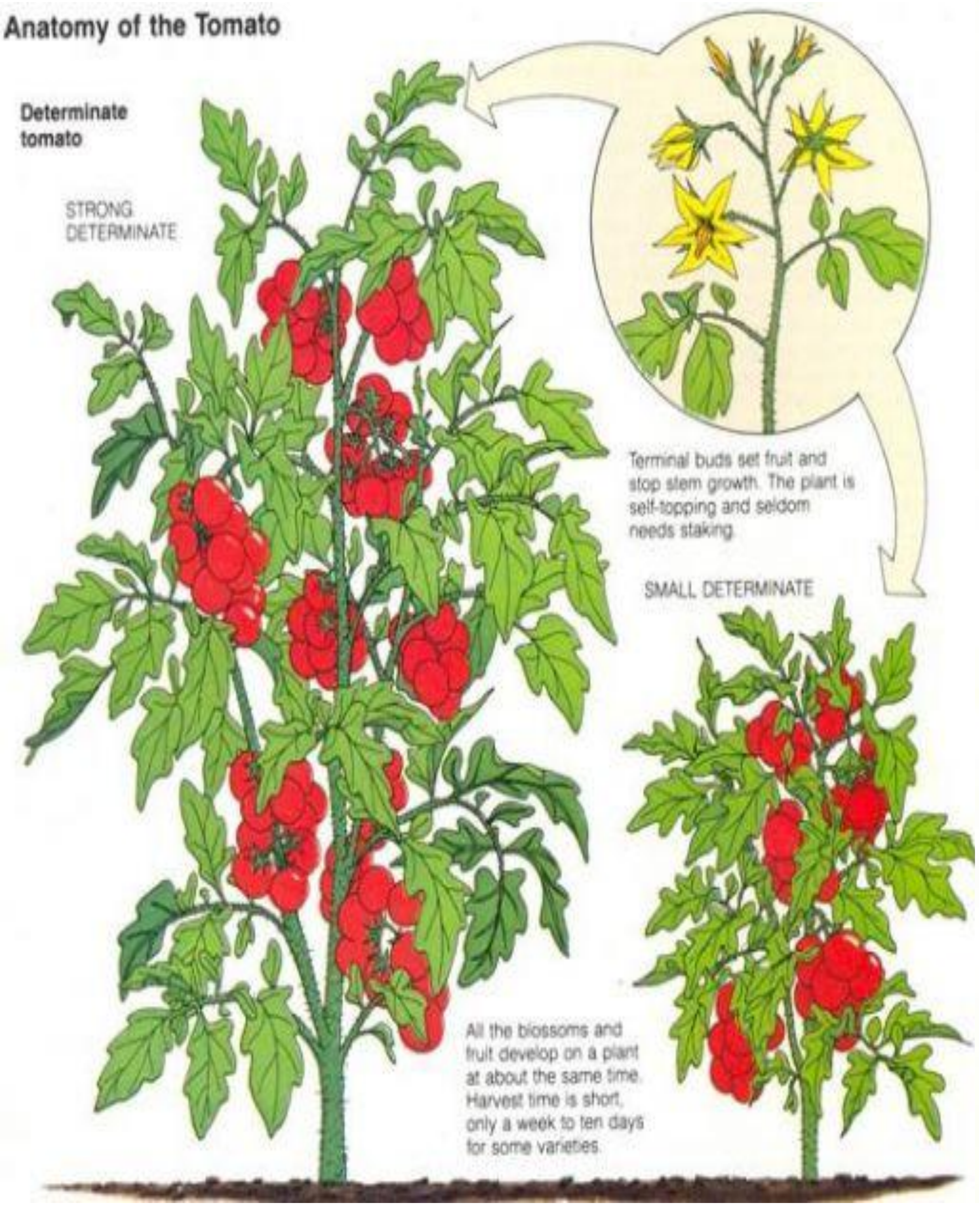
Rank	Area	Production (Int $1000)	Flag	Production (MT)
1	[redacted]	17952256	*	48576853
2	[redacted]	6218283	*	16826000
3	[redacted]	4665634	*	12624700
4	[redacted]	3456461	*	11003400
5	[redacted]	2995412	*	8105260
6	[redacted]	2522015	*	6824300
7	[redacted]	2198987	*	5950220
8	[redacted]	1632234	*	4416650
9	[redacted]	1356850	*	3821490
10	[redacted]	955322	*	2585000
11	Mexico	900180	*	2435790
12	Russian Federation	813258	*	2200590
13	Ukraine	780371	*	2111600
14	Nigeria	556071	*	1504670
15	Tunisia	474520	*	1284000
16	Portugal	460240	*	1245360
17	Morocco	456843	*	1236170
18	Greece	432352	*	1169900
19	Syrian Arab Republic	426842	*	1154990
20	Iraq	391567	*	1059540

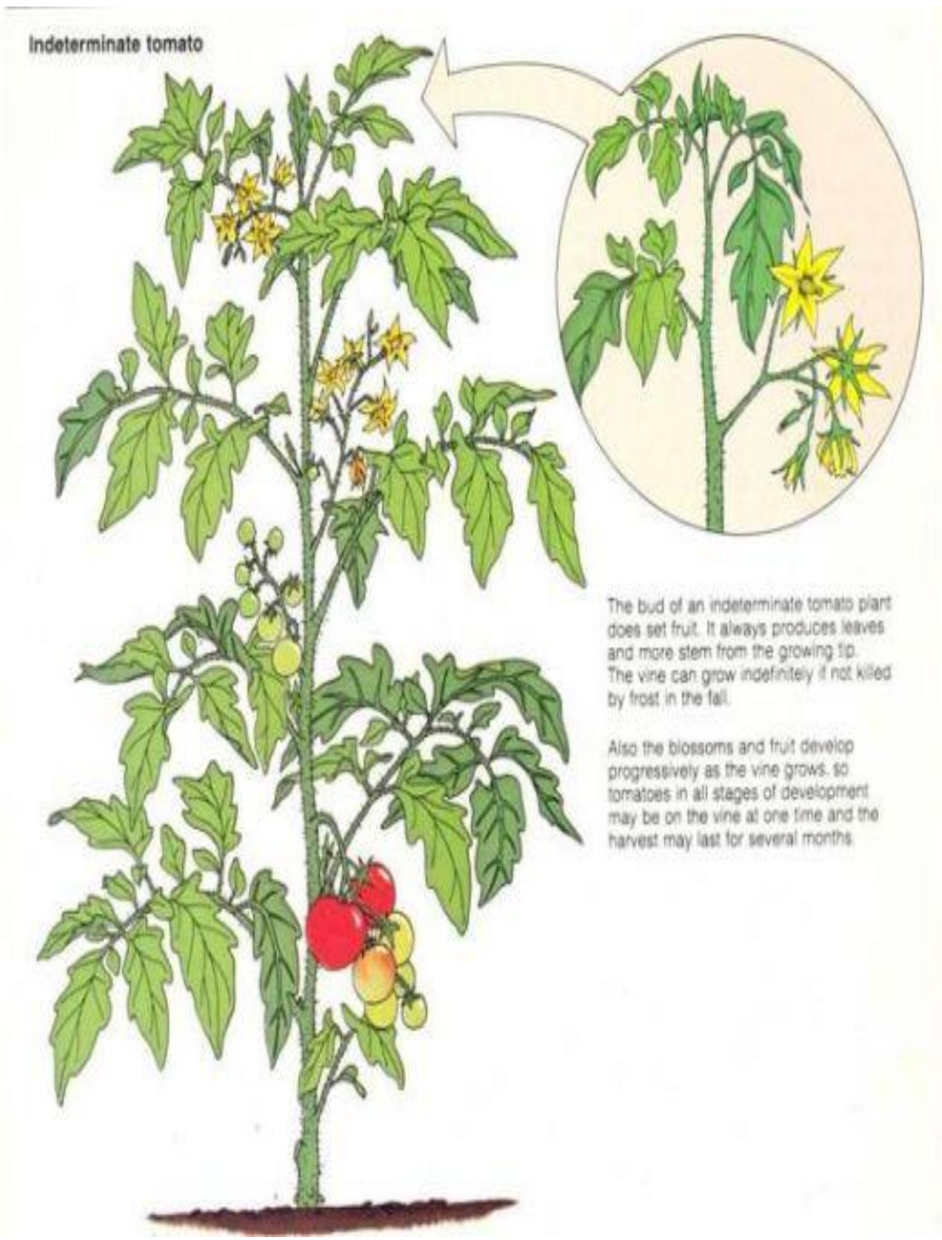
2000

Rank	Area	Production (Int $1000)	Flag	Production (MT)
1	China	8250431	*	22324771
2	United States of America	4664747	*	12622300
3	Turkey	2792610	*	8890000
4	Italy	2785810	*	7538100
5	India	2745860	*	7430000
6	Egypt	2507728	*	6785640
7	Spain	1299508	*	3766330
8	Iran (Islamic Republic of)	1179278	*	3191000
9	Brazil	1102350	*	2982840
10	Mexico	985361	*	2666280
11	Greece	770540	*	2085000
12	Russian Federation	622752	*	1685100
13	Nigeria	465942	*	1260790
14	Chile	437933	*	1185000
15	Ukraine	416313	*	1126500
16	Portugal	373141	*	1009680
17	Morocco	372853	*	1008900
18	Iraq	365498	*	989000
19	Uzbekistan	358477	*	970000
20	Tunisia	351085	*	950000

1990

Rank	Area	Production (Int $1000)	Flag	Production (MT)
1	United States of America	4038225	*	10927000
2	China	2867084	*	7758020
3	USSR	2661969	*	7203000
4	Turkey	1884683	*	6000000
5	Italy	2021171	*	5469070
6	India	1701269	*	4603450
7	Egypt	1564674	*	4233840
8	Spain	1112498	*	3160300
9	Brazil	835536	*	2260870
10	Mexico	797485	*	2157910
11	Greece	681476	*	1844000
12	Iran (Islamic Republic of)	591302	*	1600000
13	Portugal	371411	*	1005000
14	Morocco	322199	*	871836
15	Bulgaria	312681	*	846081
16	France	309775	*	838220
17	Romania	300662	*	813561
18	Japan	283492	*	767100
19	Iraq	266640	*	721500
20	Argentina	260173	*	704000


Anatomy of the Tomato
Determinate tomato
STRONG DETERMINATE
Terminal buds set fruit and stop stem growth. The plant is self-topping and seldom needs staking.
SMALL DETERMINATE
All the blossoms and fruit develop on a plant at about the same time. Harvest time is short, only a week to ten days for some varieties.


Indeterminate tomato
The bud of an indeterminate tomato plant does set fruit. It always produces leaves and more stem from the growing tip. The vine can grow indefinitely if not killed by frost in the fall.
Also the blossoms and fruit develop progressively as the vine grows, so tomatoes in all stages of development may be on the vine at one time and the harvest may last for several months.

Necessities of the processor, growers and consumers and some associated breeding objectives in tomato for processing

Requests	Breeding objectives
Processor	
High % usable fruits	Fruit firmness, resistance to cracking Ripe conservation capacity Resistance to diseases Good foliar cover
High factory yield for each type of processed product: paste, peeled (canned whole, sliced, crushed, halved, blended), ketchup and sauces, juices and soups, dehydrated	Soluble solid content, viscosity, pectins, Uniform shape and size Soluble solids, acidity, dry matter
Flexibility in factory timing: early start-up , main season, late season	Early maturity, cold ability, heat set ability, disease resistance
Grower	
High yield	Adequate number of fruits and fruit weight
Low production costs: low pesticide use, easy handling of plant	Resistance to pests and diseases, adequate growth habit and branching of the plants, varieties adapted to mechanical harvest
Flexibility: diverse cultivation cycles and periods, varieties with multiple uses	Early and late varieties, varieties with multiple uses
Consumer	
Nutritional value	Increase in vitamin content, energetic value
Culinary appeal: colour, texture, flavour	Increase in carotenoid content, especially lycopene, soluble solids content

