In the Name of God

Vegetable Seed Production and Breeding

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

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

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)
- V (HR)
- N (HR)
- TMV (HR)
- FoII (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)

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?

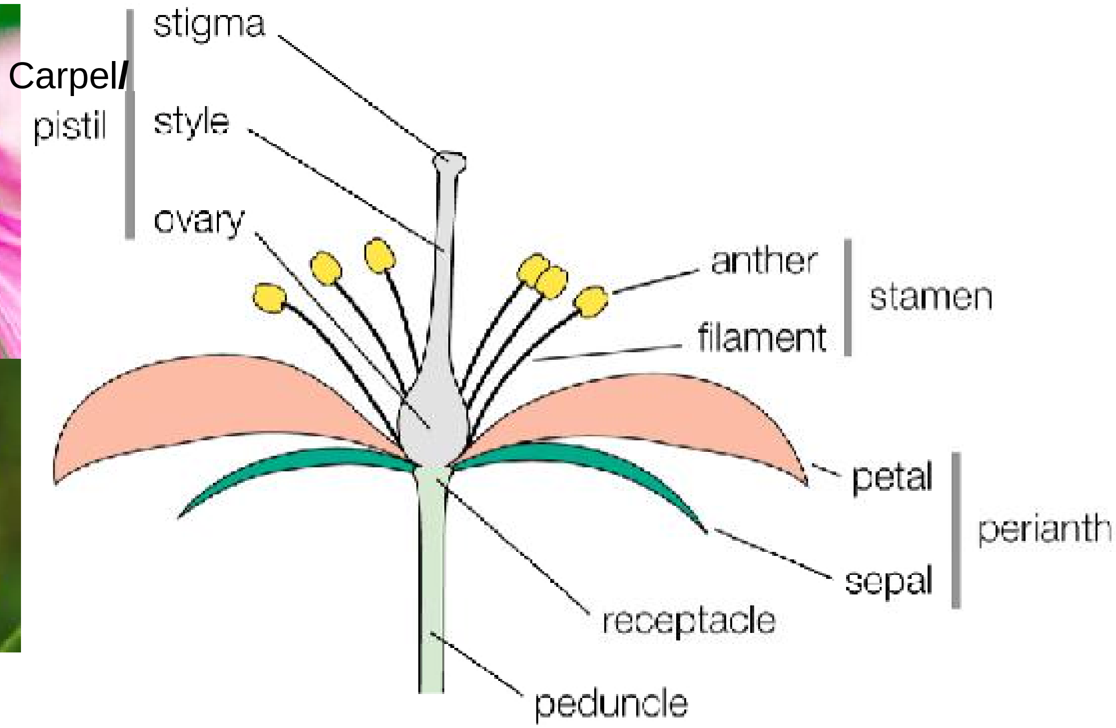
- Study of sexual and asexual reproduction
  - Pollination mechanisms
  - Gene flow
  - Genetic variation
  - Propagule dispersal

Why study it?

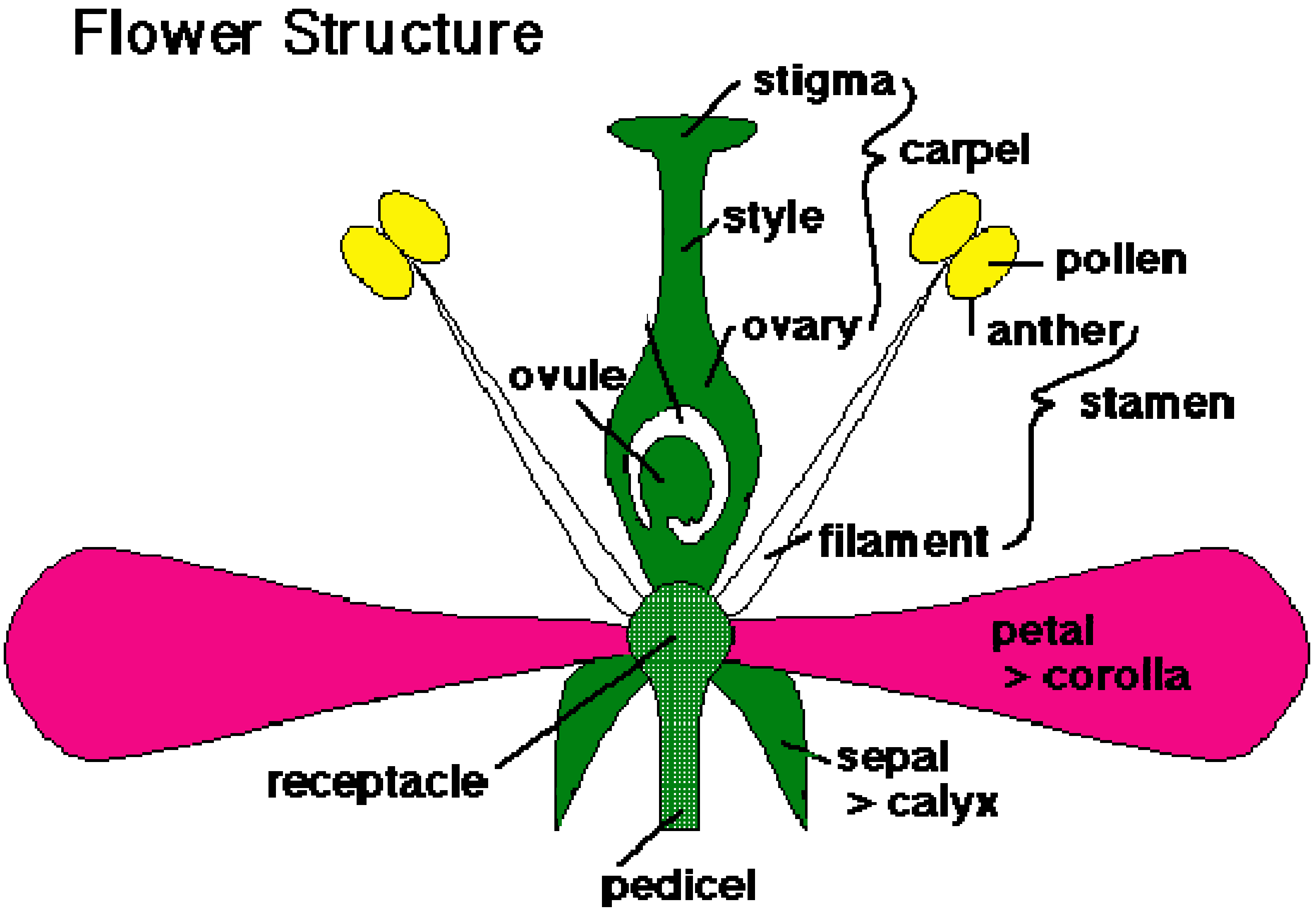
- Insight into adaptive significance & homology of systematic characters
- Insight into delimitation of species and subspecies.

Function of flower

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

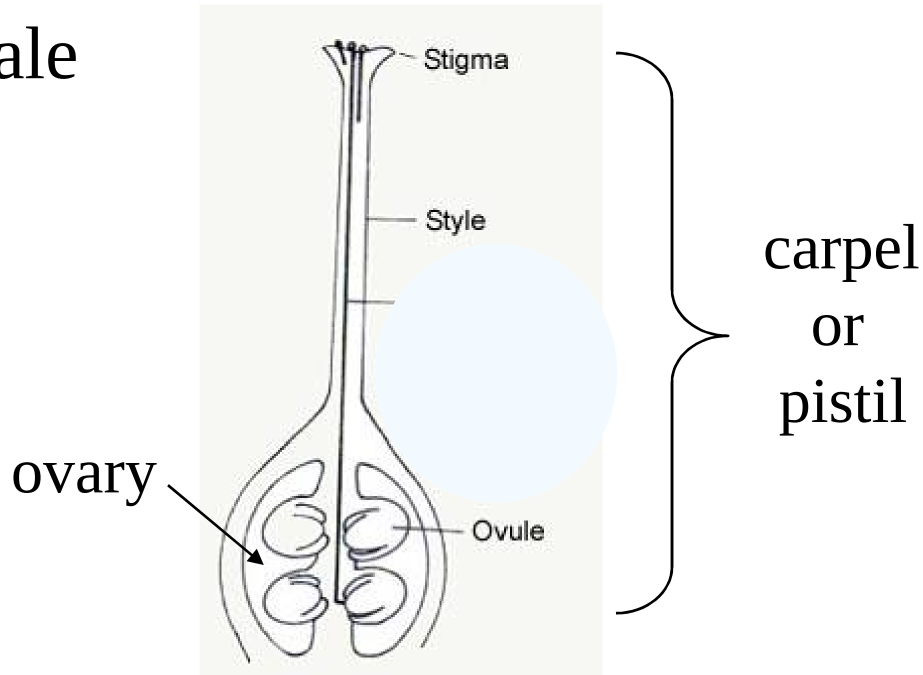


Overview of floral organs



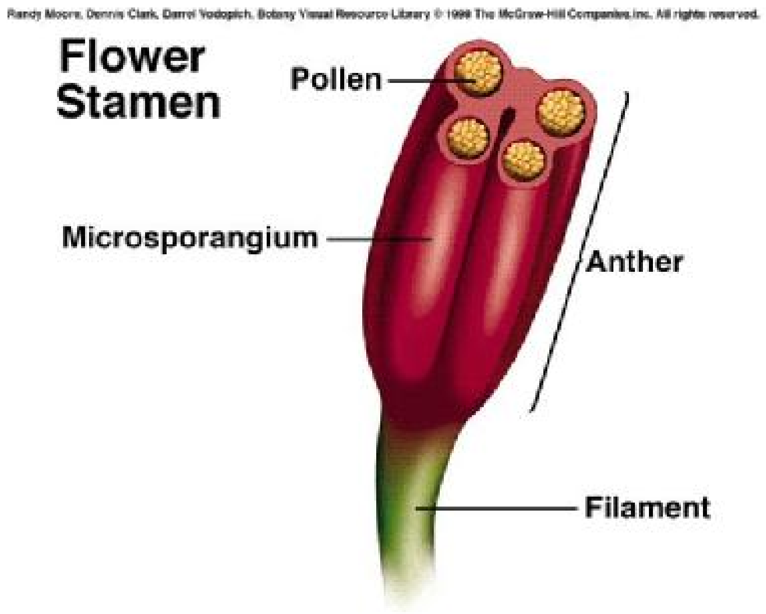
Reproductive floral organs: female

- **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!

