

Mimojaderná dědičnost

Acanthopanax - variegované listy



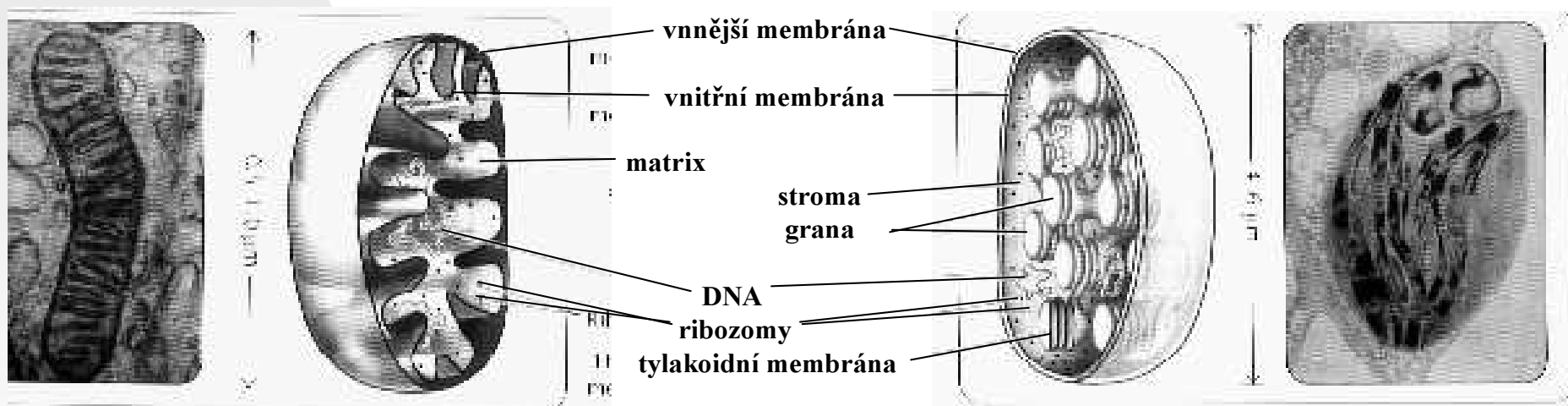
Rozdělení mimojaderné dědičnosti

- organelová dědičnost (cpDNA, mtDNA)
- dědičnost infekčních částic
- (maternální vliv na fenotyp)

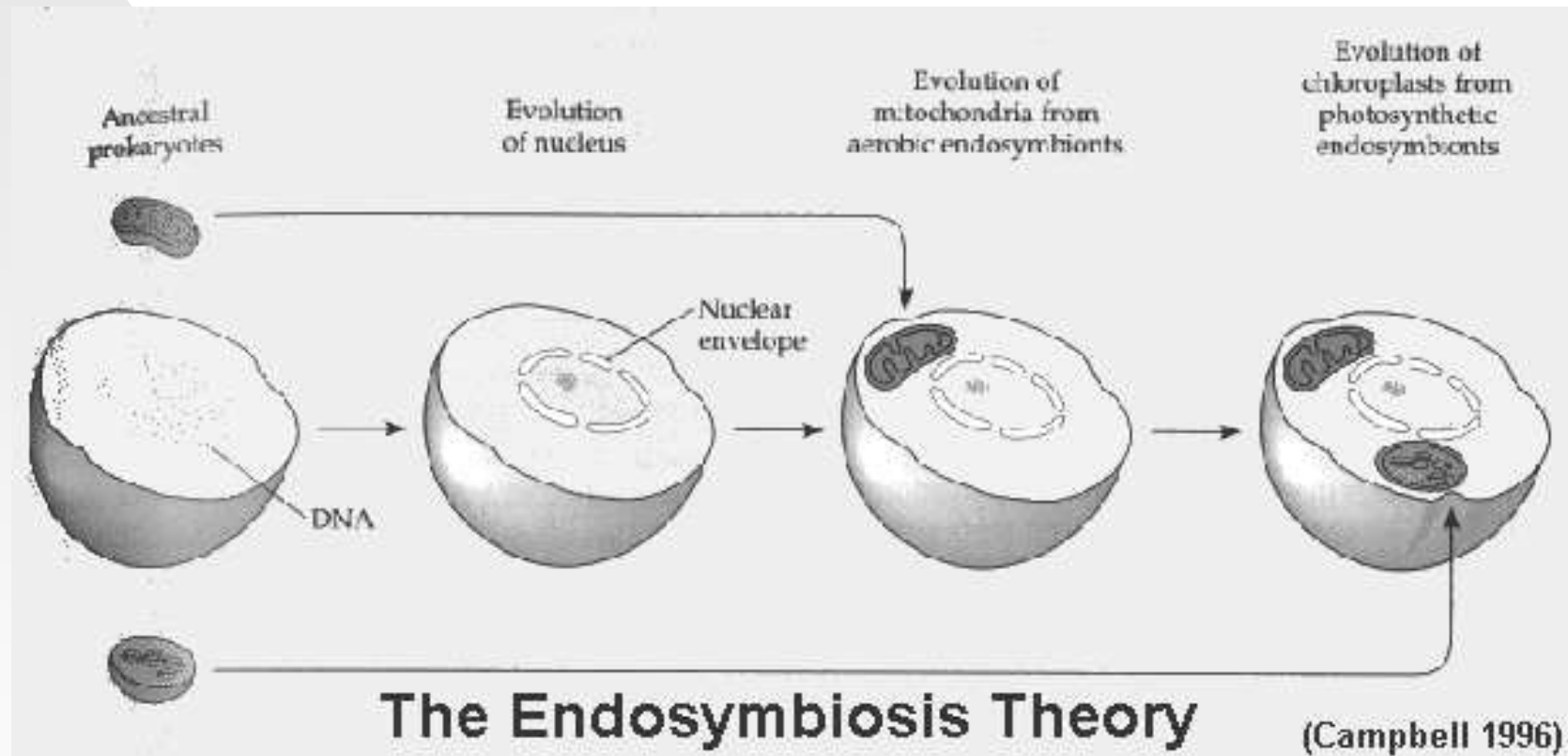
Porovnání struktury mitochondrie a chloroplastu