اهداف اختصاصی اصلاح گوجه فرنگی

۱. Earliness

۲. Growth Habit

۳. Machine Harvestability

۴. Disease Resistance 

   a. Fusarium Wilt

   b. Anthracnose fruit Rot

   c. Tobacco Mosaic Virus

۵. Insect Resistance 

۶. Nematode Resistance

اهداف اختصاصی اصلاح گوجه فرنگی

۷. Fruit Quality

a. Appearance

b. Fruit Color

c. Texture and Firmness

d. Flavour

e. Nutritional Value

۸. Processing Quality

a. Color

b. Fruit pH

c. Titratable Acidity

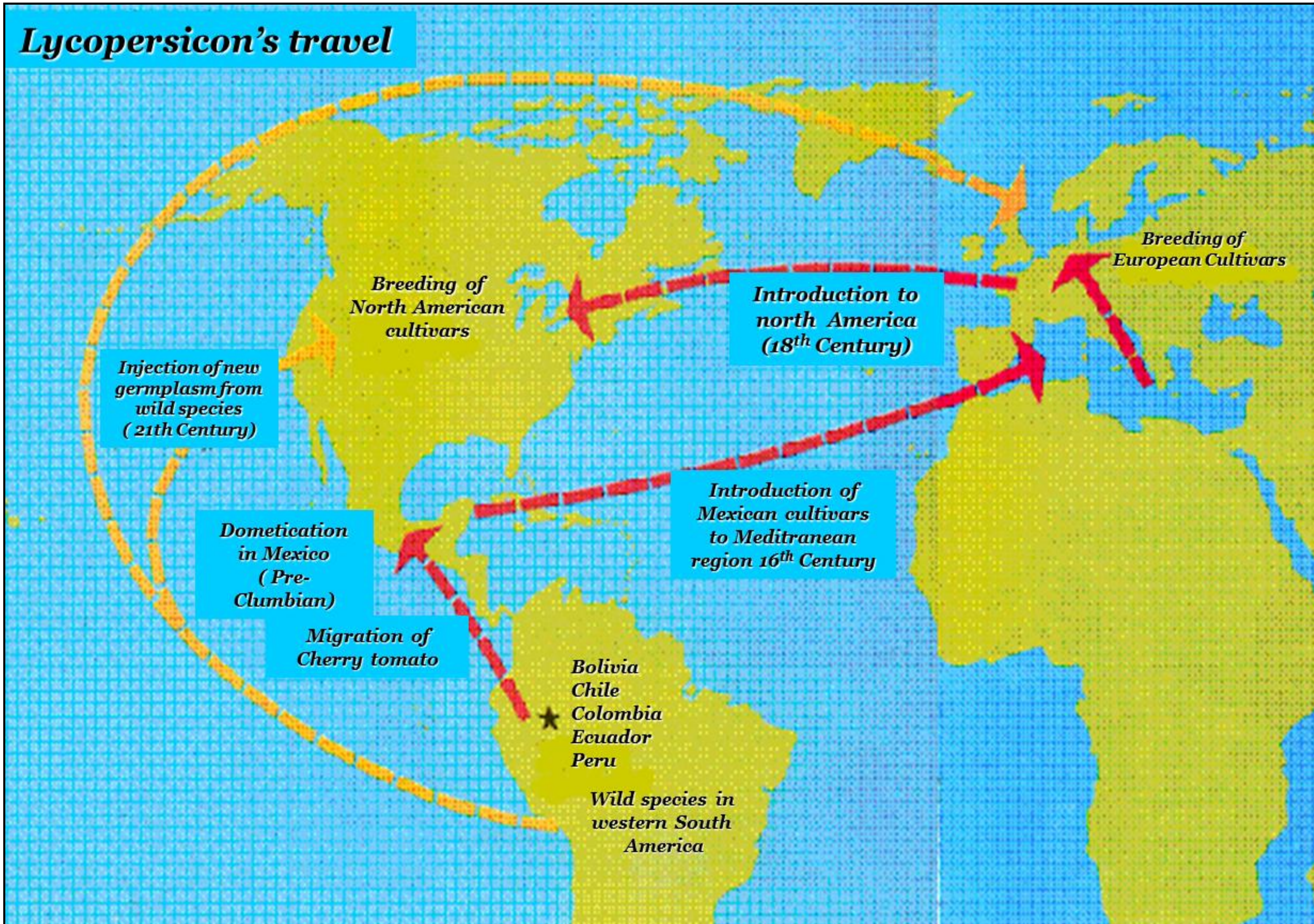
d. Soluble solides

e. Viscosity

Research organism

The main attributes of the tomato as an ideal research organism are:

1. **Short life cycle (65 to 75 days seed to seed)**
2. **Self pollinates but it is easy to hybridize (easy to emasculate, collect and store pollen)**
3. **Many seeds per plant.**
4. **Large, recognizable chromosomes .**
5. **Good array of wild relatives, 8 species.**


Lycopersicon's travel
Breeding of
European Cultivars
Breeding of
North American
cultivars
Introduction to
north America
(18th Century)
Injection of new
germplasm from
wild species
(21th Century)
Introduction of
Mexican cultivars
to Meditranean
region 16th Century
Dometication
in Mexico
(Pre-
Clumbian)
Migration of
Cherry tomato
Bolivia
Chile
Colombia
Ecuador
Peru
Wild species in
western South
America

Wild relatives in tomato

Classically,

The *Lycopersicon* species are divided into two major subgenus according to fruit color

subgenus *Eulycopersicon* for red-fruited *ssp.*
subgenus *Eriopersicon* for green-fruited *ssp.*

These are also classified by their hybridization affinity to cultivated tomato into two main complexes

Esculentum complex
Peruvianum complex

The *Lycopersicon* species

A. Red fruited species *Eulycopersicon*

- ***L. esculentum*** *SC*
- ***L. esculentum var cerasiforme*** *Red Cherry SC*
- ***L. pimpinellifolium*** *SC*
- ***L. cheesmanii form typicum*** *SC*
- ***L. cheesmanii form minor*** *SC*

SC → **Self compatible**

The *Lycopersicon* species

B. Green fruited species *Eriopersicon*

L. peruvianum , races glandulosum, dentatum SI

L. chilense SI

L. hirsutum form typicum SI

L. hirsutum form glabratum SC

L. parviflorum SC

L. chmielewskii SC

L. pennellii SI / SC

SC → Self compatible SI → Self incompatible

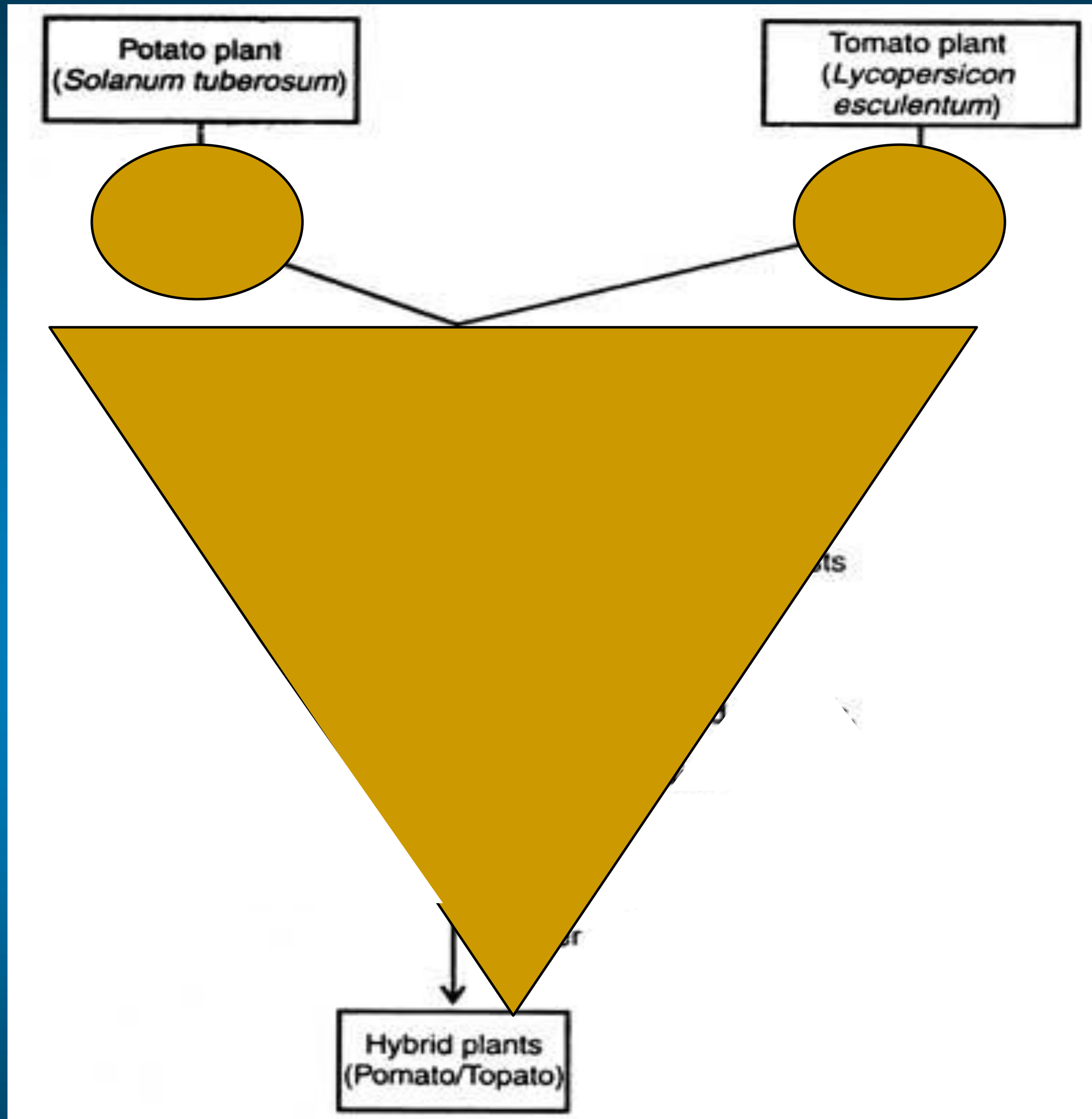
The Species of the Genus *Lycopersicon*

Species	Common name	Somatic chromosome number	Reproductive features[b]
L. esculentum	Common tomato	24	SP
L. pimpinellifolium	Currant tomato	24	SP + CP
L. cheesmanii	Wild species	24	SP
L. parviflorum	Wild species	24	SP
L. chmielewskii	Wild species	24	CP
L. pennellii	Wild species	24	SI
L. hirsutum	Wild species	24	SF, SI
L. chilense	Wild species	24	SI
L. peruvianum	Wild species	24	SI

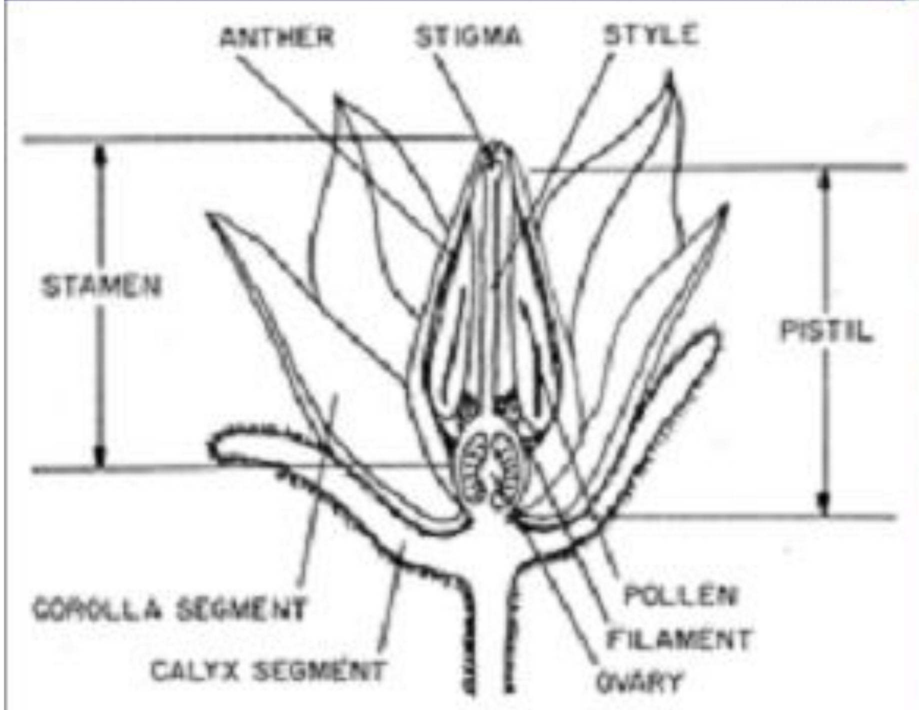
[b]SP, self-pollinated; CP, cross-pollinated; SF, self-fertile; and SI, self-incompatible.

Characteristics of interest of wild tomato relatives in tomato breeding

Species	Characteristic of interest
S. lycopersicum var. *cerasiforme* L.	Tolerance to humidity, resistance to fungi and root rot
S. cheesmaniae L.	Tolerance to salinity, *jointless* gene and thick pericarp
S. pimpinellifolium L.	Colour, characteristics of quality, resistance to diseases
S. chmielewskii	High sugar content
S. neorickii	Resistance to bacteria
S. pennellii Correll	Resistance to drought
S. habrochaites	Tolerance to cold and chilling, resistance to insects and diseases
S. chilense	Resistance to drought and diseases
Complex peruvianum: *S. peruvianum* *S. arcanum*, *S. corneliomuelleri*, *S. huaylasense*	Resistance to viral, fungal and bacterial diseases


Potato plant
(*Solanum tuberosum*)
Tomato plant
(*Lycopersicon
esculentum*)
Hybrid plants
(Pomato/Topato)