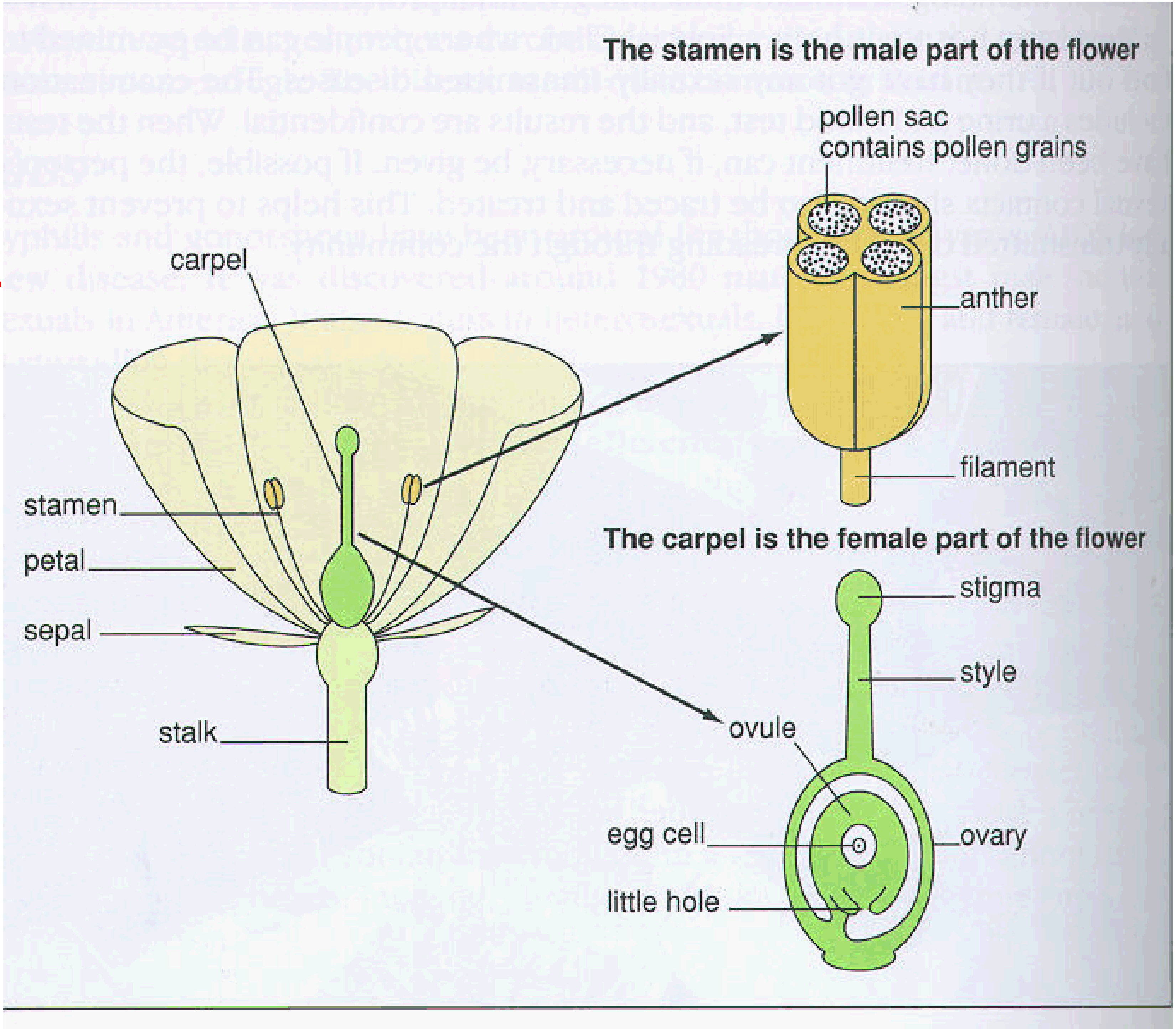


Reproductive floral organs: male

- **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

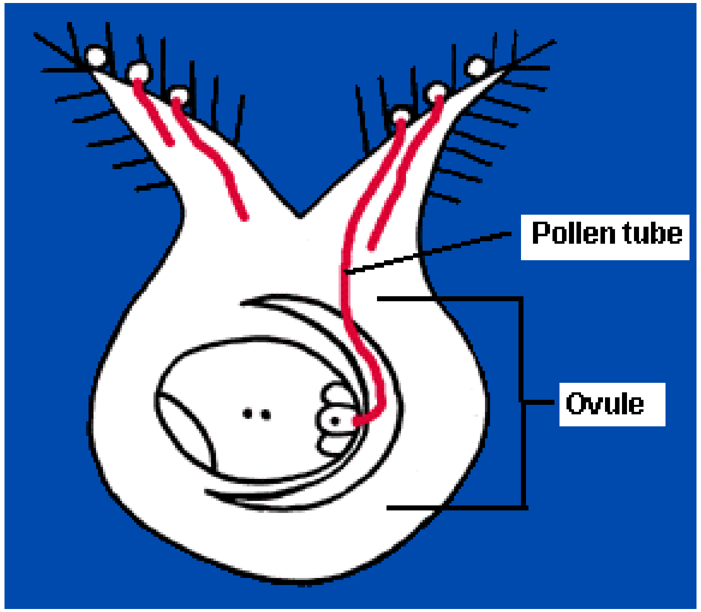


Sexua parts of a flower



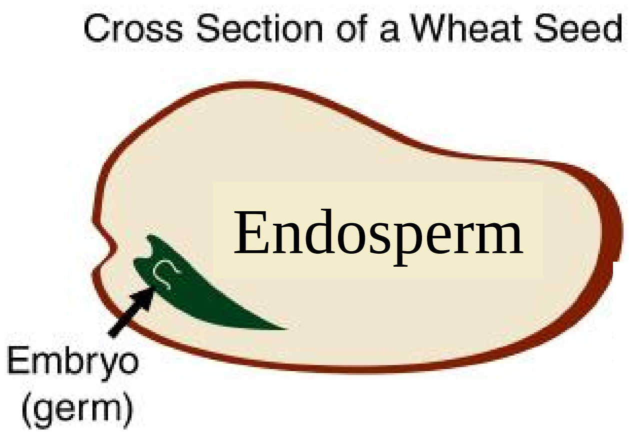
Pollination and Fertilization

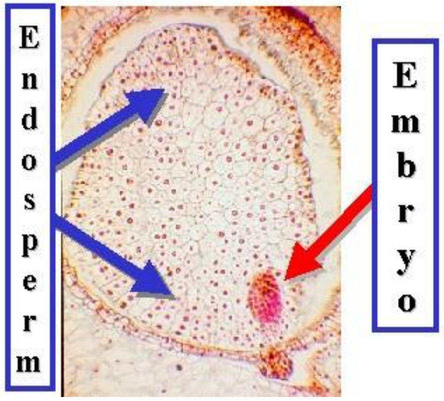
- For pollen sperm to successfully fertilize the egg, there must be **pollination**: a method to get the pollen from the male anther to the stigma.
- Pollen sticks to the stigma, starts growing a pollen tube
- **Fertilization** begins when tube begins to grow toward the egg



Double Fertilization

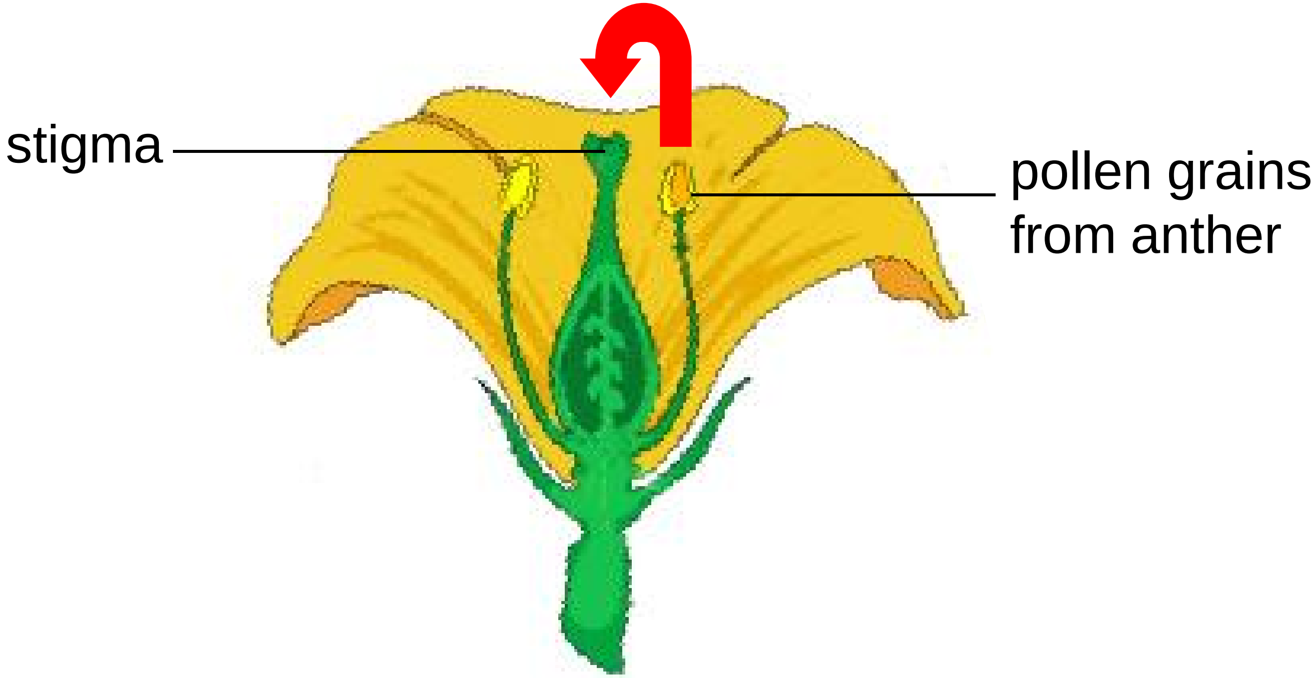
- **Double fertilization** occurs: One sperm nucleus (1n) fertilizes the egg, producing a **zygote** (2n) **à** which becomes the plant **embryo** inside the seed
- Another sperm nucleus fuses with the polar nuclei, resulting in a triploid **endosperm** (3n)
- Endosperm is a source of food for the young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



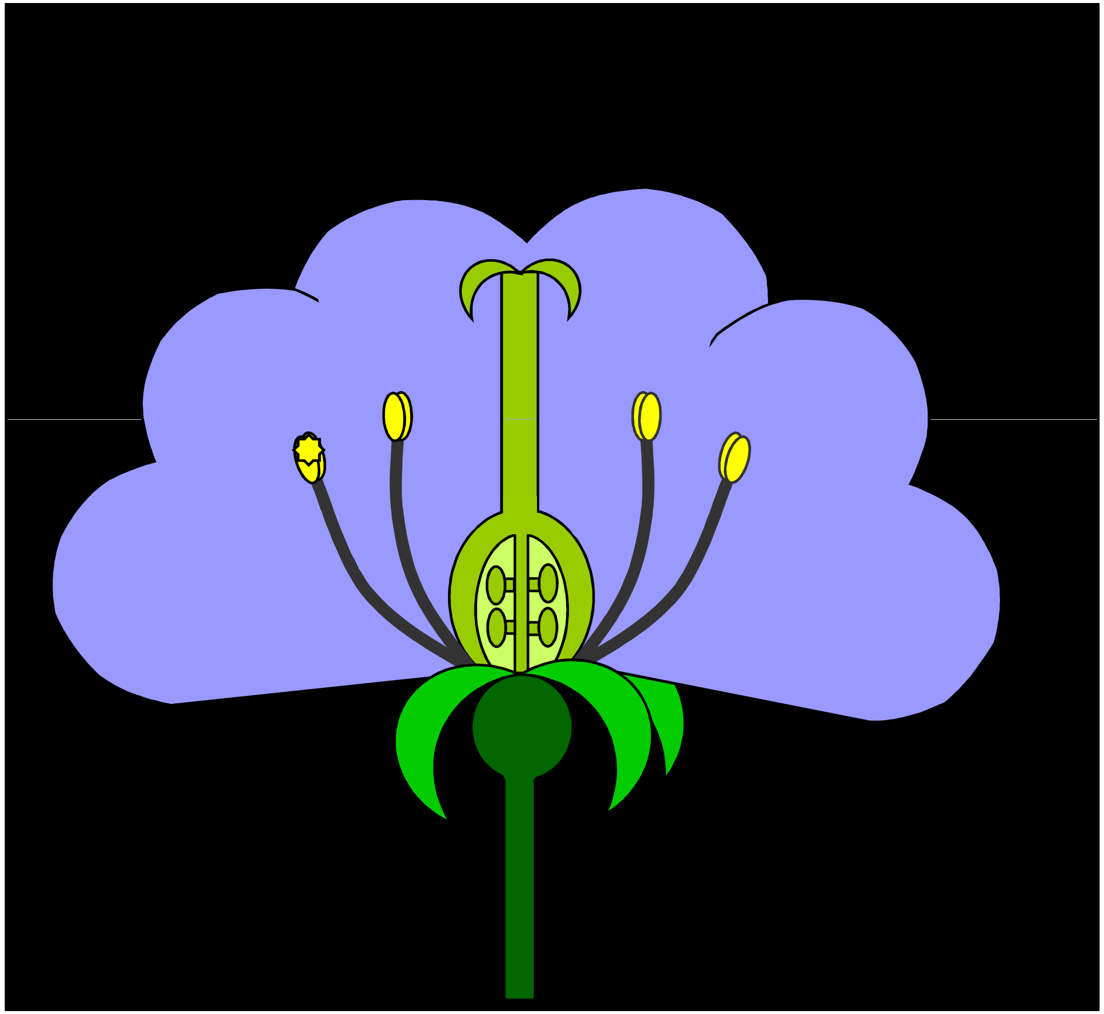


Pollination

- **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.