mitochondrie

chloroplast



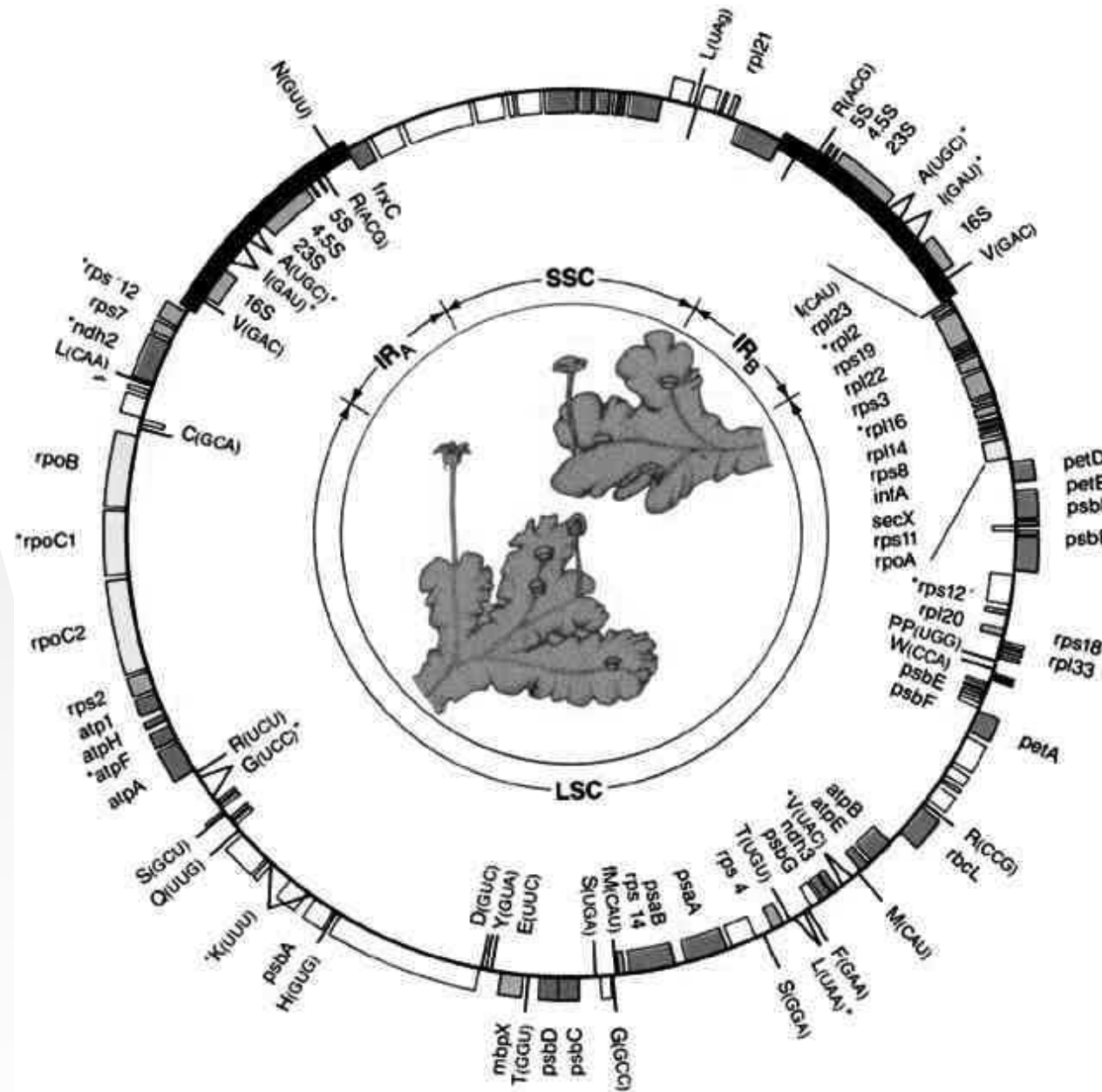
Teorie endosymbiózy: mitochondrie a chloroplasty eukaryotních buněk vznikly z eubakterií