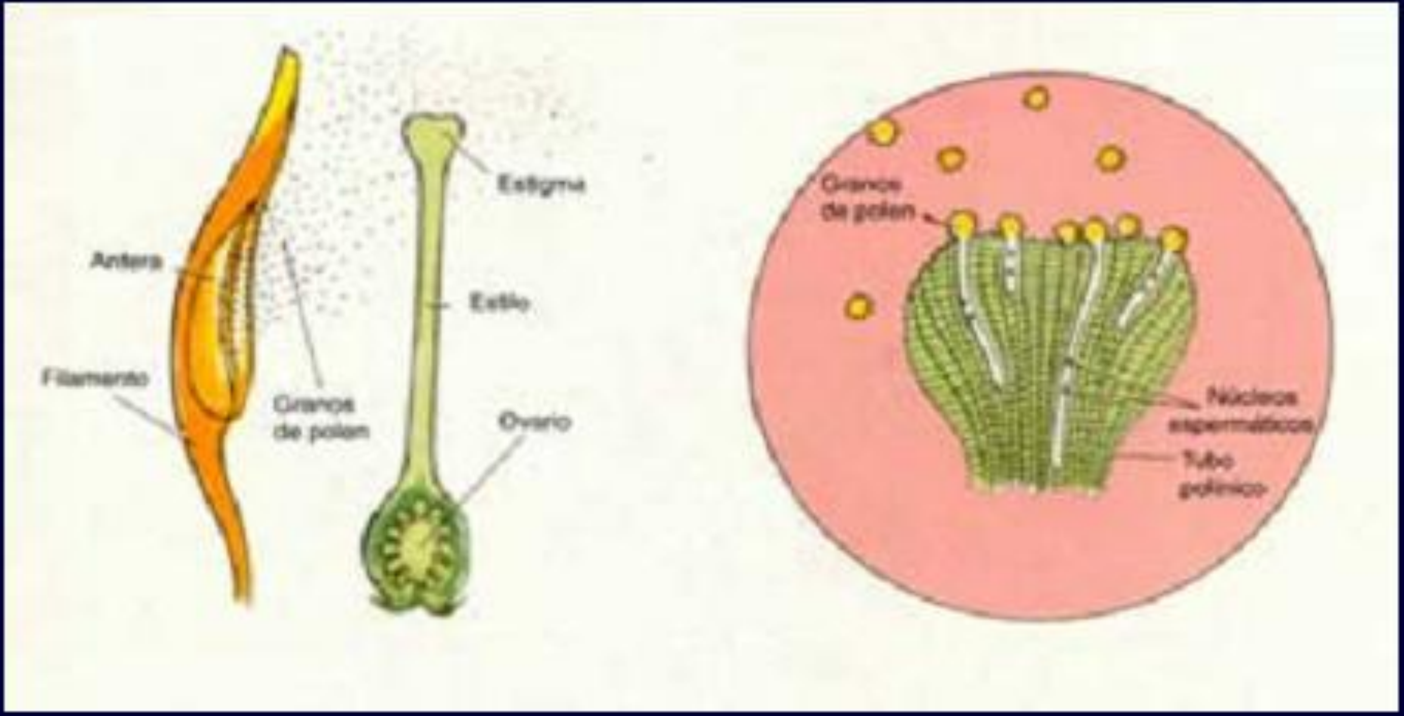
Tomato flower:

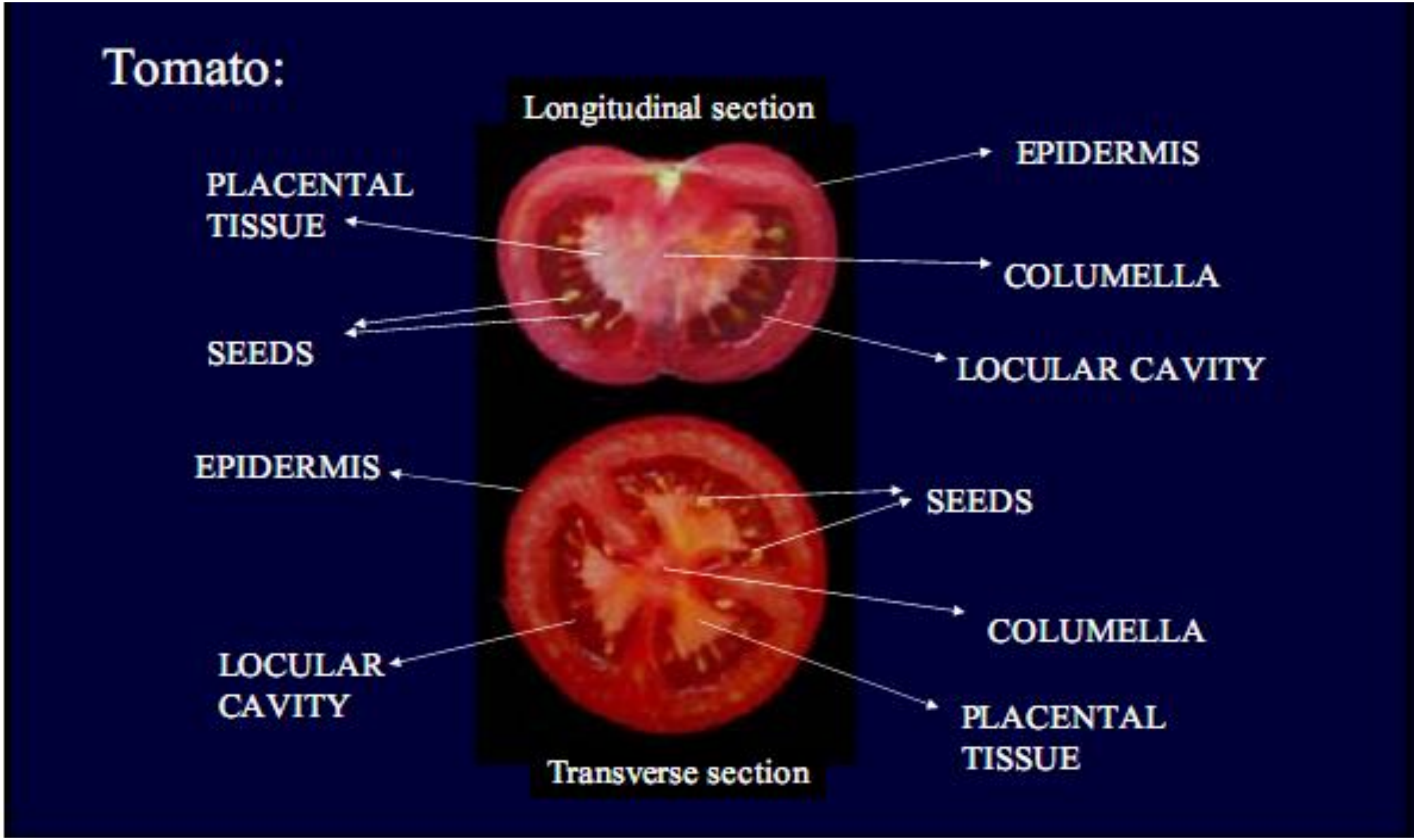


(Tigchelaar, 1986)

c) Natural pollination mechanisms

Tomato:




Tomato:
Longitudinal section
EPIDERMIS
PLACENTAL
TISSUE
COLUMELLA
SEEDS
LOCULAR CAVITY
EPIDERMIS
SEEDS
COLUMELLA
LOCULAR
CAVITY
PLACENTAL
TISSUE
Transverse section

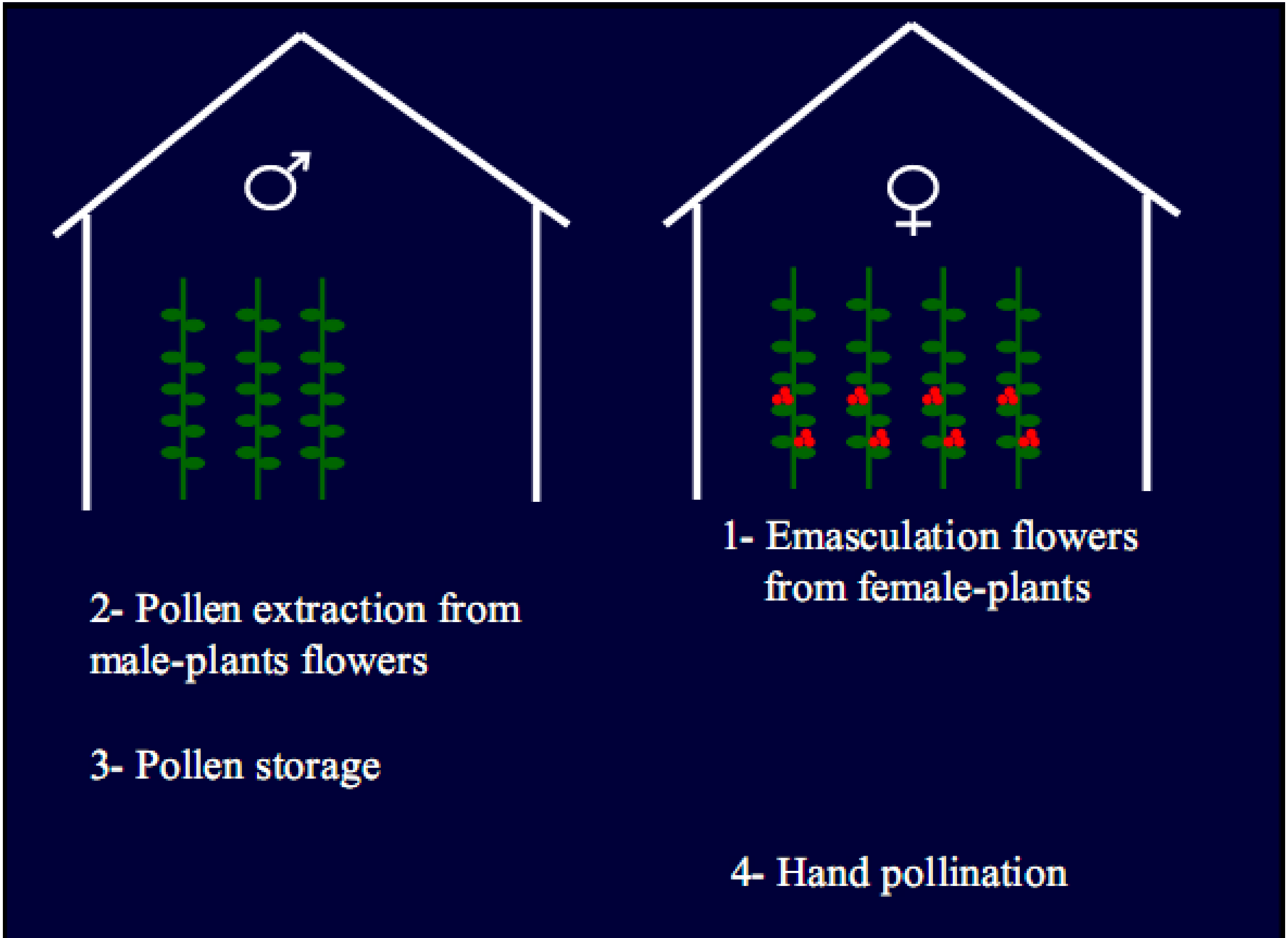
Tomato:

(http://www.oardc.ohio-state.edu/seedid)

(http://www-plb.ucdavis.edu/labs/rost/Tomato/Reproductive/flrfert.html#testa)

Seed production in protected structures

/www.avrdc.org)


♂
♀
1- Emasculation flowers
from female-plants
2- Pollen extraction from
male-plants flowers
3- Pollen storage
4- Hand pollination

a) Emasculation

Importance of optimal moment:

before → damage to flower, low yield

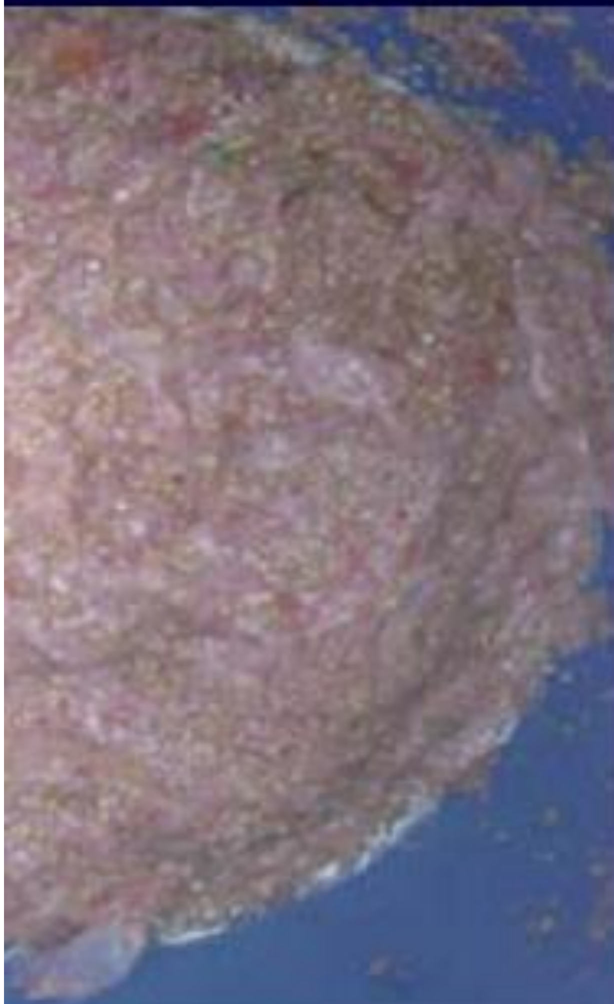
after → contamination (self-pollination), low quality