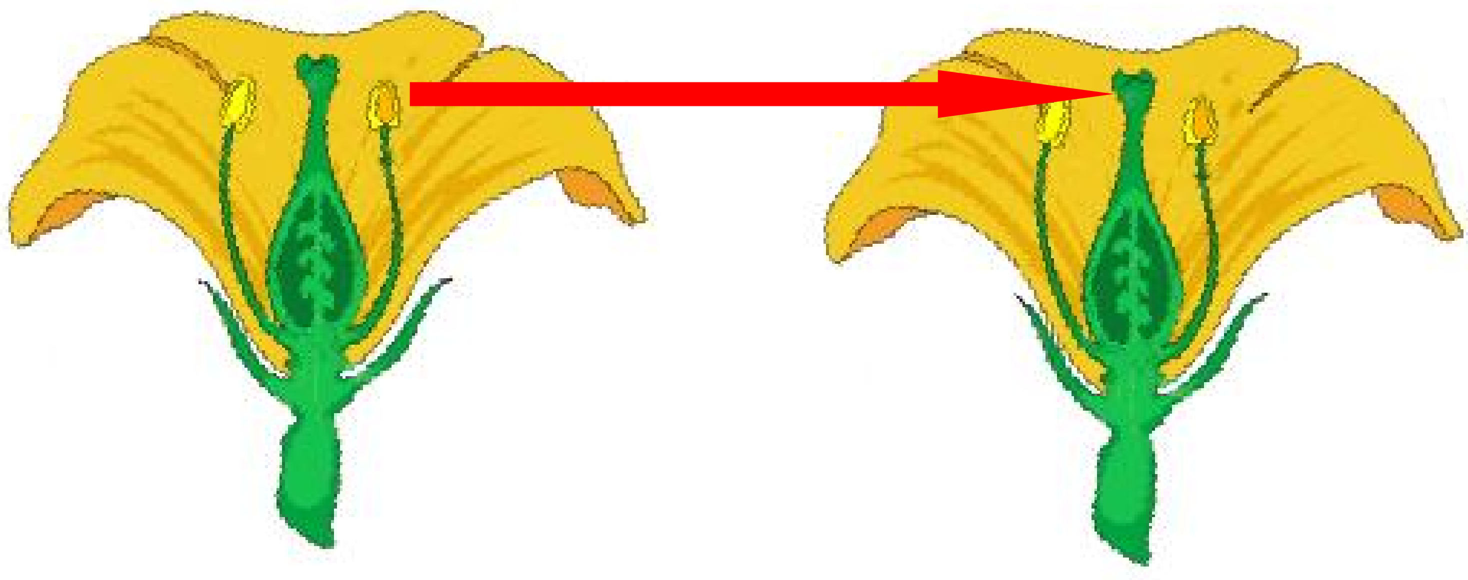
Self-pollination occurs when pollen falls from the anther onto the stigma of the same flower



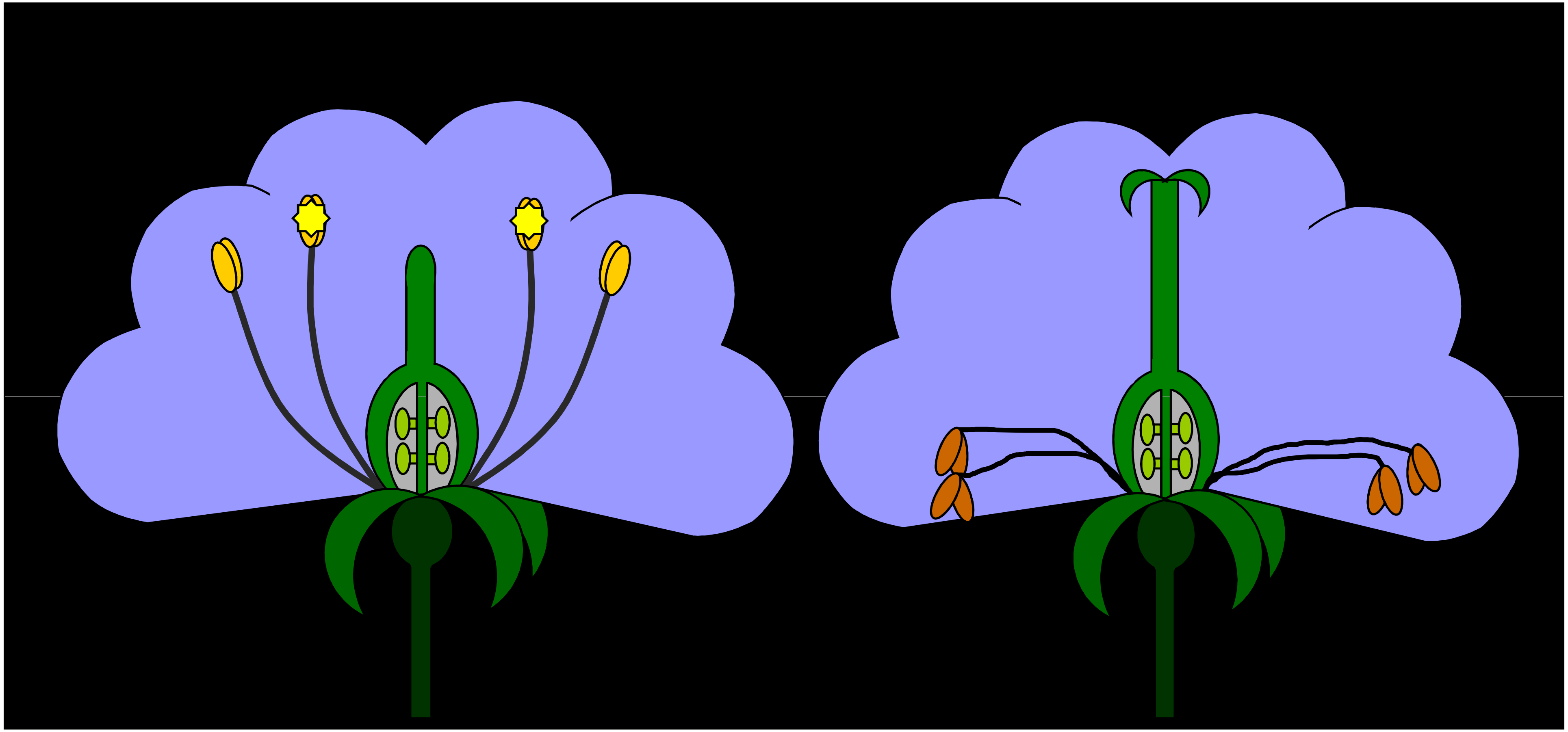
- Self-pollination is not desirable as it reduces variation

Pollination

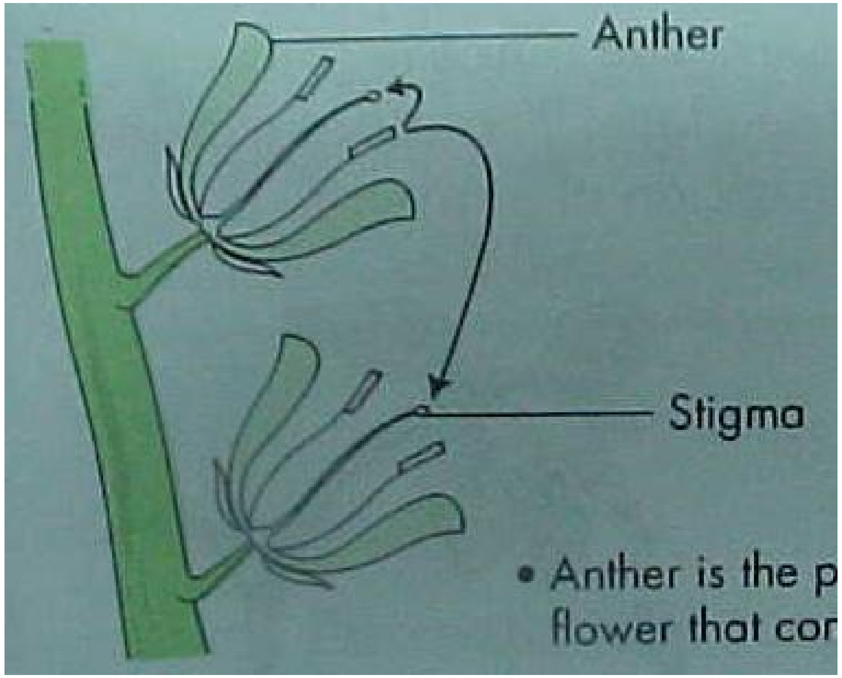
- **Pollination** is the transfer of pollen grains from the anther to the stigma of a flower.
  - The pollen grains can also be transferred from one flower to another.



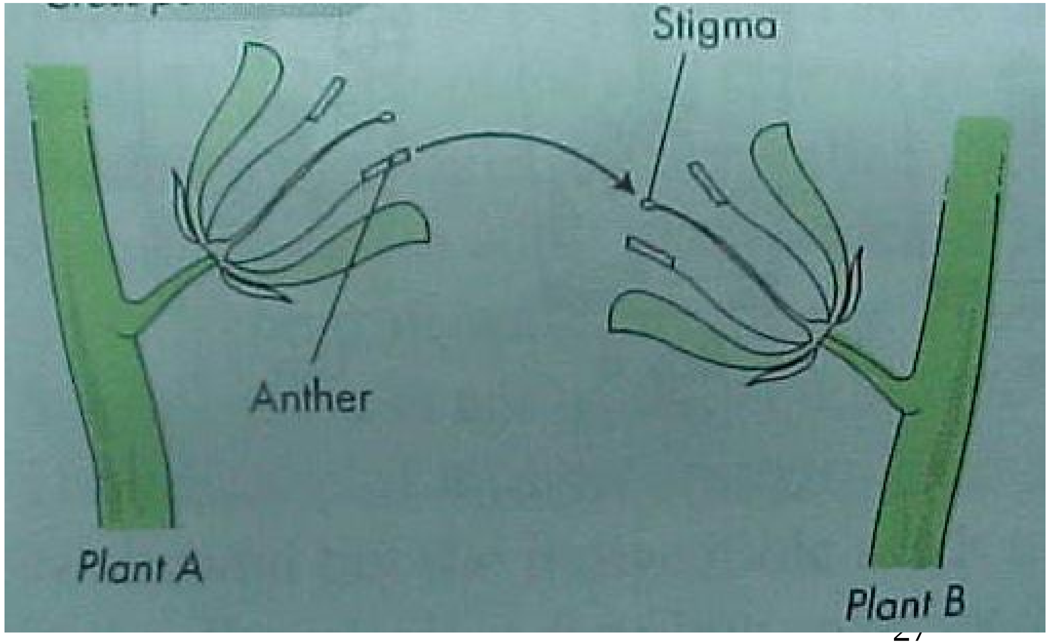
Pollination is the transfer of pollen from the anther to the stigma



- 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. à Genetic variation.
  - Offspring inherit traits from both parents à 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

						Homozygosity
P			AA x aa			
F_1			Aa			
F2		AA (25)	Aa (50)	aa (25)		50.00 %
F3	AA (25)	AA (12.5)	Aa (25)	aa (12.5)	aa (25)	75.00 %
F4	AA (37.50)	AA (6.25)	Aa (12.5)	aa (6.25)	aa (37.50)	87.50 %
F5	AA (43.75)	AA (3.125)	Aa (6.25)	aa (3.125)	aa (43.75)	93.75 %
F6	AA (46.875)	AA (1.562)	Aa (3.125)	aa (1.562)	aa (46.875)	96.87 %