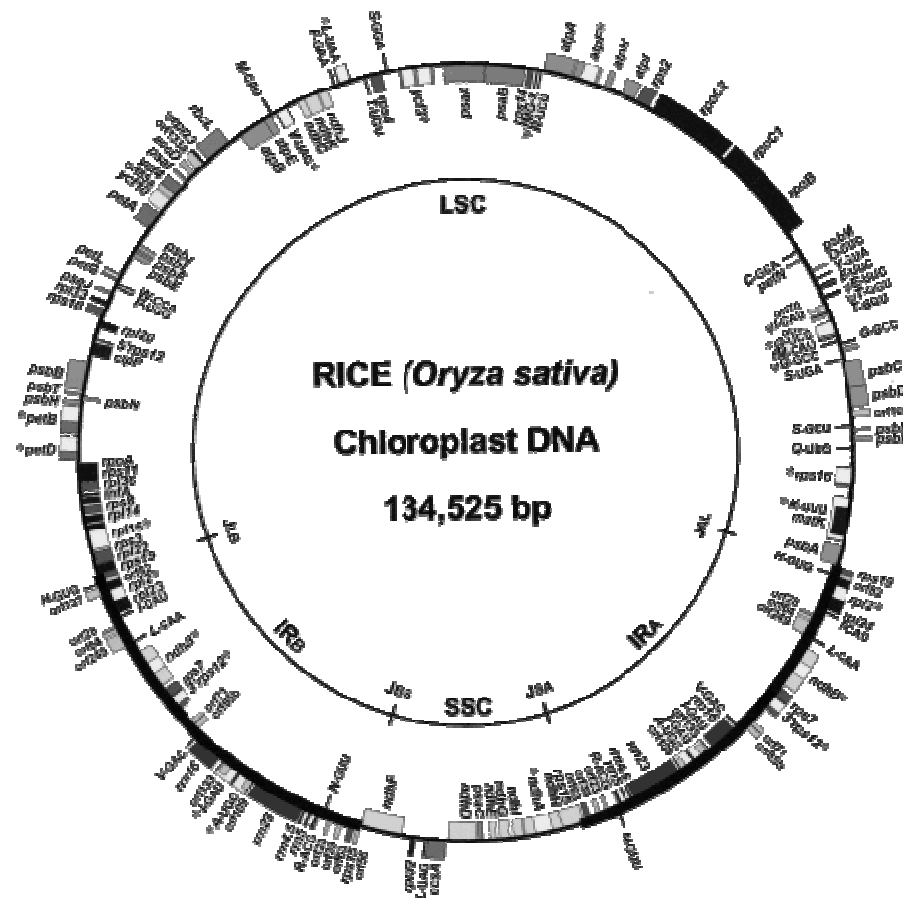
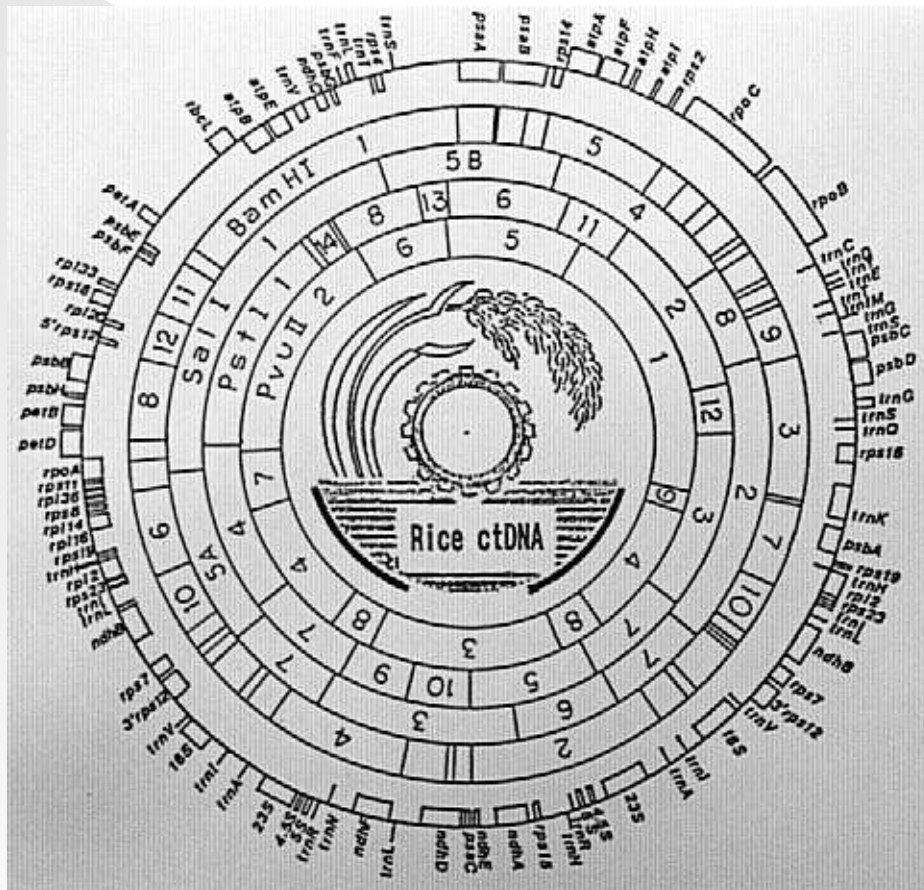
Velikost chloroplastového genomu u některých organismů