b) Pollen extraction

c) Pollen storage

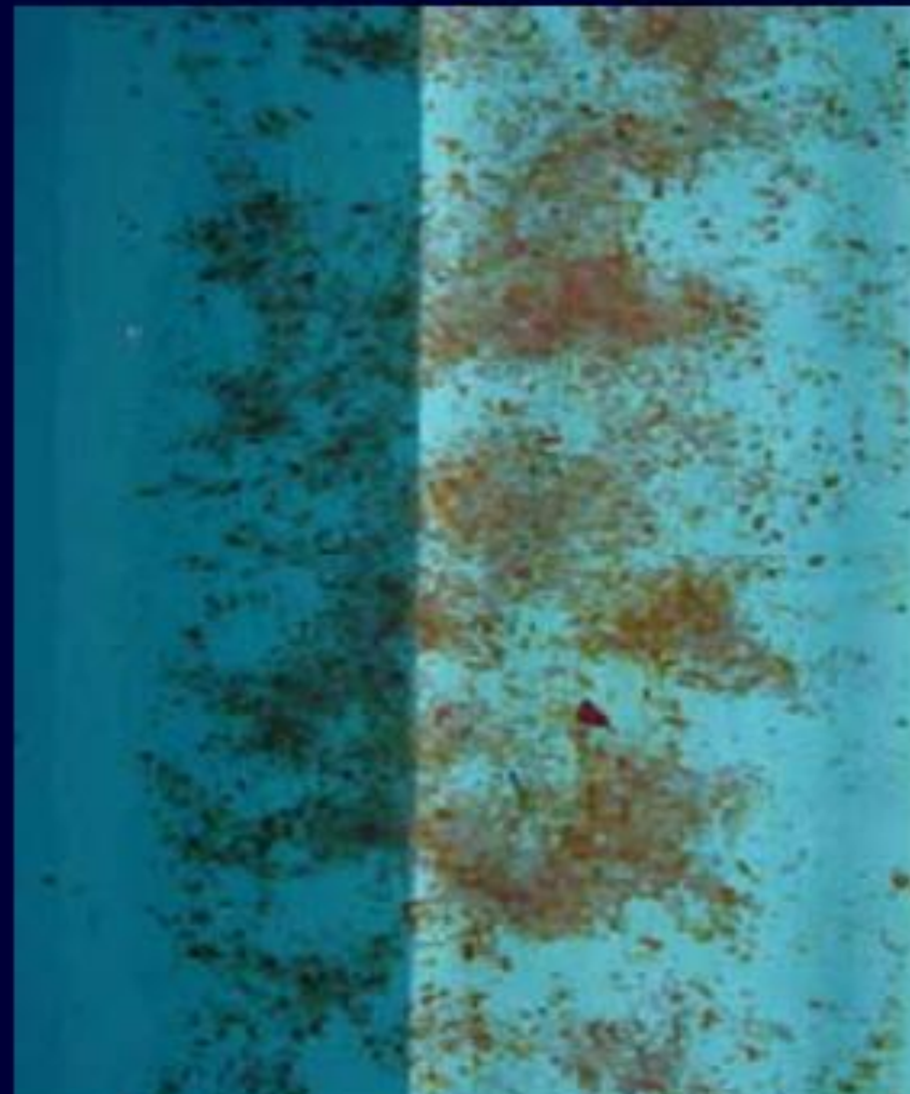
e) Hand pollination

Separation of seeds from gelatinous covering



- **Natural fermentation**
- **Sodium carbonate**
- **Hydrochloric acid**

Washing



Onion Breeding

Rank	Area	Production (Int $1000)	Flag	Production (MT)
[redacted]	[redacted]	217531	*	1066000
[redacted]	[redacted]	199776	*	978992
3	[redacted]	98387	*	482143
4	Iraq	66650	*	326616
5	Nigeria	48158	*	236000
6	Tunisia	42853	*	210000
7	Thailand	39838	*	195228
8	New Zealand	36438	*	178566
9	Turkey	31389	*	153823
10	Democratic People's Republic of Korea	22458	*	110056
11	Ecuador	14477	*	100050
12	Mexico	15866	*	77755
13	Germany	15453	*	75730
14	Syrian Arab Republic	14162	*	69403
15	France	12394	*	60739
16	Libya	10993	*	53871
17	Venezuela (Bolivarian Republic of)	9543	*	46767
18	Spain	8971	*	43964
19	Switzerland	8847	*	43356
20	Albania	7754	*	38000

* : Unofficial figure

2001

Rank	Area	Production (Int $1000)	Flag	Production (MT)
1	Republic of Korea	129725	*	635713
2	Japan	107500	*	526800
3	China	87766	*	430093
4	Nigeria	56711	*	277912
5	New Zealand	49995	*	245000
6	Turkey	45914	*	225000
7	Thailand	40513	*	198533
8	Tunisia	28364	*	139000
9	Mexico	25832	*	126592
10	Iraq	24691	*	121000
11	Ecuador	14170	*	101162
12	Democratic People's Republic of Korea	19385	*	95000
13	Libya	10815	*	53000
14	Syrian Arab Republic	10434	*	51136
15	France	9523	*	46668
16	United Arab Emirates	7008	*	34346
17	Spain	6940	*	34010
18	Greece	5509	*	27000
19	Switzerland	4938	*	24199
20	Ethiopia	4176	*	20465

Origin

Scientific name : *Allium cepa* L.
Family : Alliaceae (Amaryllidaceae)

Onions are grown in just about every country in the world.

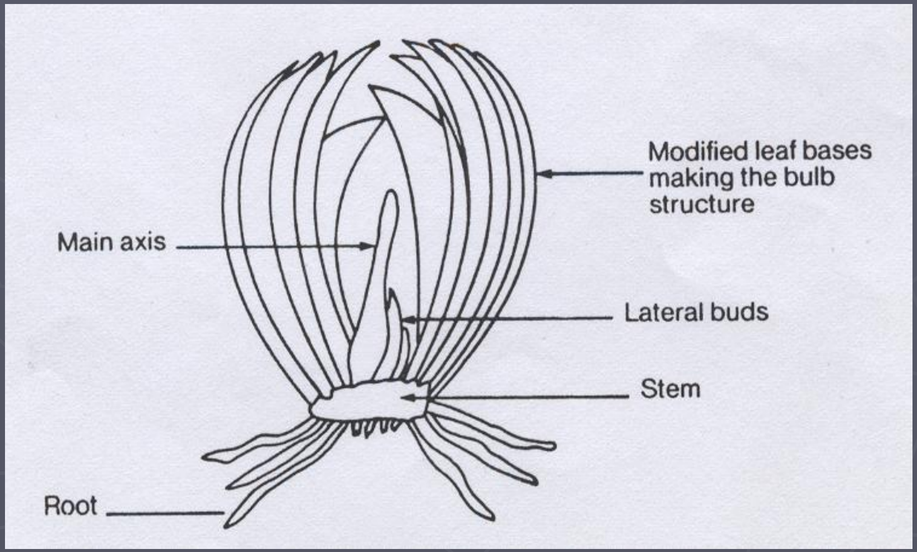
They are used in salads, as a raw or cooked vegetable, and as a condiment.

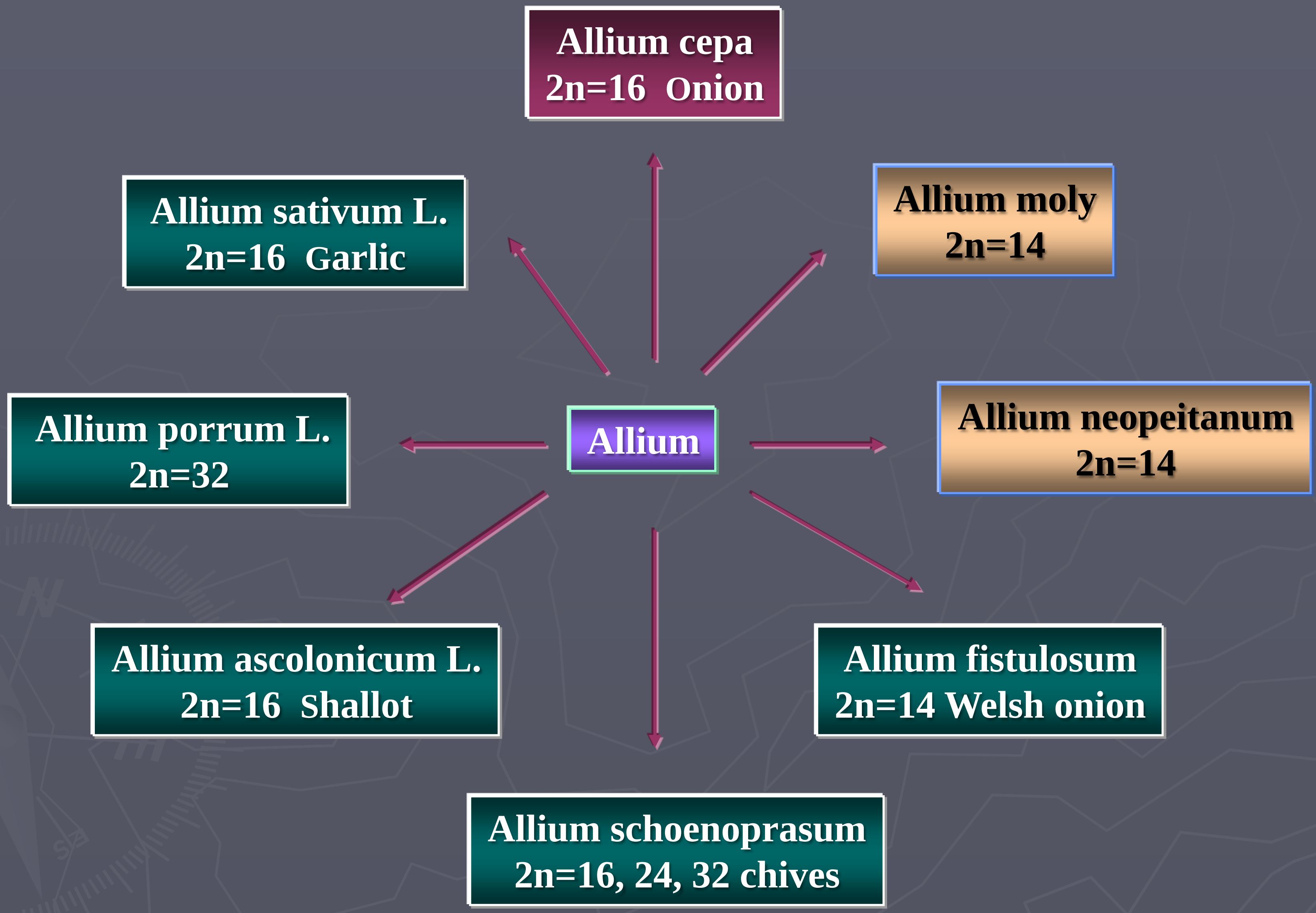
Iran to Pakistan, cultivated in very ancient times & possibly never found in the true wild state.

Introduced to the Americas by the Spanish very early and quickly spread throughout most of North & South America.

Parts Used for Food

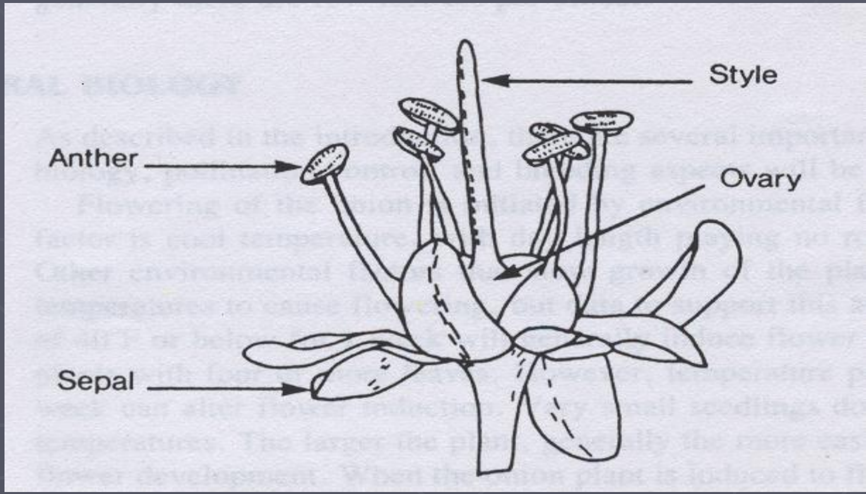
Bulb, sometimes **leaves**. **The bulb** consists of enlargements of the leaf bases in which food reserves are stored.




Allium cepa
2n=16 Onion
Allium sativum L.
2n=16 Garlic
Allium moly
2n=14
Allium porrum L.
2n=32
Allium
Allium neopeitanum
2n=14
Allium ascolonicum L.
2n=16 Shallot
Allium fistulosum
2n=14 Welsh onion
Allium schoenoprasum
2n=16, 24, 32 chives

Floral biology

The floral structure consists of : **three carpels** united into a single Pistil, **six stamens** (3 inner and 3 outer) 3 inner perianth segments (**petals**), 3 outer perianth segments (**sepals**), Sepals and petals are alike and sometimes called tepals. The ovary is **superior**.



Inflorescence

An umbel composed of many smaller inflorescences (cymes) of 5-10 flowers each.

The flowers open in a sequence within each of the cymes with a delay between flowers.

Flowering may be in progress within a single umbel for two weeks or more.

Inflorescence

50 to 2000 florets are borne in a simple oval umbel at the top of the elongated seed stalk.

The individual floret, only 3 to 4 mm in length, a simple style leading to a three-celled ovary with two ovules in each cell.

The anthers of the **three inner stamens open first**, & one after another, shed their pollen. Then the anthers of the **outer whorl open, also at irregular intervals**.

Pollination

Onion is a dichogamous plant and largely **cross pollinated by insects**, primarily by honey bees.

Self pollinations can occur because pollen may be transferred between different flowers on the same plant.

Most of the pollen is shed between **9 am and 5 pm of the first day the flower is open**.

Inflorescence

When flowering begins, only a few flowers open each day on an umbel, but the number increases until at full bloom 50 or more florets may be open on a single day.

They continue to open over a two -week period, and 30 days or more may be involved in the flowering on all of the flower stalks.

The normal flower in onions is perfect, but genetic & cytoplasmic sterility variations were reported in a single plant segregant of the cultivar Italian Red.

Floral biology

Plants grown from seed usually produce only one seed stem if induced to flower.

Plants grown from bulbs may produce six or more seed stems since several lateral buds may be present that formed during development of the bulb.

It is common for plants to produce bulbs and seed stems when grown during the winter and into the spring.

Flowering

Flowering of the onion is initiated by Environmental factors

The primary inductive factor is cool temperature with day length that playing no role as with bulb development.

Temperatures of 4.5° C or below for one week will induce flower formation in bulbs or growing plants with 4 or more leaves.

Flowering

The larger the plant, generally the more easily it can be induced to initiate flower development.

When the onion plant is induced to flower, the shoot apex ceases to produce leaf primordia and initiates the inflorescence.

The number of seed stems produced per plant depends on the number of lateral buds contained on the stem. which is the compact base plate on the bottom of the bulb.

Major Breeding Achievements

Onions fall into 2 major types, Short day and long day onions.

The third group should be recognized as intermediate day legth types, which bulb somewhere between the two major groups.