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

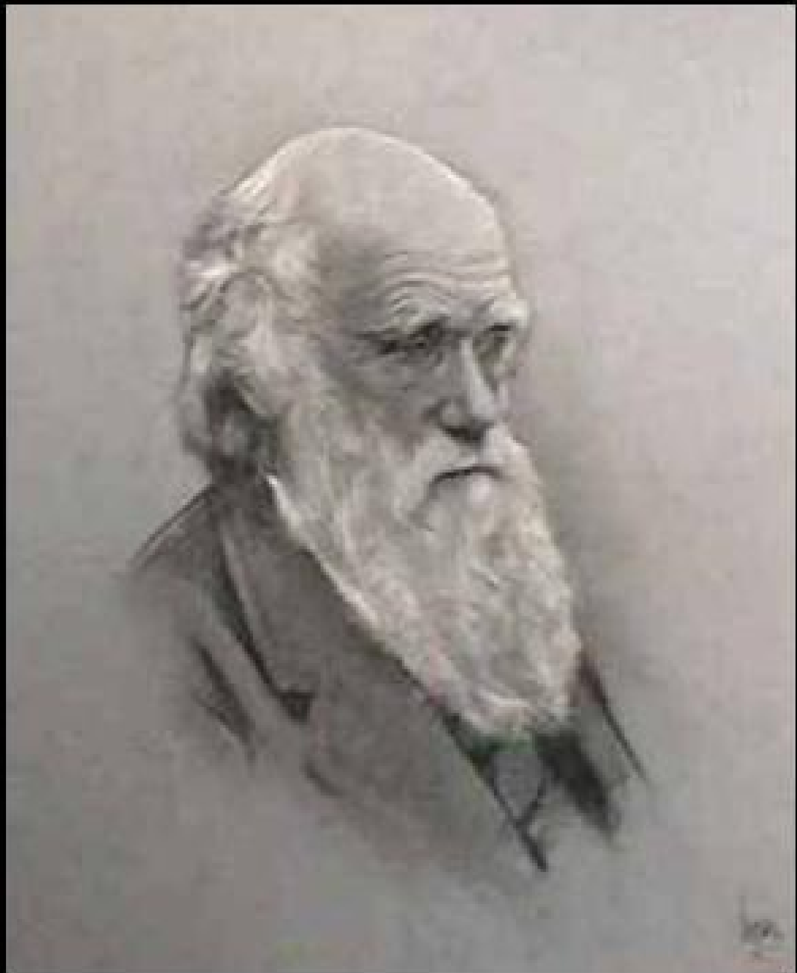
2) Self-incompatibility genes

    Gametophytic and sporophytic

3) Sexual expression

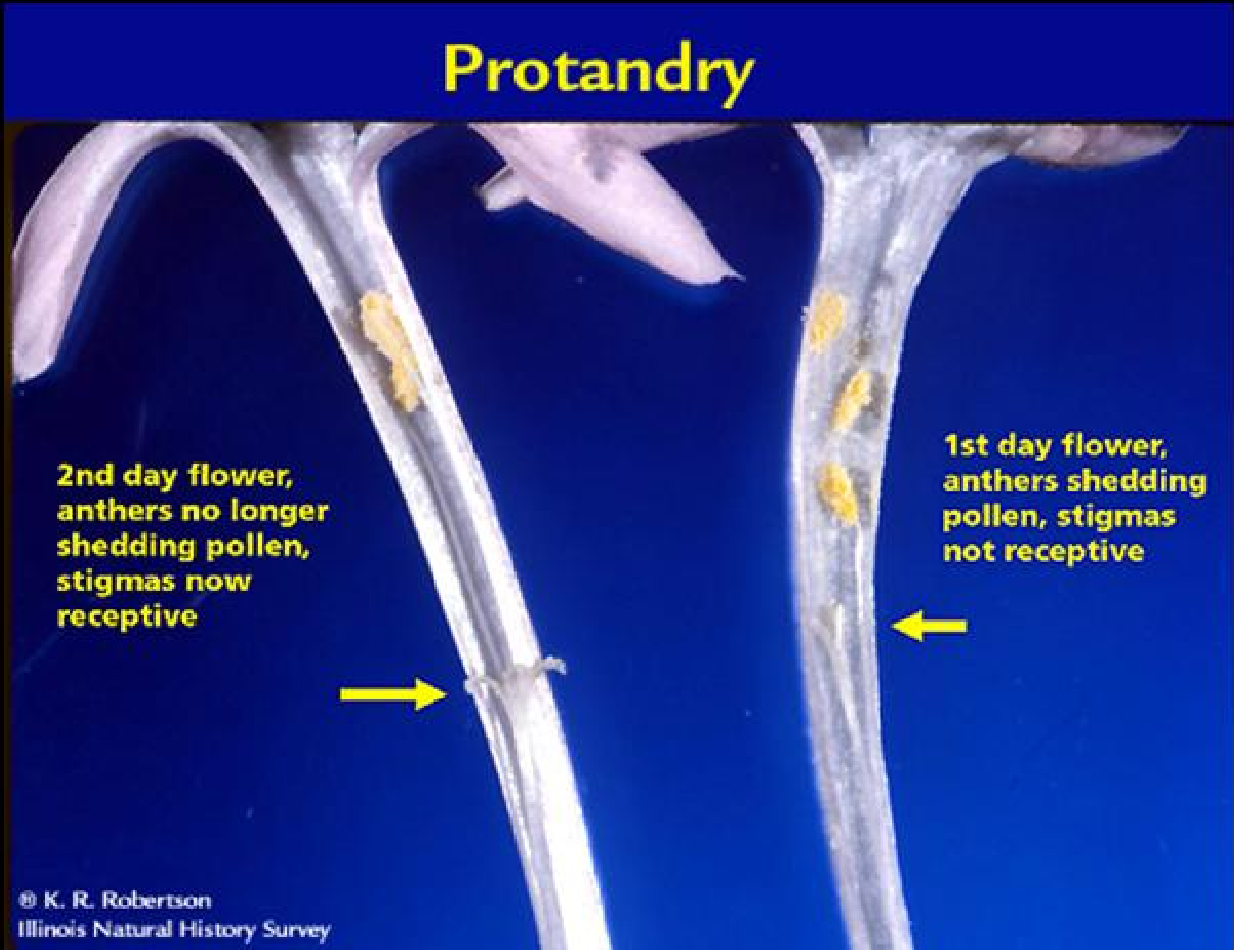
    Monoecy and Dioecy

HETEROMORPHIC FlOWERS



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

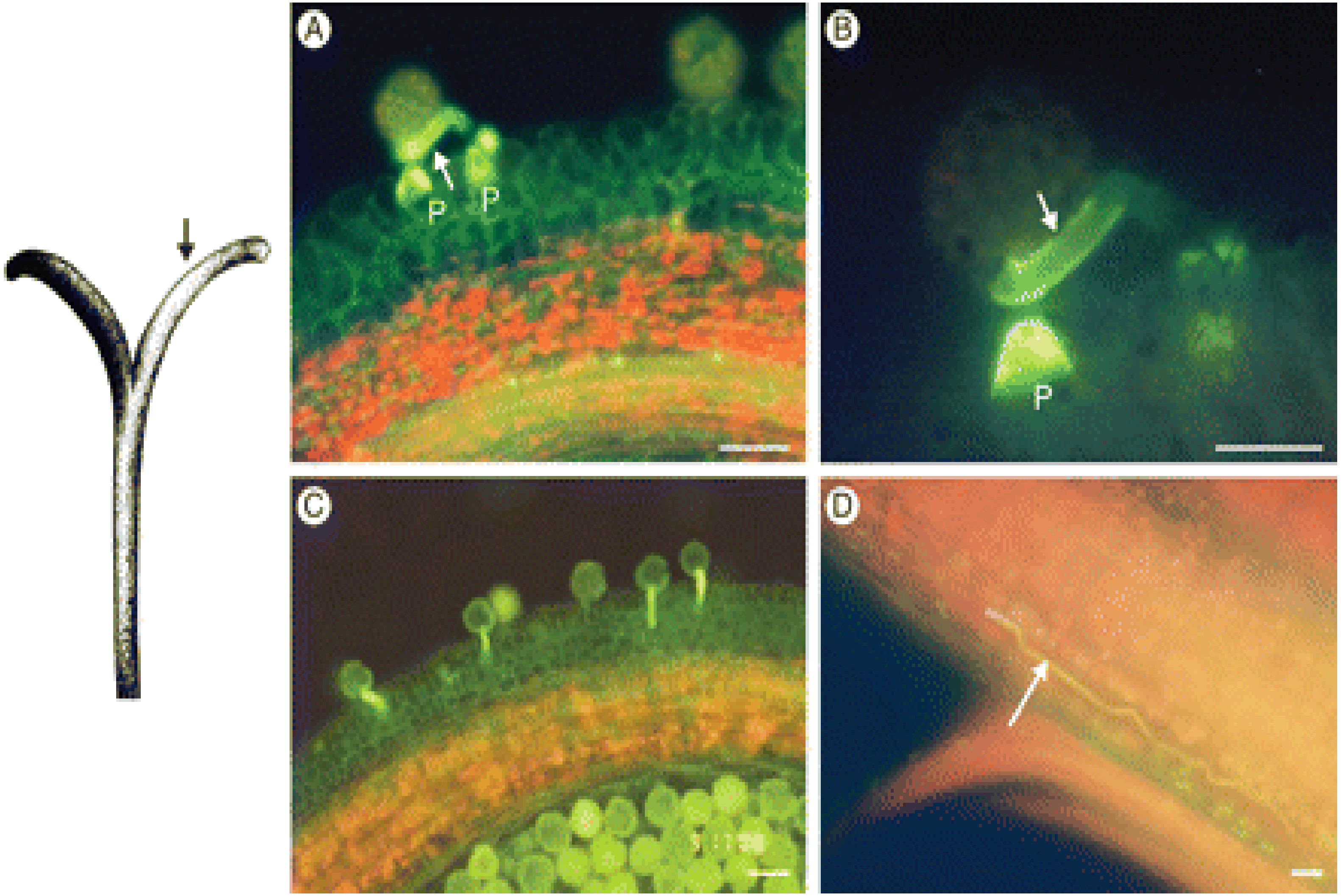
Dichogamy I



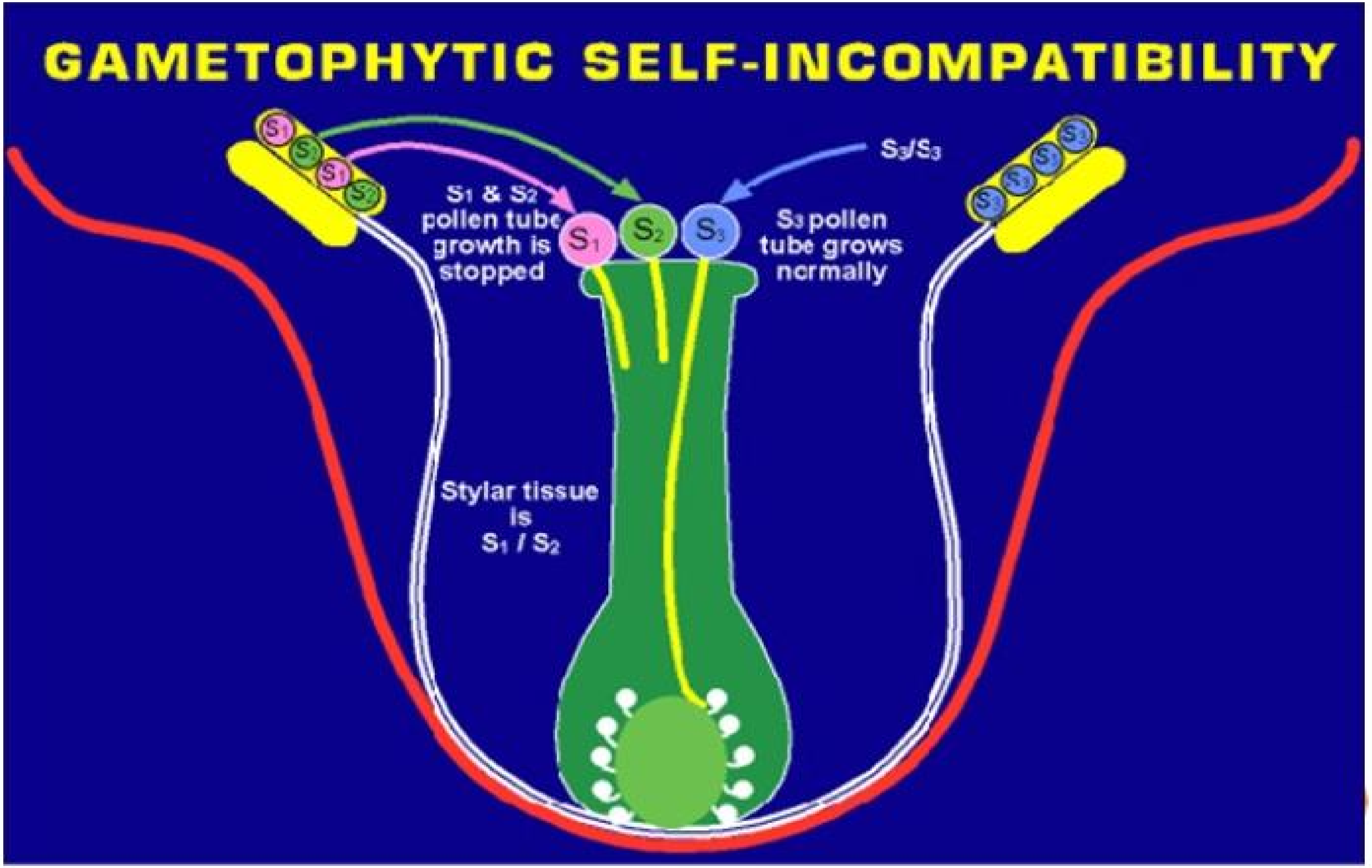
Protandry
2nd day flower, anthers no longer shedding pollen, stigmas now receptive
1st day flower, anthers shedding pollen, stigmas not receptive
® K. R. Robertson
Illinois Natural History Survey