The onion has been greatly improved in characteristics such as :

- Quality
- Yield
- Uniformity

Major Breeding Achievements

The **important traits** that are controlled by **multiple genes** or **additive action** and should be considered in **the onion breeding program** includes :

Male sterility	Bulb shape and color
Ease of bolting	Foliage color
Bolt resiatance	Foliage morphology
Long storage	Disease resistance
Insect resistance	High percentage of dry matter

Progenies Resulting from Various Genetic and Cytoplasmic Combinations Crossed onto a Male-Sterile onion Line

Male-sterile line (A)	Male-fertile line (B)	Progenies
	N*ms*/*ms*	S*ms*/*ms*
S*ms*/*ms* ×	N*Ms*/*ms*	S*Ms*/*ms*
		S*ms*/*ms*
	N*Ms*/*Ms*	S*Ms*/*ms*
	S*Ms*/*Ms*	S*Ms*/*ms*
	S*Ms*/*ms*	S*Ms*/*ms*
		S*ms*/*ms*

[a]Only the S*ms*/*ms* condition is male sterile.

The Genetics of Several traits In the Onion

Onion traits	Genetic condition
Albino seedling	*a/a*
Yellow seedling linked with glossy	*y1/y1*
Yellow seedling not linked with glossy	*y2/y2*
Pale green seedling	*pg/pg*
Virescent seedling	*v/v*
Glossy foliage	*gl/gl*
Exposed anther	*ea/ea*
Yellow anther	*ya/ya*
Pink root resistance	*pr/pr*
Male sterility[b]	*ms/ms*
Bulb color	
Homozygous red	*i/i,C/C,R/R*
Heterozygous red	*i/i,C/c,R/R*
Heterozygous red	*i/i,C/C,R/r*
Heterozygous red	*i/i,C/c,R/r*
Homozygous yellow	*i/i,C/C,r/r*
Heterozygous yellow	*i/i,C/c,r/r*
Homozygous recessive white	*i/i,c/c,R/R*
Homozygous recessive white	*i/i,c/c,R/r*
Homozygous recessive white	*i/i,c/c,r/r*
Homozygous dominant white	*I/I,–,–*
Heterozygous dominant white (buff)	*I/i,–,–*

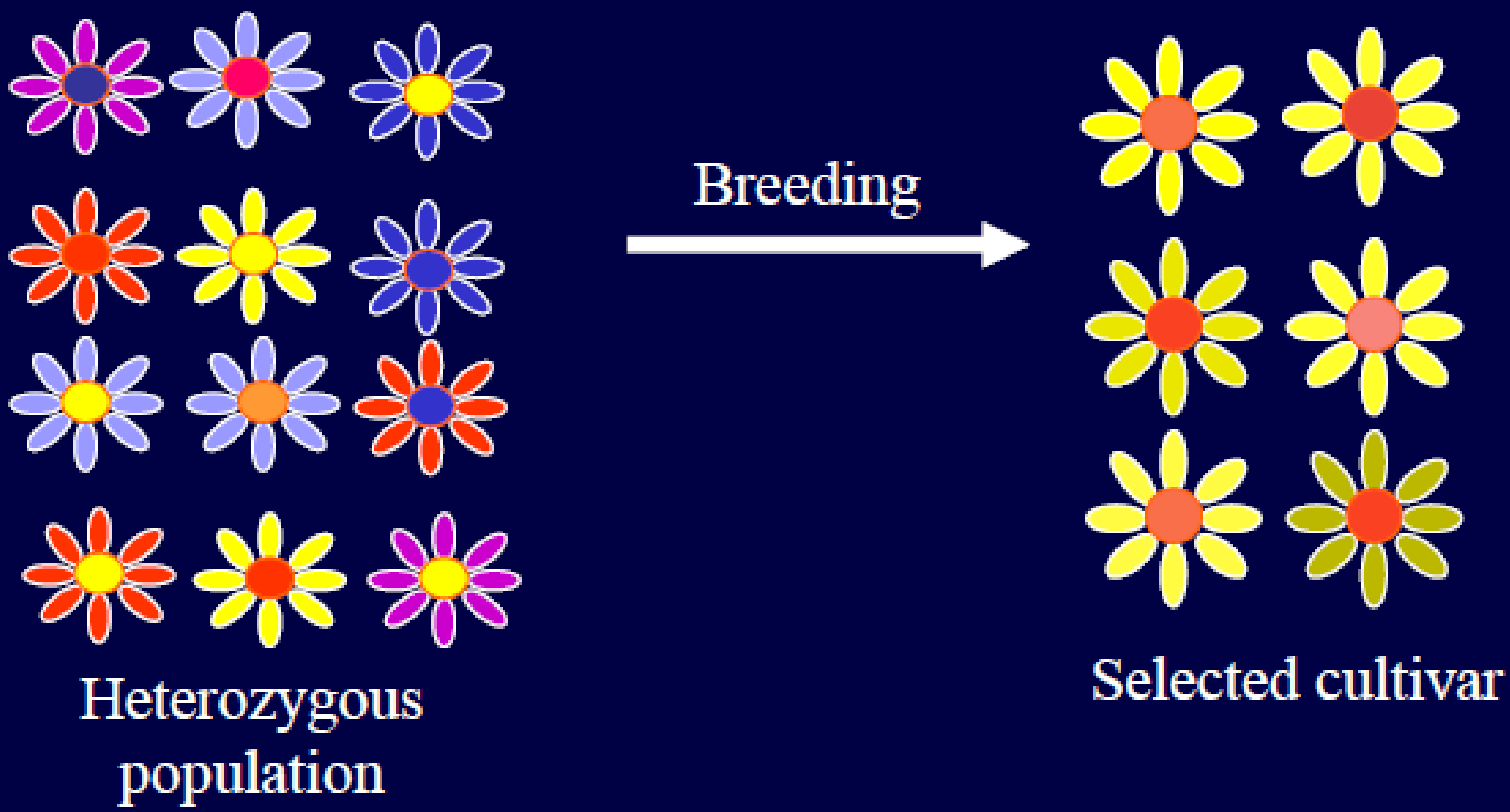
Fundamentals of Seed Production I: Genetics, Breeding, and Seed Production

How to deal with the increasing demand?

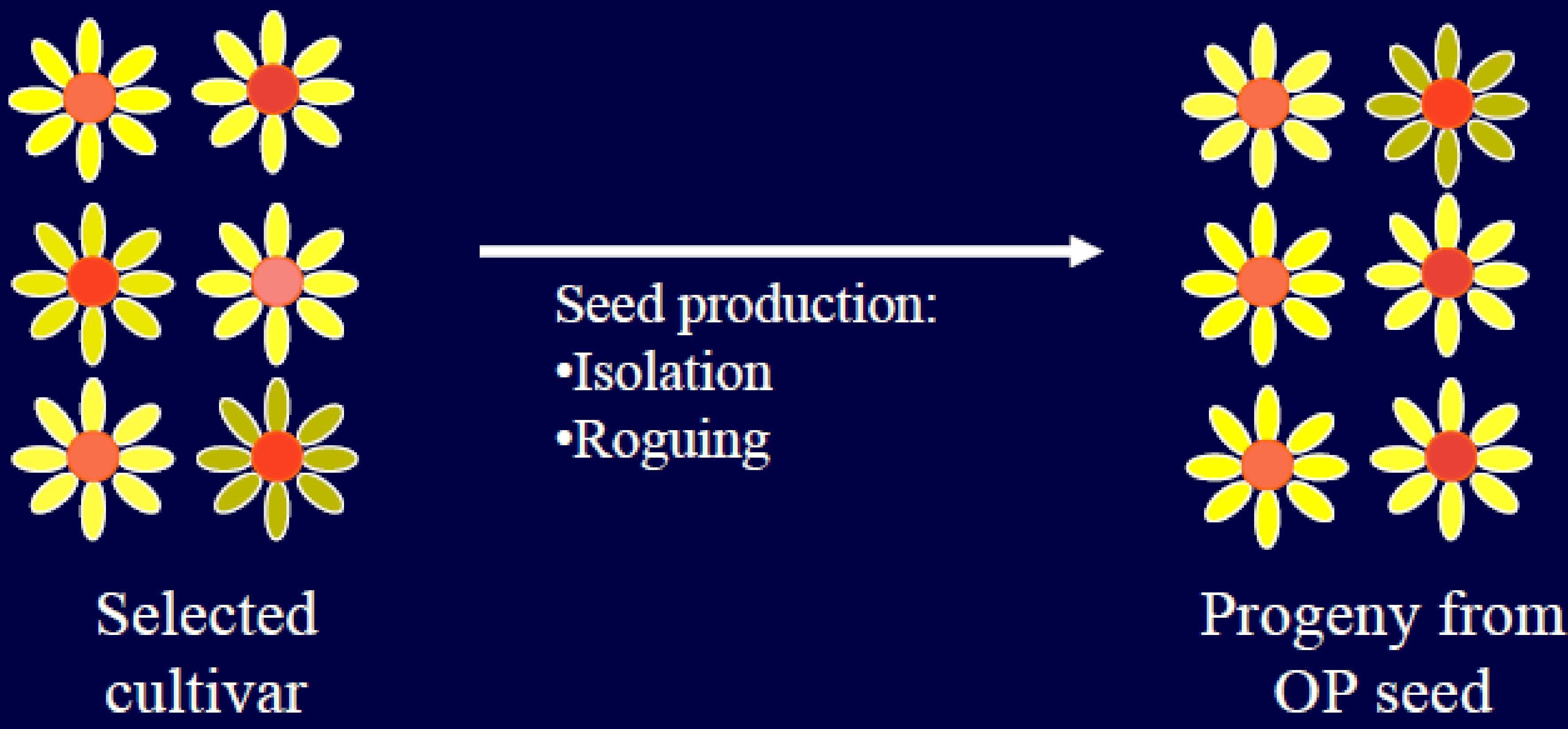
- New technologies for yield improvement:
  - Development of new cultivars (breeding) ⇒ **50%**
  - Establishment techniques
  - Watering
  - Nutrient supply
  - Crop protection
  - Post harvest
  - etc.

- Seed has become a delivery mechanism for new technologies and a high value products

Open pollinated seed production



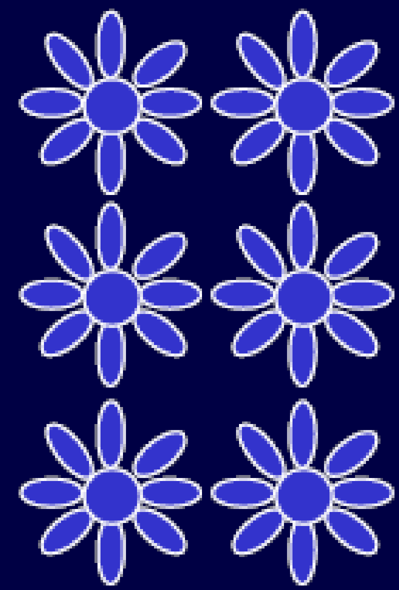
Open pollinated seed production



Hybrid seed production

Heterozygous population

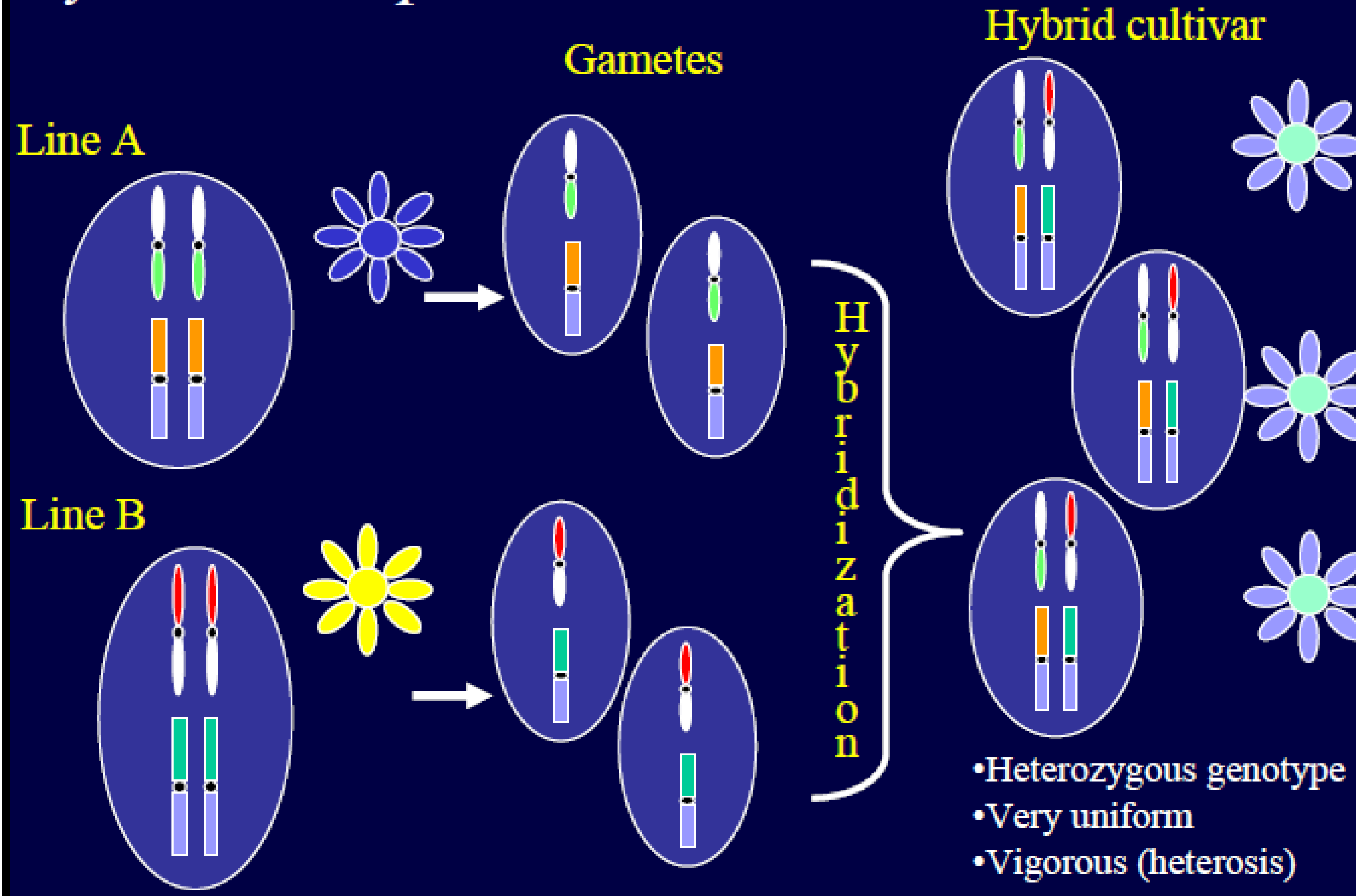
Enforced self-pollination of selected individual through several generations



Inbred line

- Homozygous genotype
- High uniformity
- Low vigor (inbreed depression)

Hybrid seed production



- Heterozygous genotype
- Very uniform
- Vigorous (heterosis)

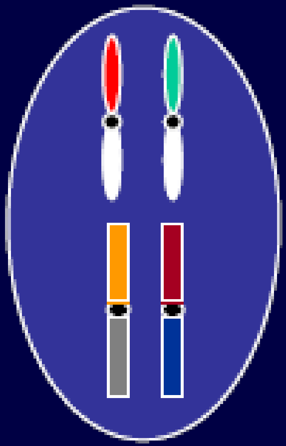
Hybrid seed production

- An ***hybrid cultivar*** may be defined as the first generation from a cross that results from controlled pollination between progenitors with different genotype. The seed obtained from that cross is the only commercial seed that may be designated as hybrid.

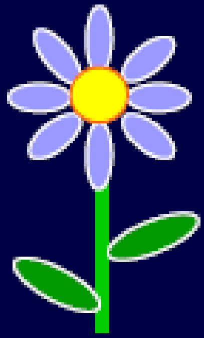
Attributes of genetically pure seed (Kester et al 1997):

- Trueness to name
- Trueness to type
- Freedom from contaminants

• In general, the objective of any propagation technique is to multiply a specific *genotype* and produce the kind of plant or *phenotype* that we are interested.



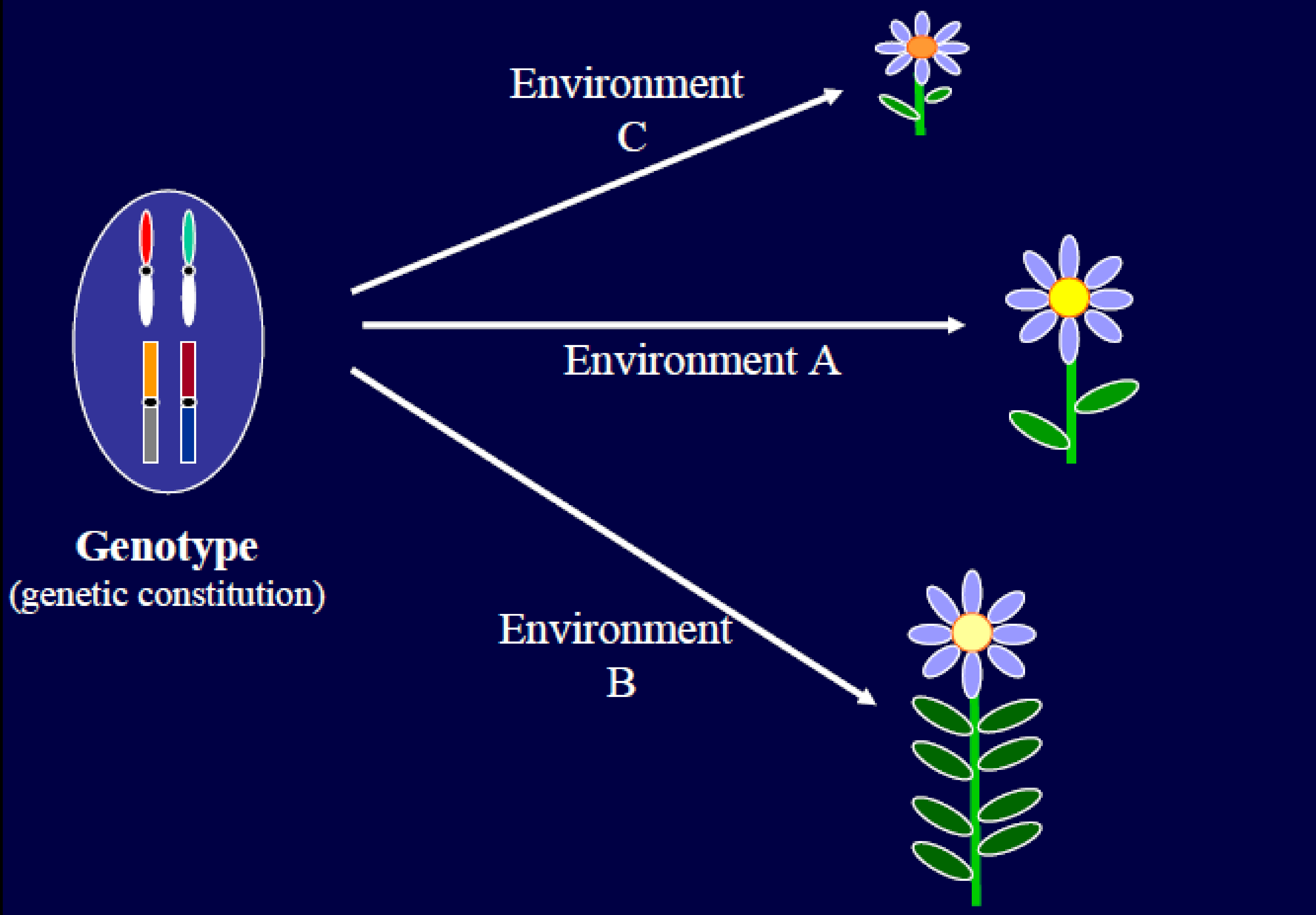
Genotype
(genetic constitution)

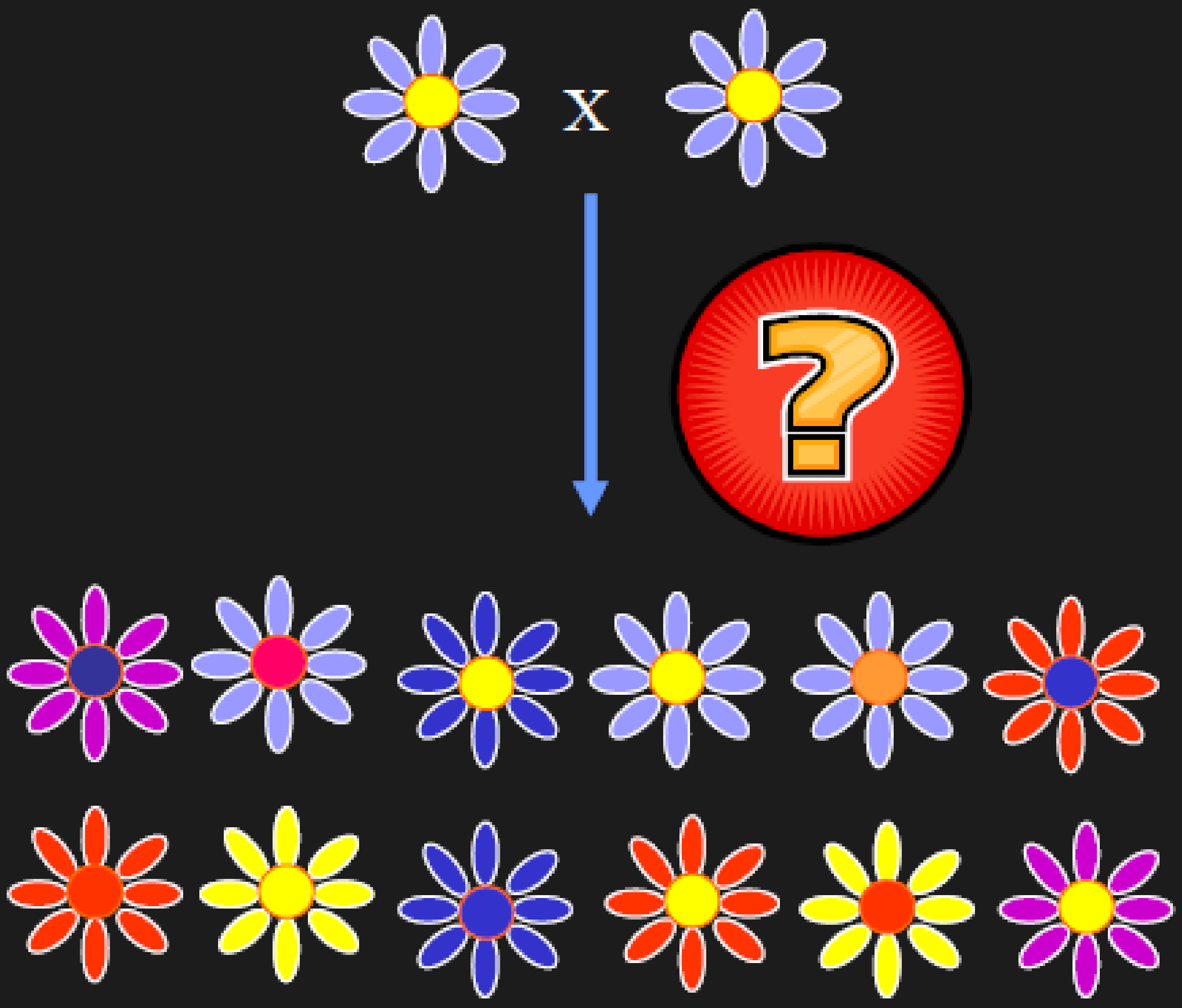


Phenotype
(external appearance)

• In general, the objective of any propagation technique is to multiply a specific *genotype* and produce the kind of plant or *phenotype* that we are interested.