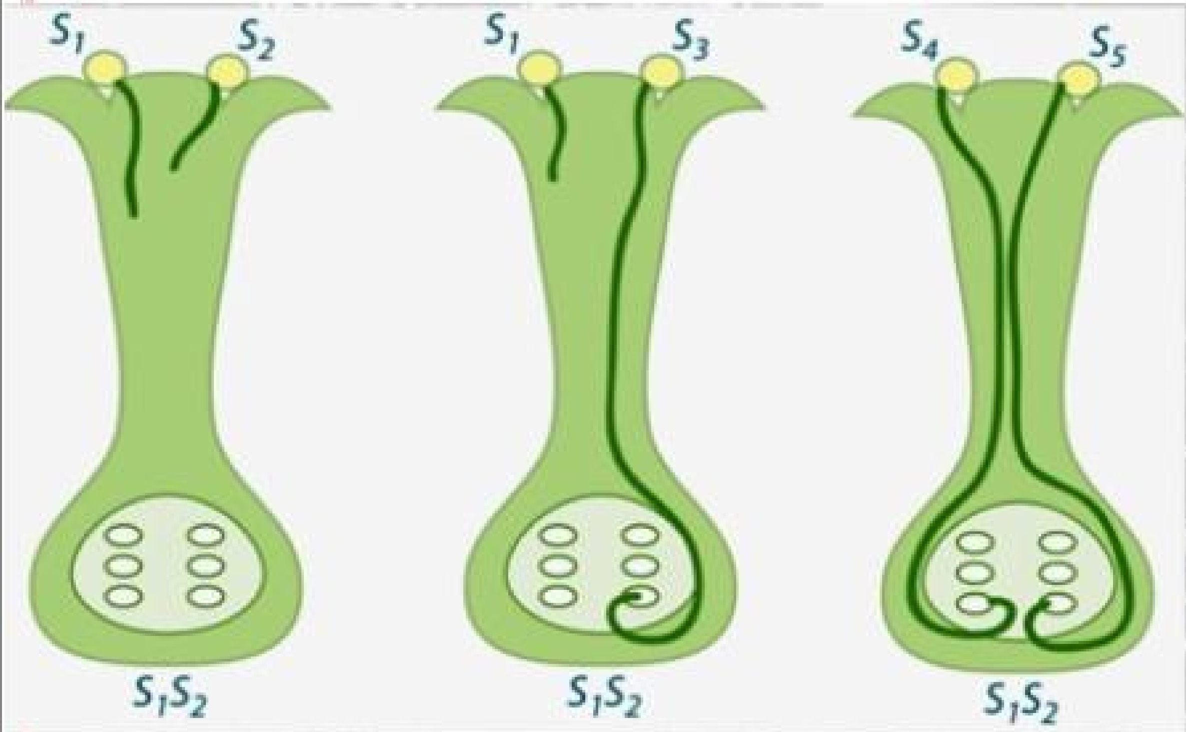
Dichogamy II

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



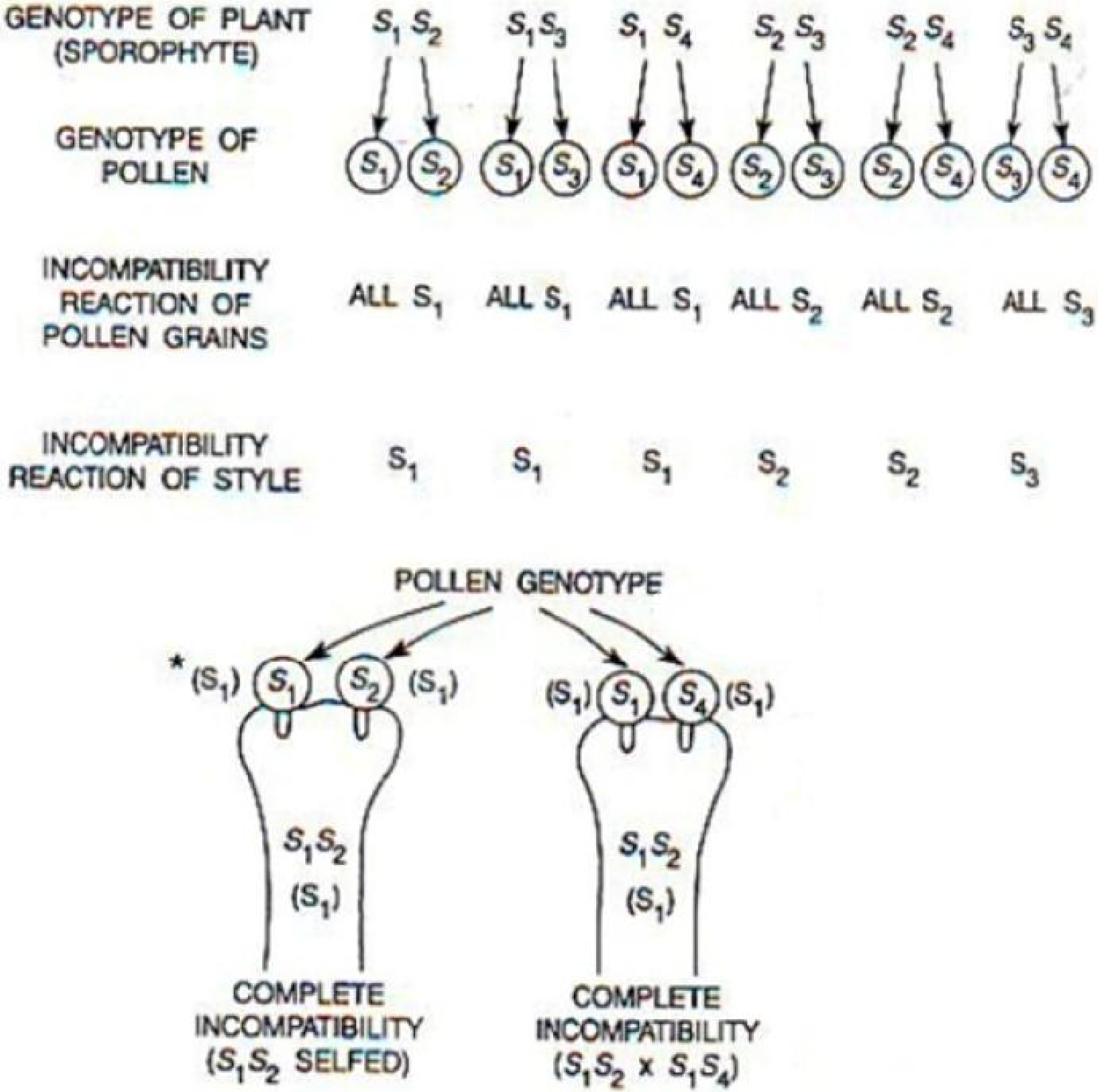
Incompatible and compatible pollinations in *Senecio squalidus.* Squash preparations of stigmas stained with aniline blue and viewed under UV light. (A,B) Incompatible pollination; pollen tube (arrow) blocked from entering papillae (P). (C) Compatible pollination; pollen tubes penetrating stigma tissue.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


GAMETOPHYTIC SELF-INCOMPATIBILITY
S1
S2
S1
S2
S3/S3
S3
S3
S3
S3
S1 & S2
pollen tube
growth is
stopped
S1
S2
S3
S3 pollen
tube grows
normally
Stylar tissue
is
S1 / S2

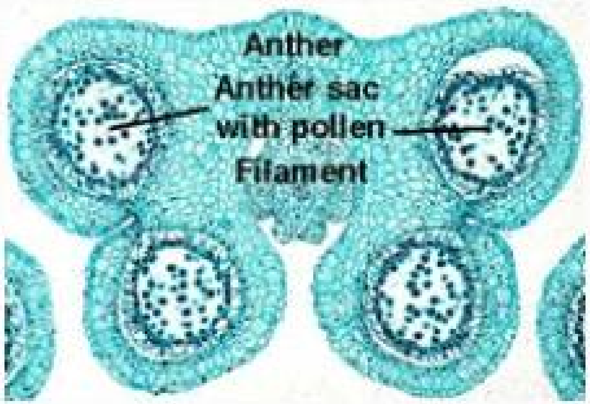


Self-incompatibility is well understood at the cellular and molecular level; it is a mechanism that prevents self-fertilization and fertilization between conspecifics that share alleles at an incompatibility locus

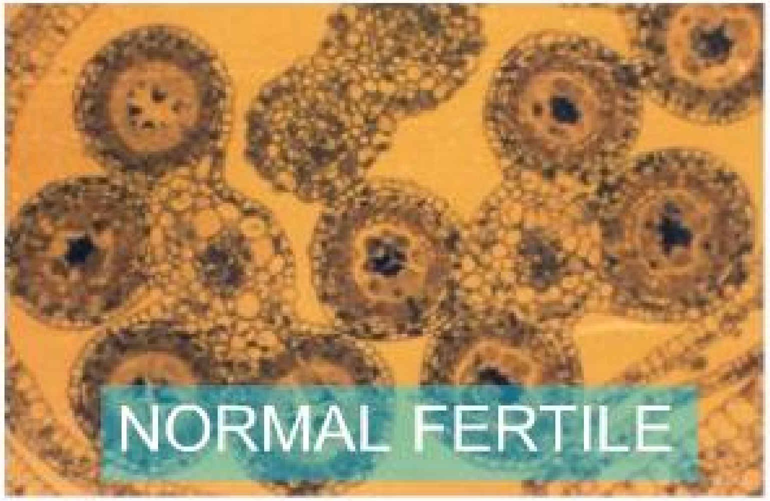
Gametophytic incompatibility

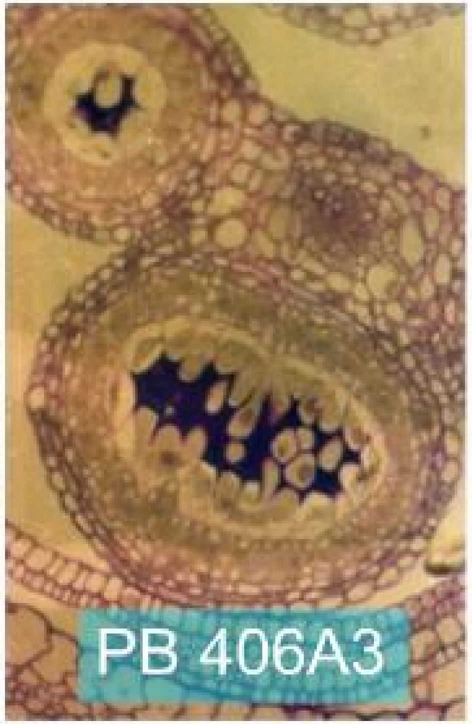

GENOTYPE OF PLANT (SPOROPHYTE)
S1 S2
S1 S3
S1 S4
S2 S3
S2 S4
S3 S4
GENOTYPE OF POLLEN
S1 S2 S1 S3 S1 S4 S2 S3 S2 S4 S3 S4
INCOMPATIBILITY REACTION OF POLLEN GRAINS
ALL S1
ALL S1
ALL S1
ALL S2
ALL S2
ALL S3
INCOMPATIBILITY REACTION OF STYLE
S1
S1
S1
S2
S2
S3
POLLEN GENOTYPE
*(S1) S1 S2 (S1)
(S1) S1 S4 (S1)
S1S2
(S1)
S1S2
(S1)
COMPLETE INCOMPATIBILITY (S1S2 SELFED)
COMPLETE INCOMPATIBILITY (S1S2 x S1S4)