Genotype x Environment = Phenotype

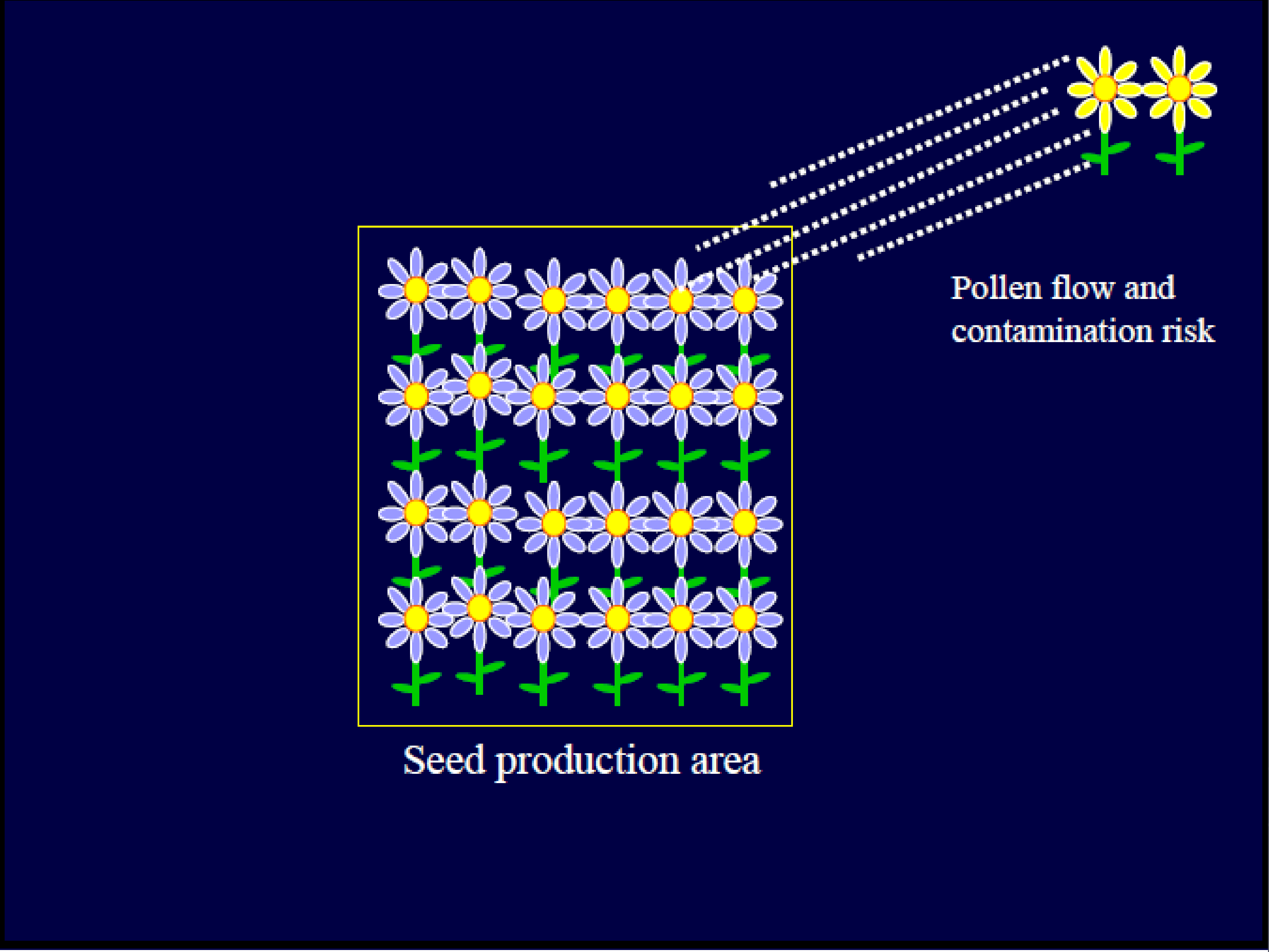

Environment
C
Environment A
Genotype
(genetic constitution)
Environment
B

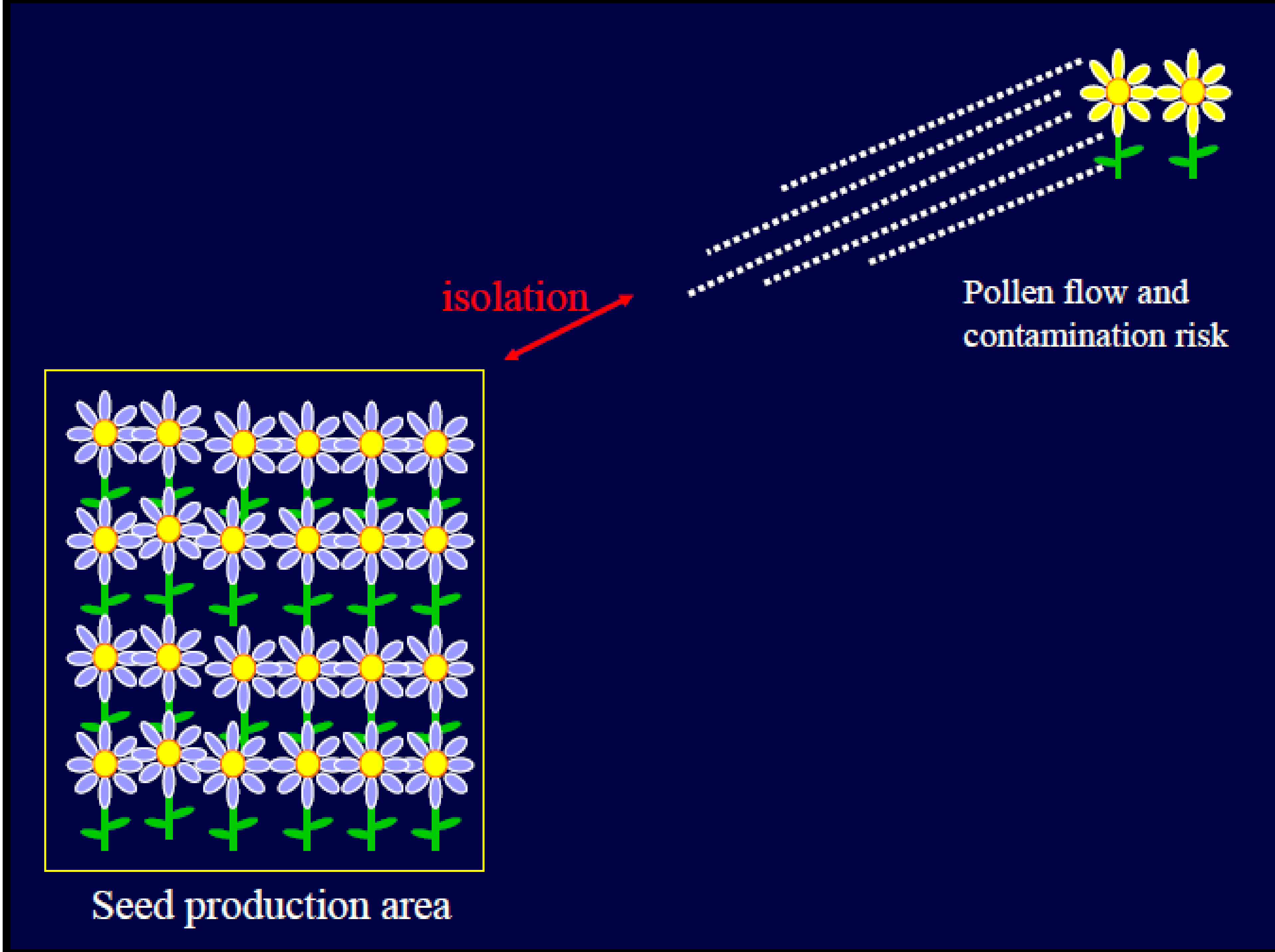

x

Chemically induced male sterility

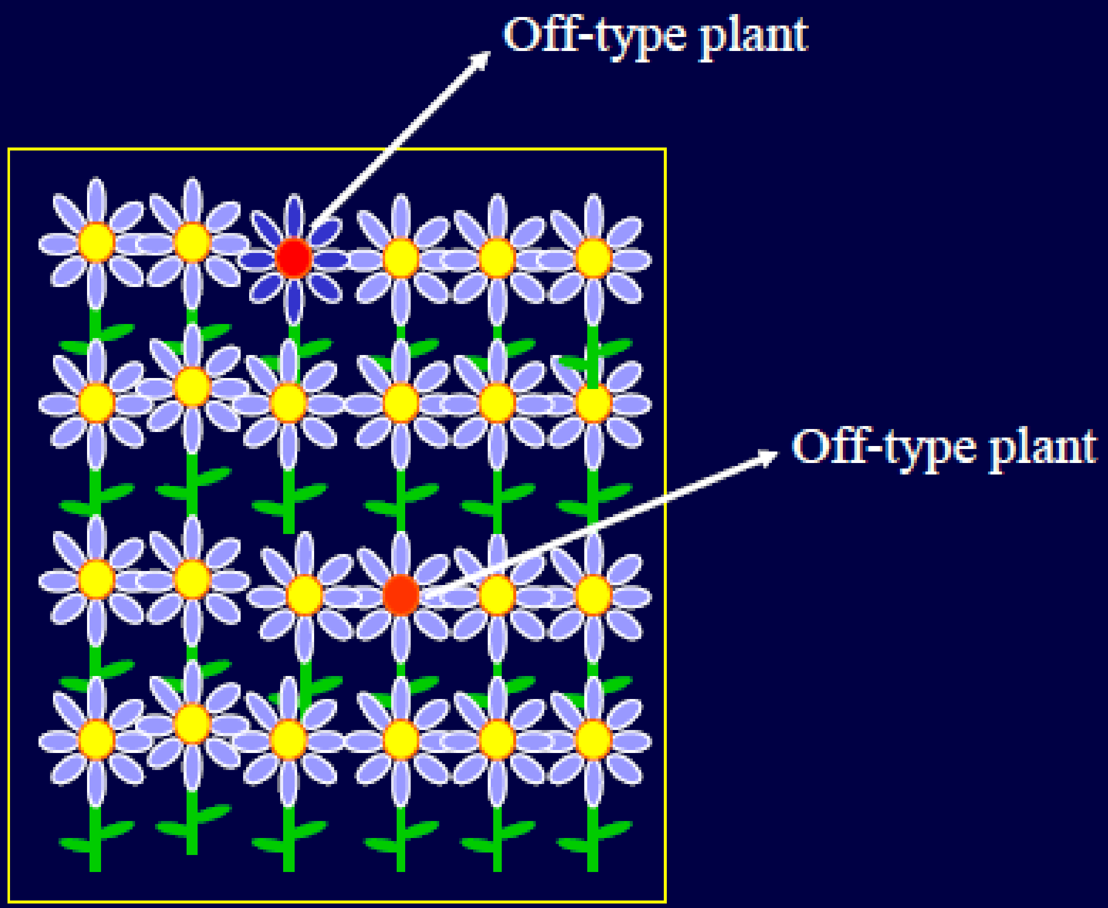
- Chemical Hybridizing Agents are commonly used
- Several CHA's are being used viz. maleic hydrazide, NAA, IAA, FW450, Ethrel, RH531, MSMA, ZMA etc.

CHAS


Pollen flow and
contamination risk
Seed production area

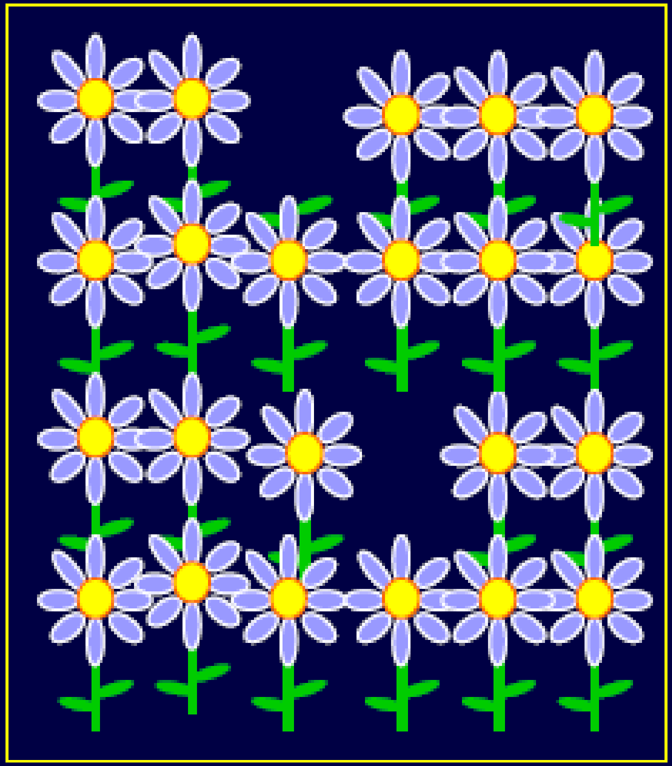

isolation
Pollen flow and
contamination risk
Seed production area

Roguing: elimination of off-type plants



Seed production area

Roguing: elimination of off-type plants



Seed production area


3 May 10

Seed certification

گواهی بذر یا Seed certification برنامه ای برای حفظ و تأمین بذرهای با کیفیت عمومی بالا وتکثیر مواد ژنتیکی ارقام گیاهان زراعی و باغی خاص است.

در این برنامه، بذرگواهی شده به وسیله کشاورزان خبره و تولیدکنندگان بذر با رعایت کنترل دقیق کیفی، کاشت به روش شجره ای، بازرسی مرتب درطول فصل رشد و بازرسی پس از برداشت تولید می شود.

گواهی بذر یا Seed certification روش رسمی شناخته شده ای برای حفظ هویت بذر یک رقم در بازار آزاد می باشد . از این رو، گواهی بذر برای گیاهان باغی به ویژه بذور گل وسبزی بسیار مهم و ضروری است

Seed certification

الگوی کلی برنامه تولید بذرگواهی شده از اصلاح یک رقم تا قابلیت دسترسی به آن توسط کشاورزان به صورت زیر است

Breeder's seed

بذر اصلاح شده یا بذر نوکلئوس

این بذر زیر نظر مستقیم اصلاح گر تولید می شود و شجره حقیقی یک رقم را نشان میدهد.

Foundation seed

بذر پایه

به اولین بذر ی که از تکثیر بذر اصلاح شده به دست می آید، بذر پایه می گویند.معمولاً این کارضمن عقد قرار داد با سازمان های بذر پایه و تحت کنترل اصلاح گر انجام میشود. بذر پایه با برچسب سفید گواهی بذر مشخص می شود.

Seed certification

Registered seed — بذر ثبت شده

به بذر ی که از تکثیر بذر پایه به دست می آید، بذر ثبت شده می گویند . هدف از این مرحله افزایش نسل دیگری از بذرقبل از اقدام به تولید بذر گواهی شده می باشد. بذر ثبت شده در رده تجاری قرار نمی گیرد. این طبقه بندی را با برچسب ارغوانی مشخص می کنند.

Certified seed — بذر گواهی شده

بذر ی است که از تکثیر بذر پایه یا ثبت شده به دست می آید، و آخرین کلاس بذر در برنامه گواهی بذر می باشد. این طبقه با برچسب آبی رنگ علامت گذاری می شود.