Phenotypic expressions of MS



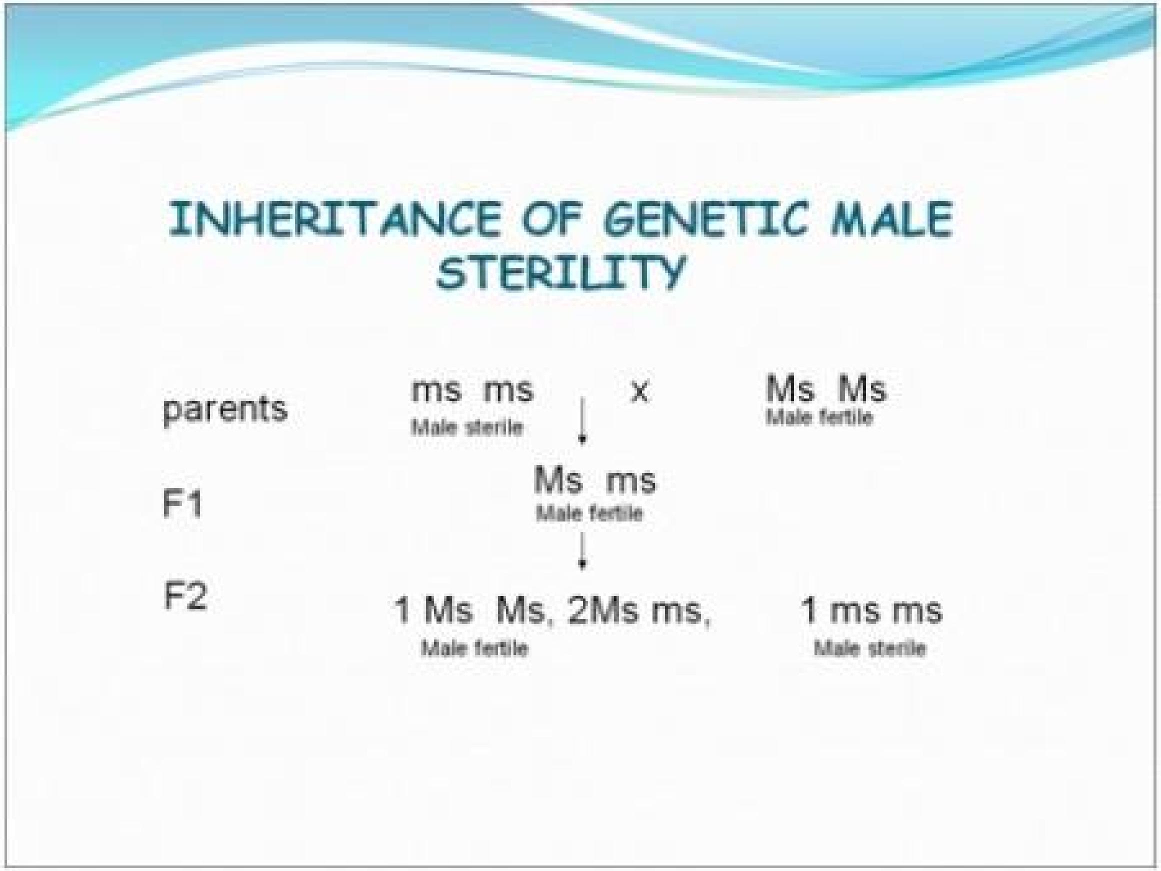
- Absence , atrophy or malformation of androecium
- Lack of normal anther sac or anther tissues
- Inability of the pollen to mature or to be released from anther sac
- Inability to develop normal microspores or pollen



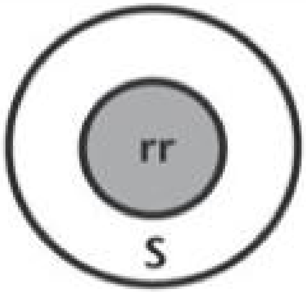


Genetic Male Sterility

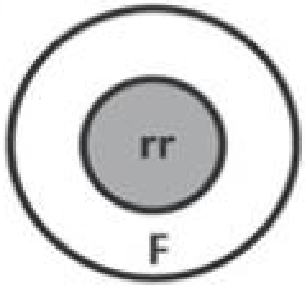
- Ordinarily governed by single recessive gene but sometimes by dominant genes e.g. Safflower
- Alleles arise spontaneously by mutation or may be artificially induced by use of mutagens
- MS x MF = MF in F_1 while a ratio of 3(MF):1(MS) in F_2