Seed Conditioning

- After harvest, seed must be cleaned: a process known as seed conditioning or processing
- Ultimate goal is to obtain the maximum percentage pure seed with maximum germination potential
- Pure Live Seed:

Pure Seed X Germination = Pure Live Seed

95% X 93% = 88.35%

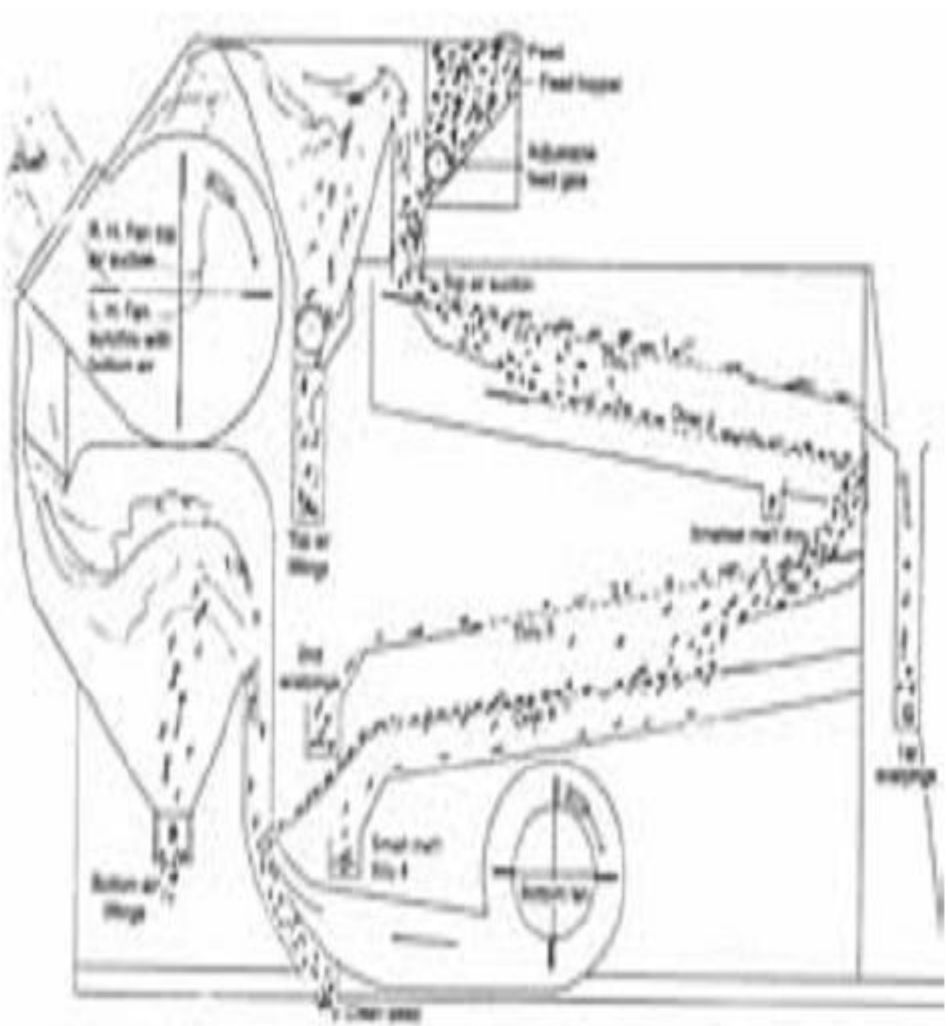
Seed Conditioning

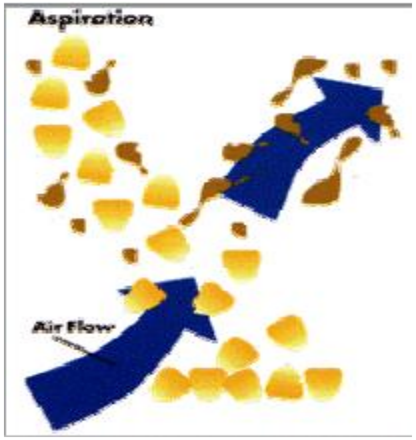
- Objectives
  - Complete separation
  - Minimization of seed loss
  - Upgrading
  - Efficiency
  - Minimization of labor

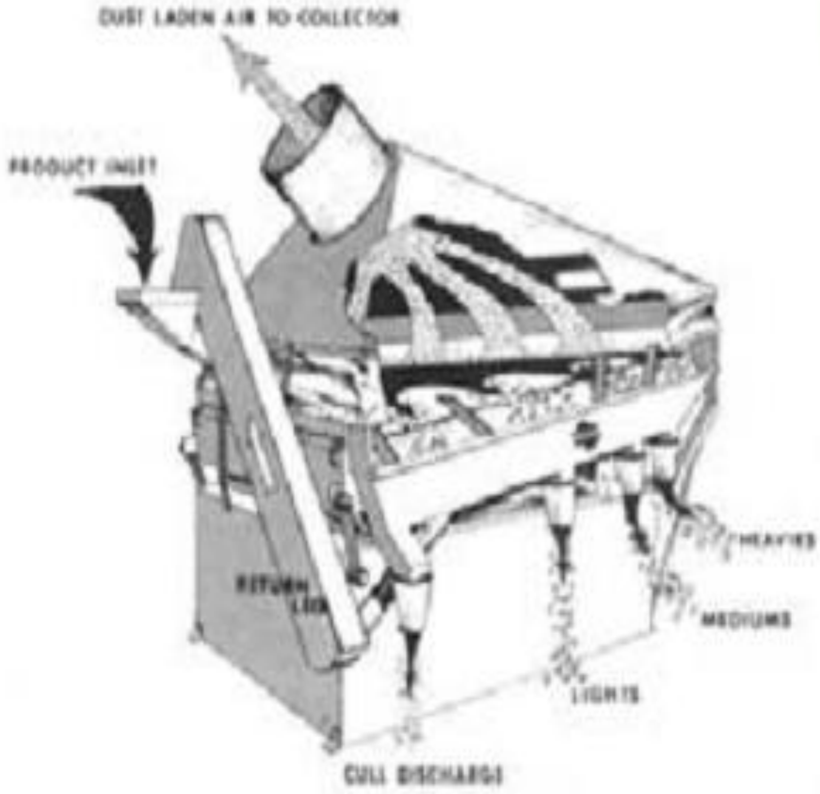
- Preconditioning
  - A precleaning operation
  - Commonly done by a scalper
    - Enough trash is removed to permit conditioning
    - Seeds feed more evenly through equipment
    - High moisture, green material is removed decreasing time and cost of drying
    - Removal of bulk of trash permits finer top screens to be used resulting in precise separations
    - Cleaning machines are more efficient

- Conditioning
  - Components must differ in some physical characteristic
  - Seed separations usually made on two characteristics
    - Seed size
    - Seed weight

- Air-screen cleaner
  - Basic cleaner in most plants
  - Uses
    - Airflow
    - Perforated screens

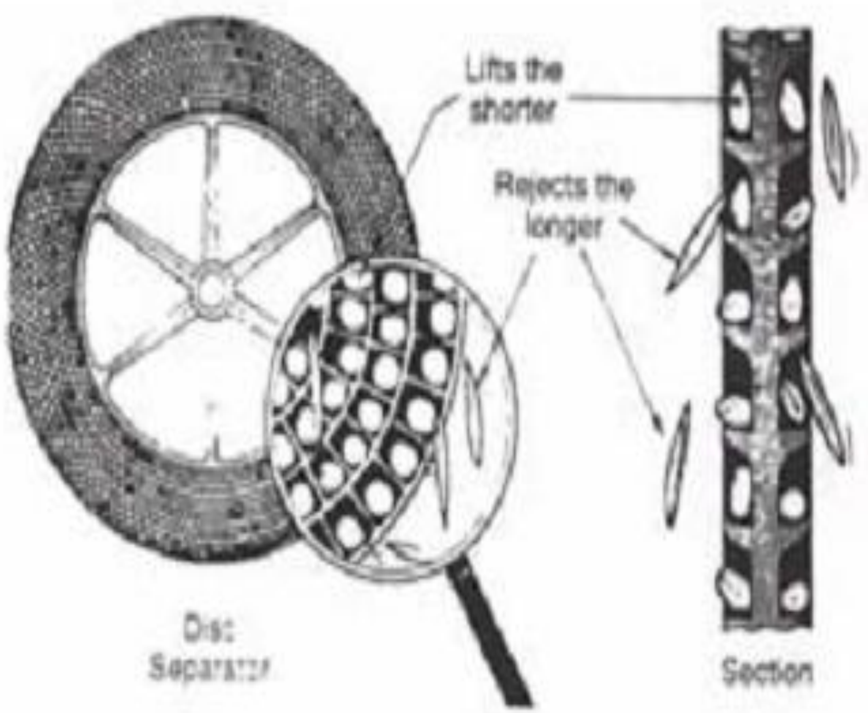






- Gravity Separator
  - Employs a flotation and oscillation principle
  - Dense seeds walk to the top
  - Light seeds float to the bottom
  - Operation is sophisticated
    - Air flow
    - Oscillation rate

- Dimensional Sizing Equipment
  - Length separators
  - Indent disk
    - Uses a series of indent disks
    - Disks are rotated in a cylinder with seeds
    - Seeds are lifted out from contaminating seeds or vice versa



Seed Conditioning

- Seed Treatments
  - Applying chemicals to control seed pathogens
  - Specialized operation, expensive, considered cheap insurance
  - Usually last step in conditioning sequence
  - Can be applied as a slurry (mixture of powder and water), liquid or dust
  - Slurry method most common

- Ideal seed treatment chemical must be
  - Highly effective against pathogens
  - Relatively non-toxic to plants
  - Harmless to humans and livestock
  - Stable for long periods during seed storage
  - Easy to apply
  - Economically competitive

- State and federal laws require that treated seed be identified in two ways
  - By incorporating a dye into the treatment to give the seed a contrasting color
  - By a statement that the seed has been treated and the name of the chemical(s) used
  - Ensures that humans recognize the seed has been treated and should not be used for animal consumption

Seed Storage

Definition of Seed Storage:

Seeds are considered to be in storage from the moment seed reach to physiological maturity until they germinate or thrown away because they are dead.

Importance of Seed Storage

- Helps preserve viability from harvest to sales;
- Protects producers investment, profit and reputation

Seed storage occur at following stages

- Storage in plant Physiological maturity to harvest
- Harvest, until processed and stored in warehouse
- In storages (warehouse)
- In transit
- In retail stores
- On the user's farm

Involves following elements:

- Dry and Cool Seed storage area;
- Effective storage pest control;
- Proper sanitation in seed stores;
- Before storage seed to be dried to safe moisture limits;
- Storing of high quality seed only i.e well cleaned, treated as well as of high germination/vigour and good pre storage history
- Determine seed storage needs in view of length of storage time and prevailing climate of the area during storage.

Seed Deterioration

Definition: "Deteriorative changes occurring with time that increase the seed's vulnerability to external challenges and decrease the ability of the seed to survive."

Consortium for International Seed Technology Training, CISTT

Seed Deterioration

"Seed deterioration is inexorable and the best that can be done is to control its rate."

Predisposition for Seed Deterioration

- Genetics
- Seed Structure
- Seed Chemistry
- Physical/physiological seed quality
- Relative humidity and temperature of the storage environment
- External environmental factors

Relative Storage Life of Flower Seeds

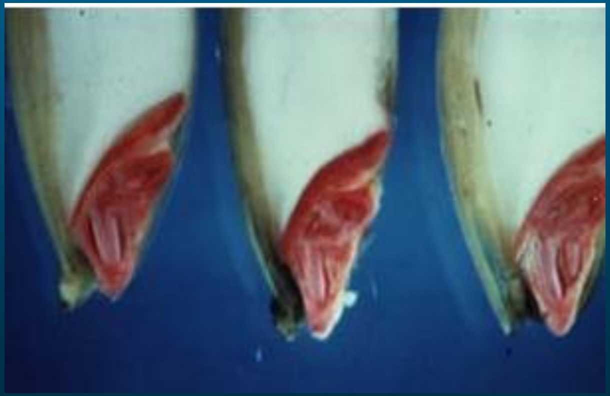
Short	Medium	Long
Anemone	Ageratum	Centaurea
Aster	Alyssum	Chrysanthemum
Begonia	Cycalmen	Shasta Daisy
Coneflower	Dusty miller	Morningglory
Coreopsis	Gaillardia	Sweet pea
Impatiens	Lisanthus	Zinnia
Pansy	Marigold	
Phlox	Nicotiana	
Salvia	Petunia	
Vinca	Snapdragon	
Viola	Verbena	

From McDonald and Kwong. 2006. Flower Seeds: Biology and Technology.

- Seed Structure
  - Size/surface area
  - Seed coat permeability

- Seed Chemistry
  - Lipid vs. protein vs. starch
  - mucilage

- Physical/physio-logical seed quality
  - Maturity
  - Physical damage
  - Dormancy



Causes of Seed Deterioration

- **Temperature**
  - Increases air's ability to suspend water
  - Enhances physiological speed of deterioration reactions

ºC	g H_2O/kg air
0	3.9
10	7.6
20	14.8
30	26.4
40	41.4

Consortium for International Seed Technology Support · CISTT ·

"Rules of Thumb"

- Every 1% decrease in seed moisture content doubles seed storage life.
- Every 5°C decrease in storage temperature doubles seed storage life.
- Practical seed storage equation:

$$\% \text{ RH} + {}^{\circ}\text{C} \leq 45.5$$

CISTT: Consortium for International Seed Technology Training

Role of moisture and temperature on seed viability and storability

Seed moisture %	Effect on seed
35-80	Moisture content of developing seed. Seed not mature enough to harvest
18-40	Physiologically mature seed, High respiratory rate, susceptible to field deterioration, heating occurs if seed is bulked without proper ventillation.
13-18	Respiratory rate still high, mold and insects can be damaging and seed resistant to mechanical damage
10-13	Seed store well for 6-8 months in open storage in temperate climates.
8-10	Seed sufficiently dry for 1-3 years open storage in temperate climates. Very little insect activity.
4-8	Safe moisture for sealed storage
0-4	Extreme desiccation. Can be damaging to seed.
33-60	Seed germinates when they imbibe water to these levels.

Table 1. Maximum seed moisture content for seeds stored in sealed containers. The seed moisture percentage of stored seed should not be higher than the values given below (USDA Federal Seed Act, 1976).

Vegetable	Seed moisture (%)	Vegetable	Seed moisture (%)
Bean, common	7.0	Leek	6.5
Bean, Lima.	7.0	Lettuce	5.5
Beet	7.5	Muskmelon	6.0
Broccoli	5.0	Mustard	5.0
Brussels sprouts	5.0	Onion	6.5
Cabbage	5.0	Onion, Welsh	6.5
Carrot	7.0	Parsley	6.5
Cauliflower	5.0	Parsnip	6.0
Celeriac	7.0	Pea	7.0
Celery	7.0	Pepper	4.5
Chard, Swiss	7.5	Pumpkin	6.0
Chinese Cabbage	5.0	Radish	5.0
Chives	6.5	Rutabaga	5.0
Collards	5.0	Spinach	8.0
Corn, sweet	8.0	Squash	6.0
Cucumber	6.0	Tomato	5.5
Eggplant	6.0	Turnip	5.0
Kale	5.0	Watermelon	6.5
Kohlrabi	5.0	Unlisted	6.0