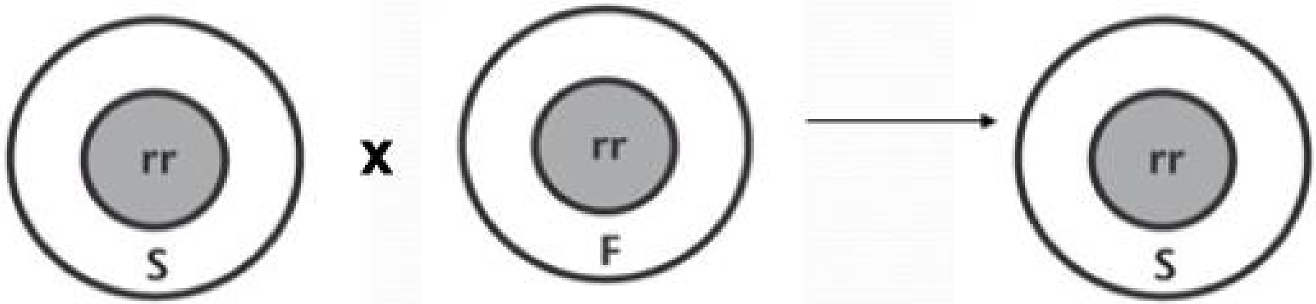
CYTOPLASMIC MALE STERILITY



Cytoplasmic sterile nuclear gene non restorer

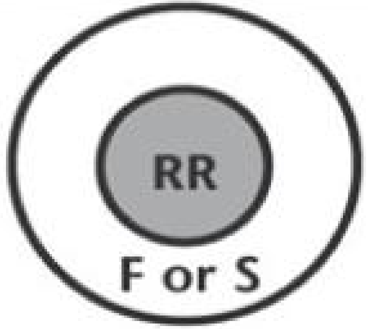


Cytoplasmic fertile nuclear gene non restorer

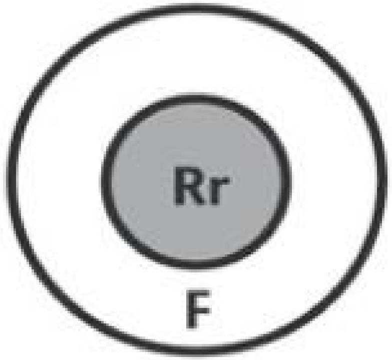


Male sterile   Male fertile   Male sterile

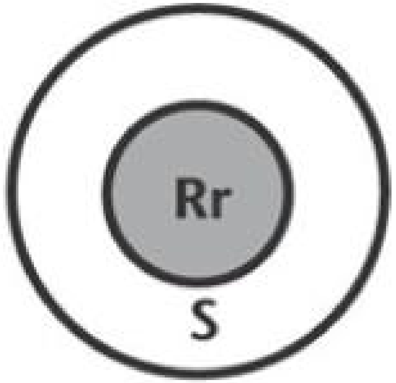
CYTOPLASMIC - GENETIC MALE STERLITY



Male fertile

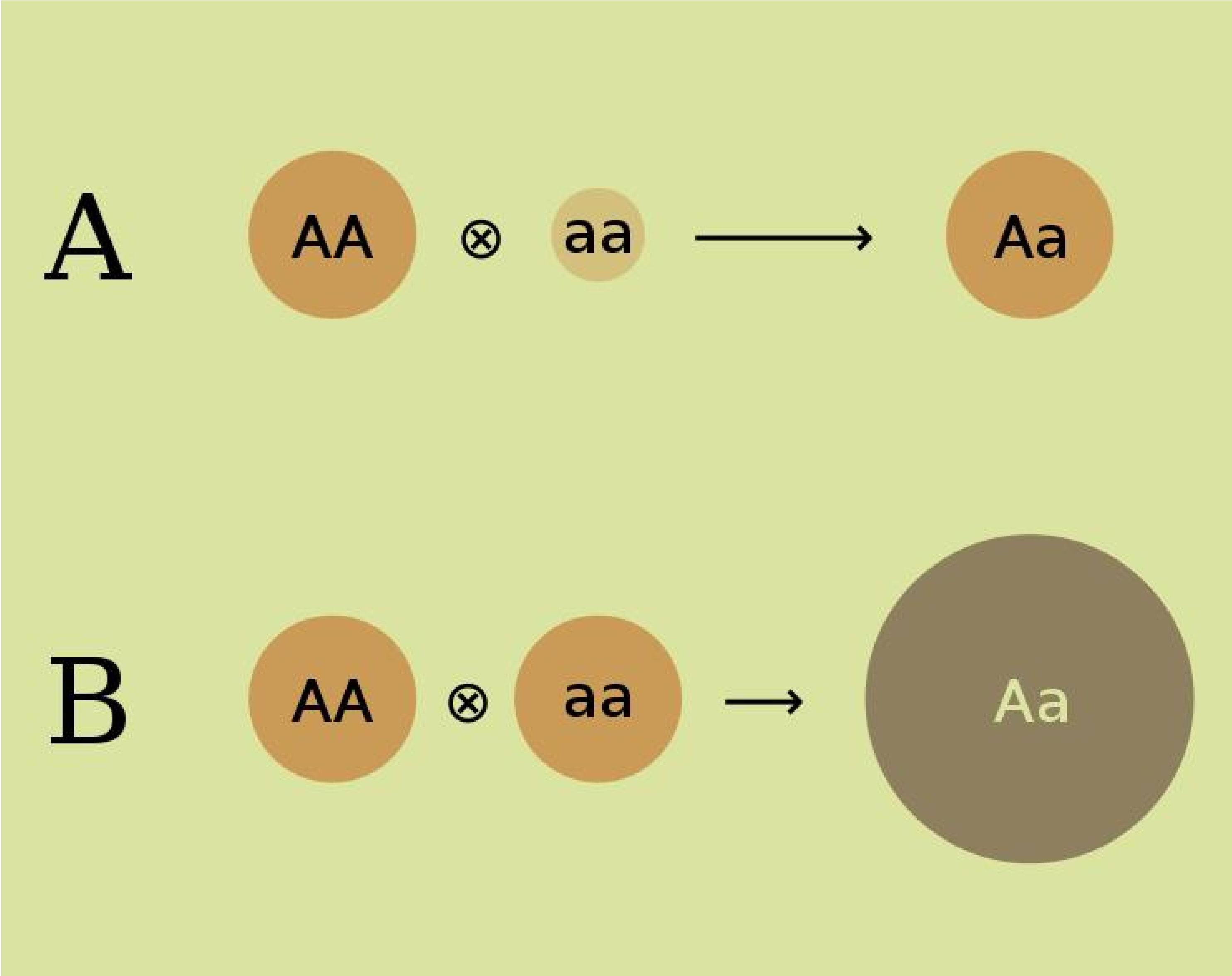


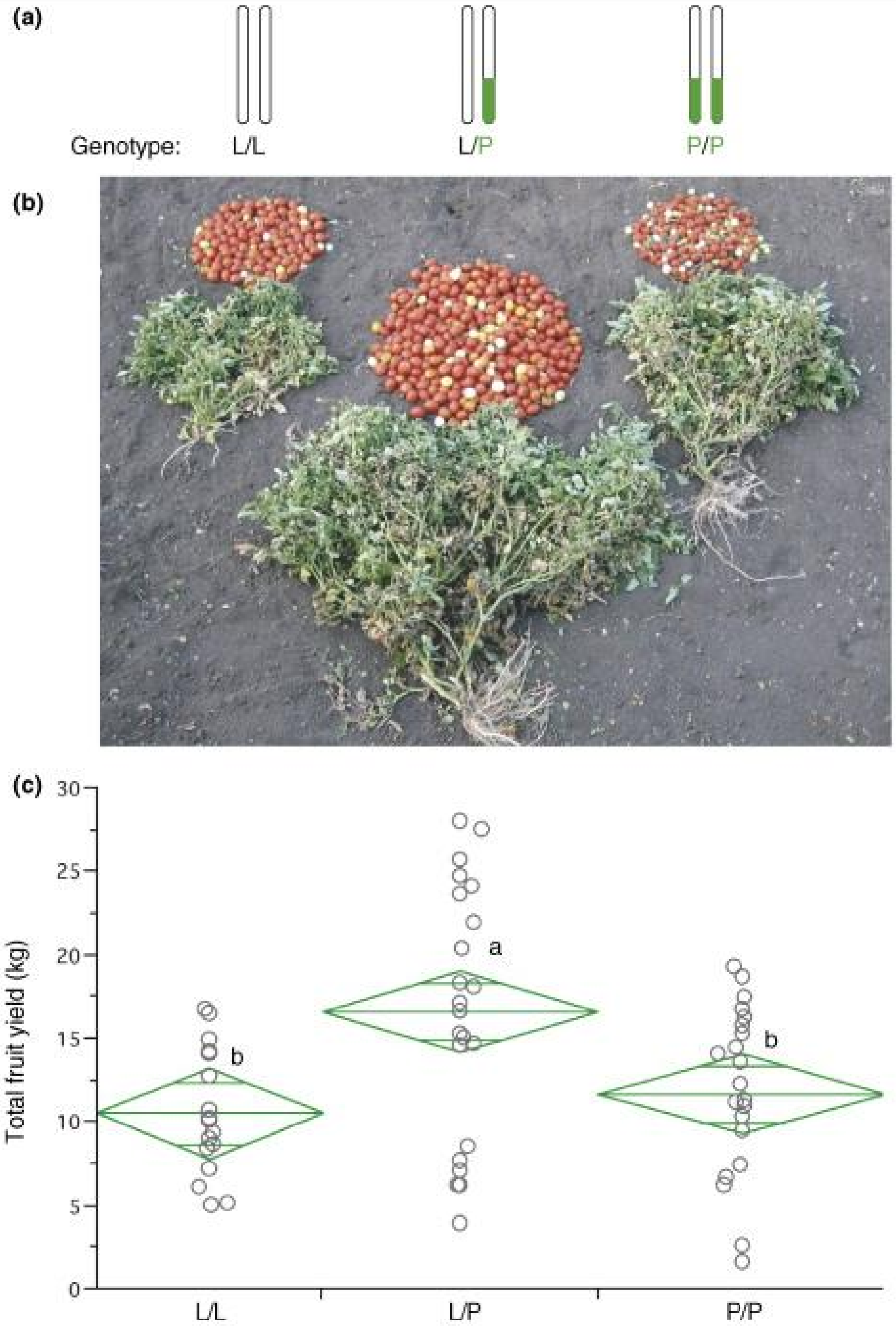
Male fertile



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

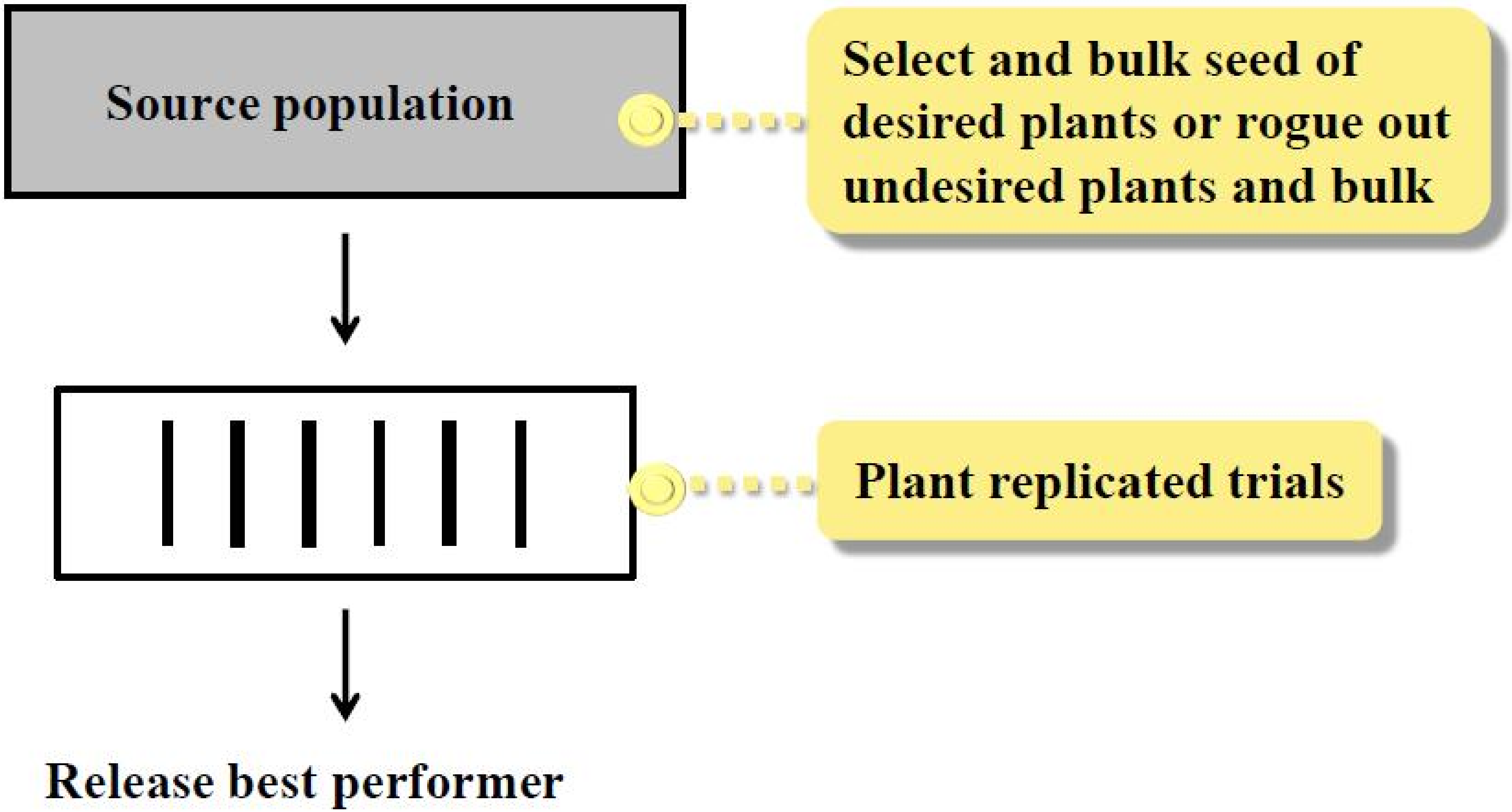
- Mass selection is often described as the oldest method of breeding self pollinated plant species.
- Mass selection is an example of selection from a biologically variable population.
- Selection is based on plant phenotype.

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.

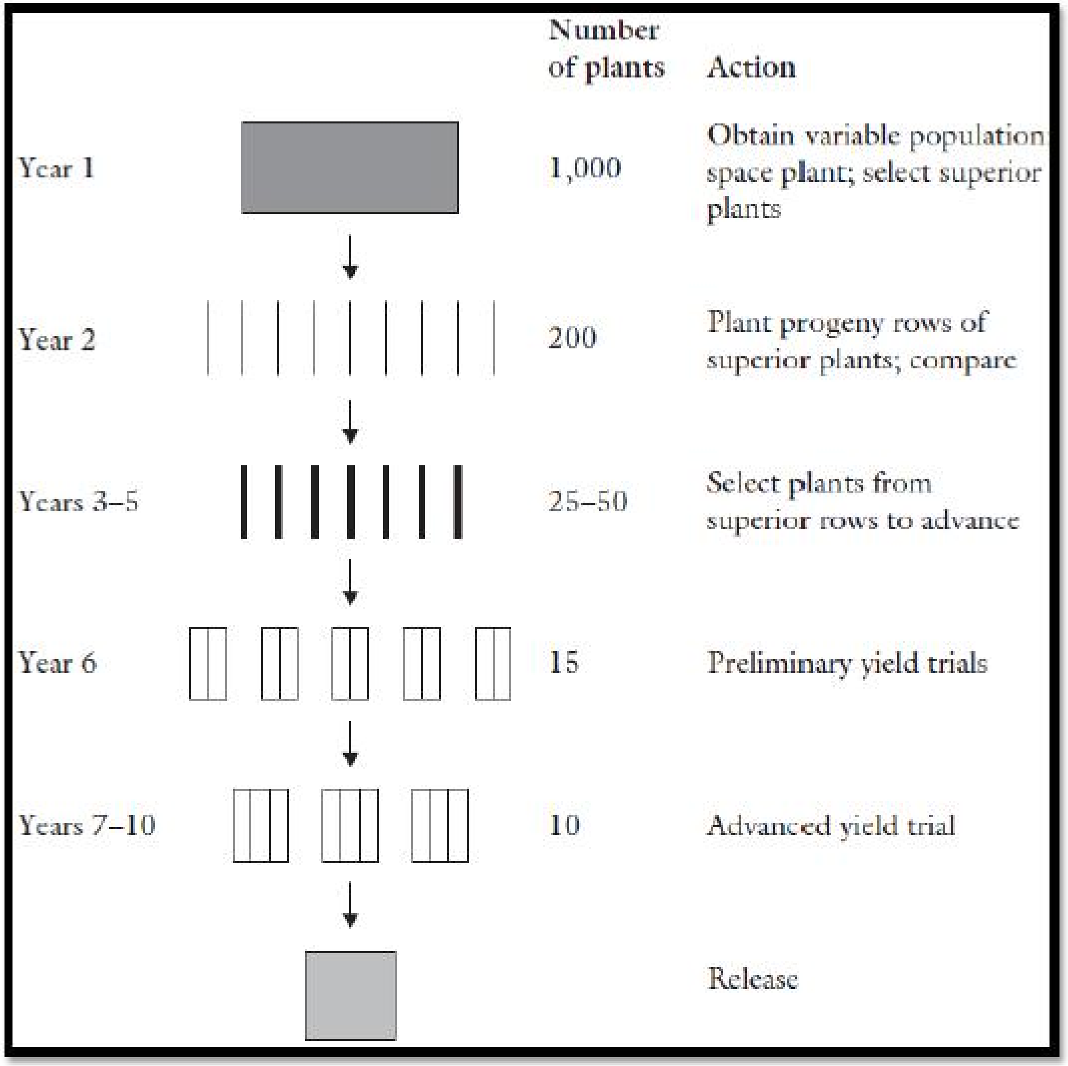
- Phenotypic uniformity is less than in cultivars produced by pure-line selection.

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

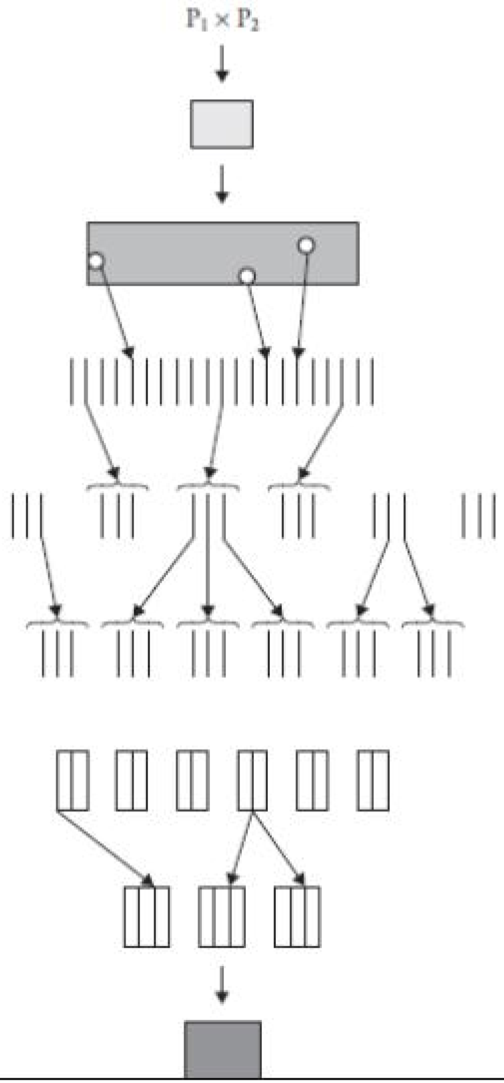
Pedigree selection

- 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



Year	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

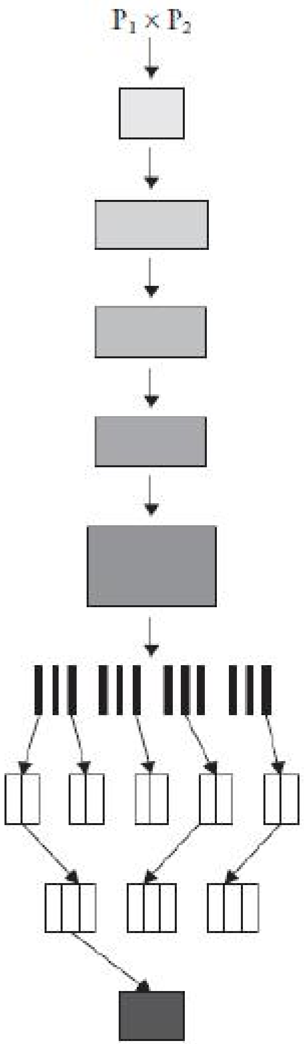
- The bulk method applies pure-line theory to segregating populations to develop pure-line cultivars.

- 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

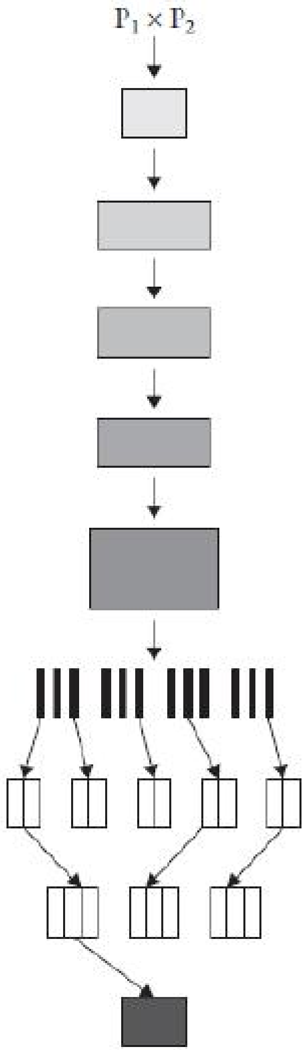
- Environmental changes from season to season so adaptive advantages shift
- Final genotypes may be able to withstand environmental stress, but may not be highest yielding.
- Not useful in selecting plant types at a competitive disadvantage (dwarf types).

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	$P_1 \times P_2$		
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

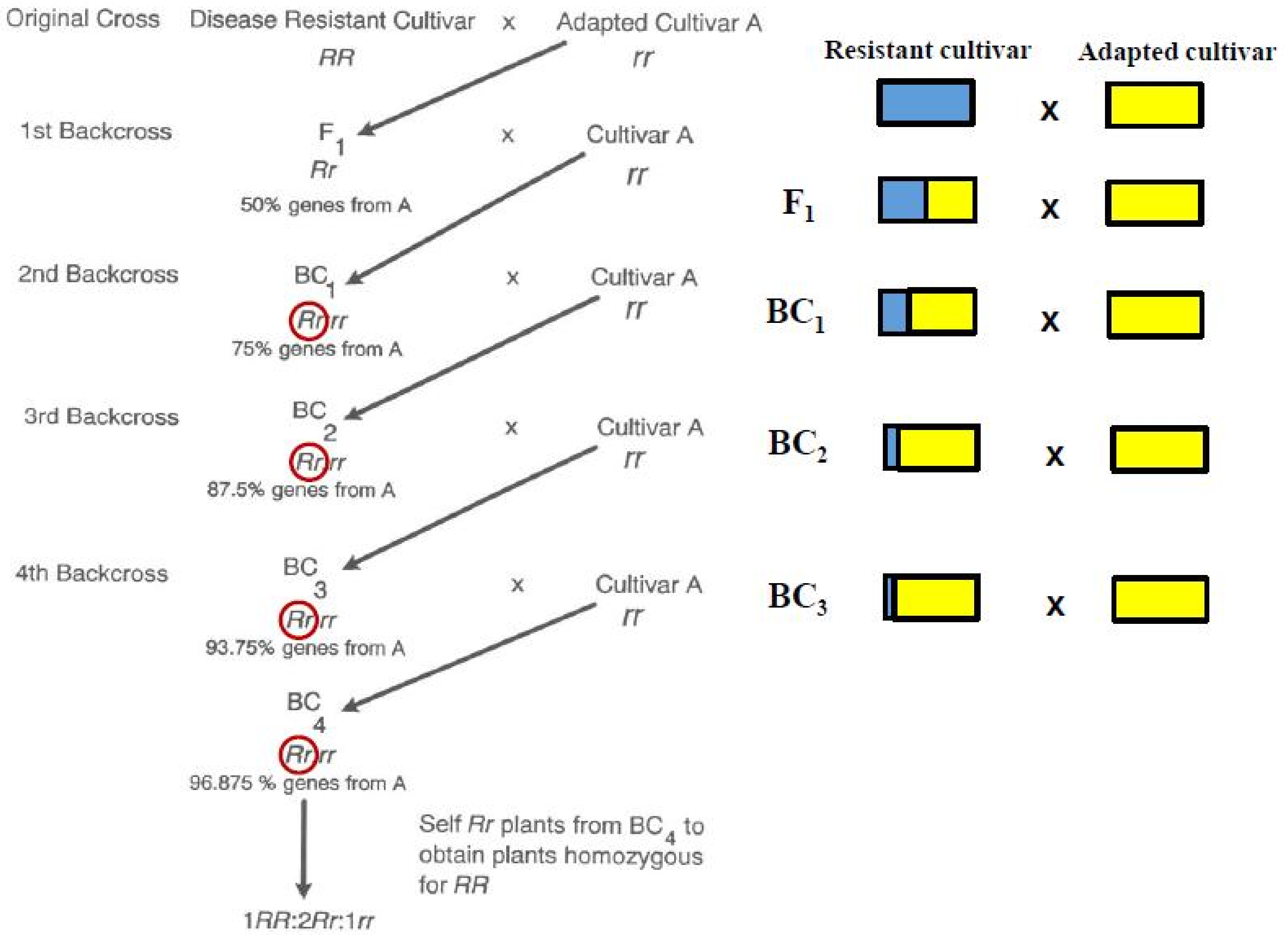
- It is an easy and rapid way to attain homozygosity.
- Small spaces are required in early generations to grow the selections.
- The duration of the breeding program can be reduced by several years by using single seed descent.

Disadvantages

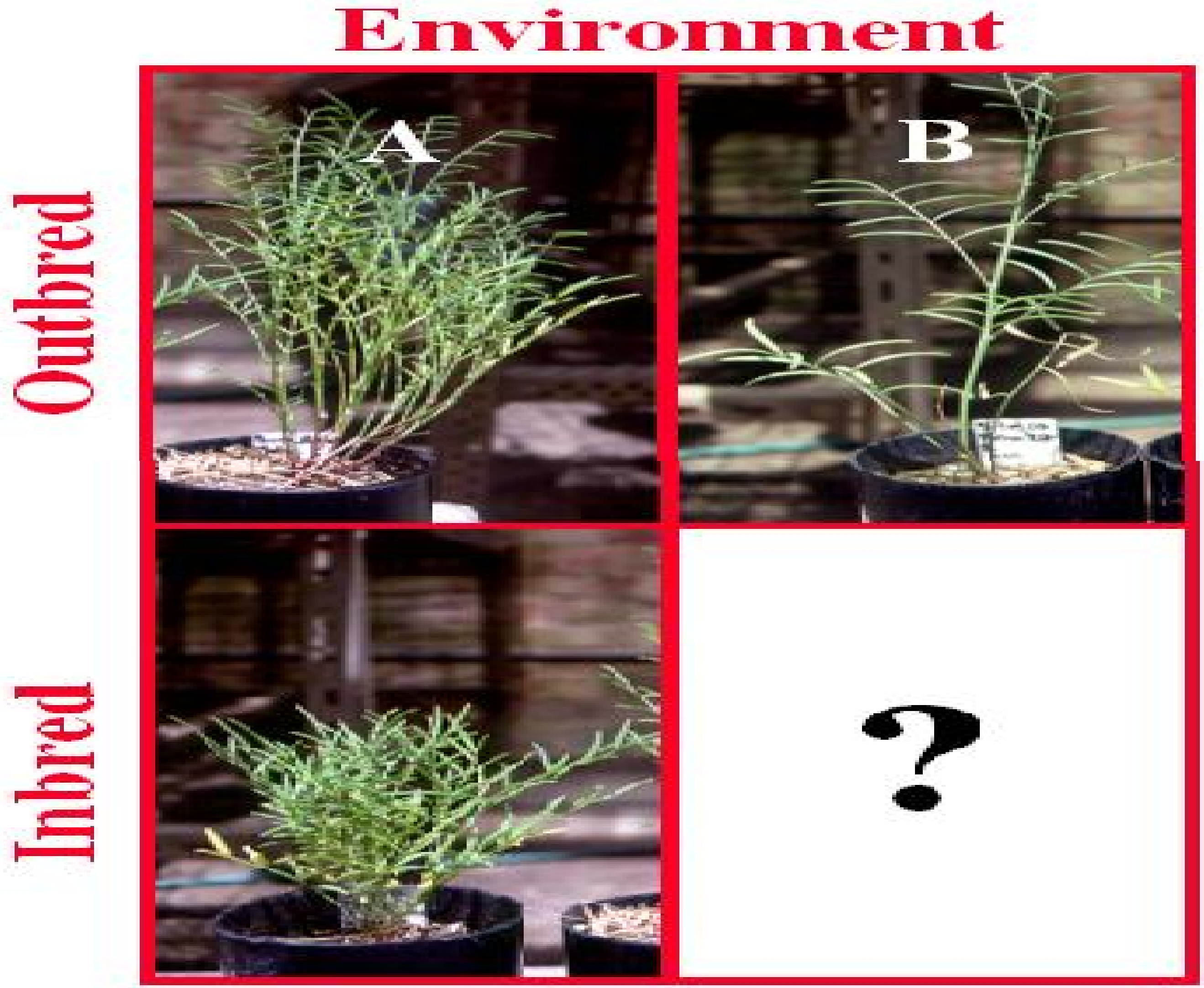
- Natural selection has no effect.
- An inability of seed to germinate or a plant to set seed may prohibit every F_2 plant from being represented in the subsequent population.
- Selecting a single seed per plant runs the risks of losing desirable genes.

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

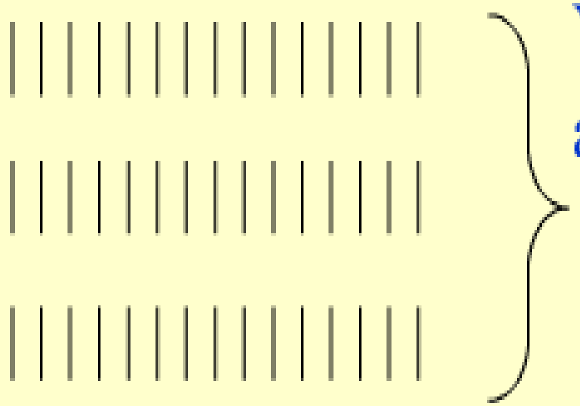
- Mass Selection
  - Same form as with self-pollinated crops
  - essentially a form of maternal selection since no pollination control
    - select desirable plants
    - bulk seed
    - repeat cycle
      - with strict selection breeder will reduce popul. Size
      - slow genetic gain since lack pollination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



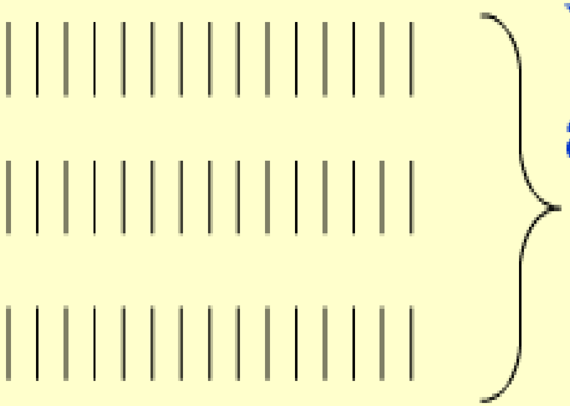
Year 2: Plant in an intercross block and allow intermating to re-establish HWE

- 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)



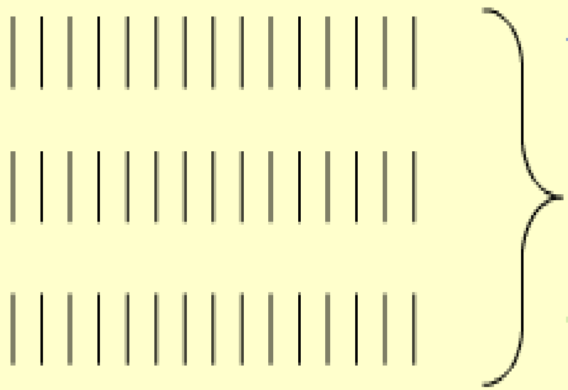
Year 4: Plant in an intercross block and allow intermating to re-establish HWE

- 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