Organismus	velikost cpDNA (bp)
<i>Euglena gracilis</i> (krásnoočko)	143.172
<i>Porphyra purpurea</i> (červená řasa)	191.028
<i>Chlorella vulgaris</i> (zelená řasa)	150.613
<i>Marchantia polymorpha</i> (jatrovka)	121.024
<i>Nicotiana tabacum</i> (tabák)	155.939
<i>Zea mays</i> (kukuřice)	140.387
<i>Pinus thunbergii</i> (borovice)	119.707

Chloroplastový genom jatrovky (*Marchantia polymorpha*)



Chloroplastová DNA rýže



Epifagus virginiana



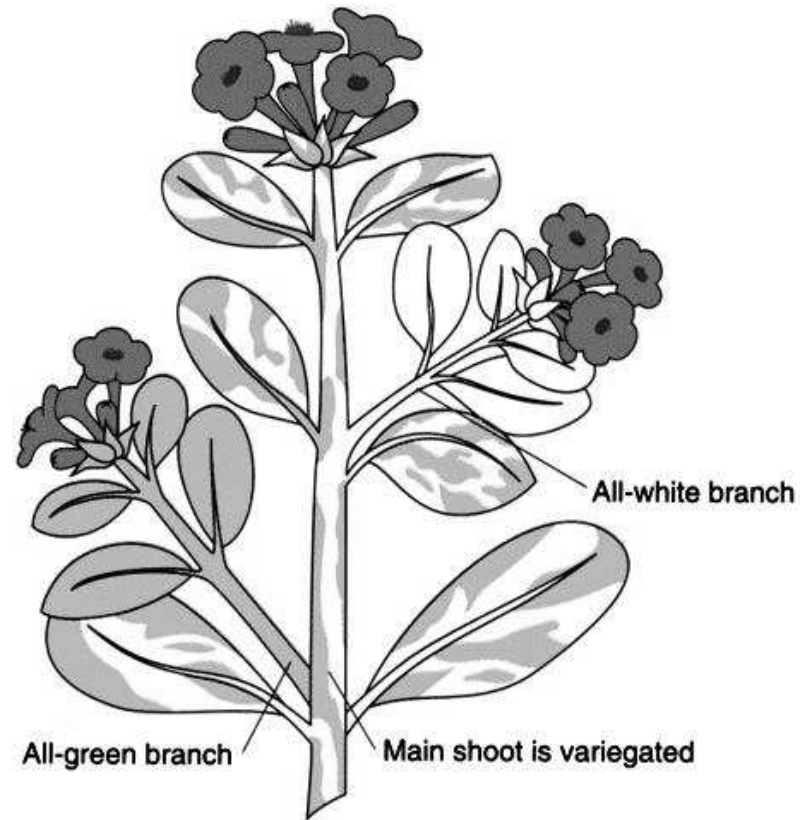
© 2000 Eleanor A. Saulys



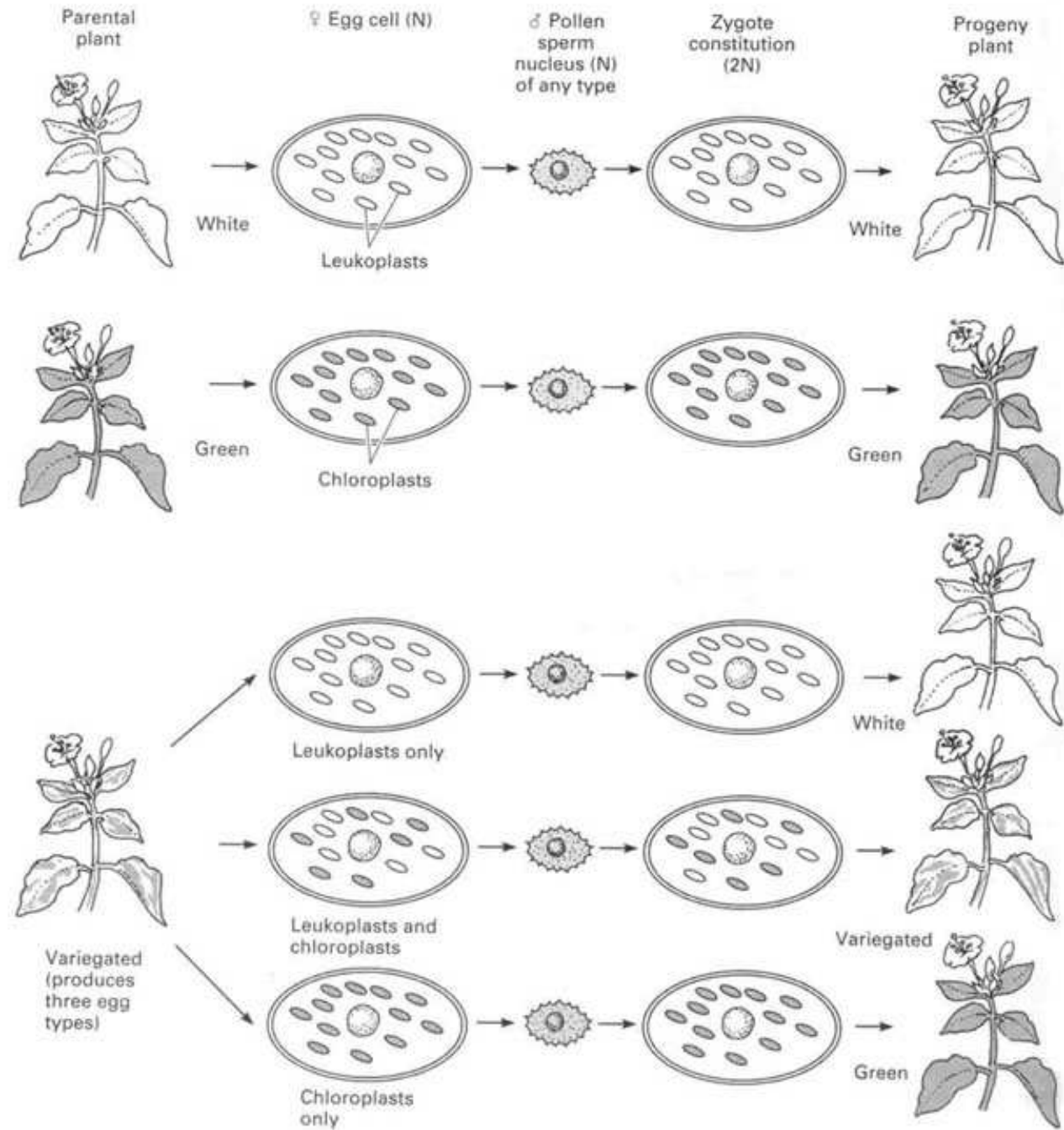
Organelová dědičnost - chloroplasty, cpDNA



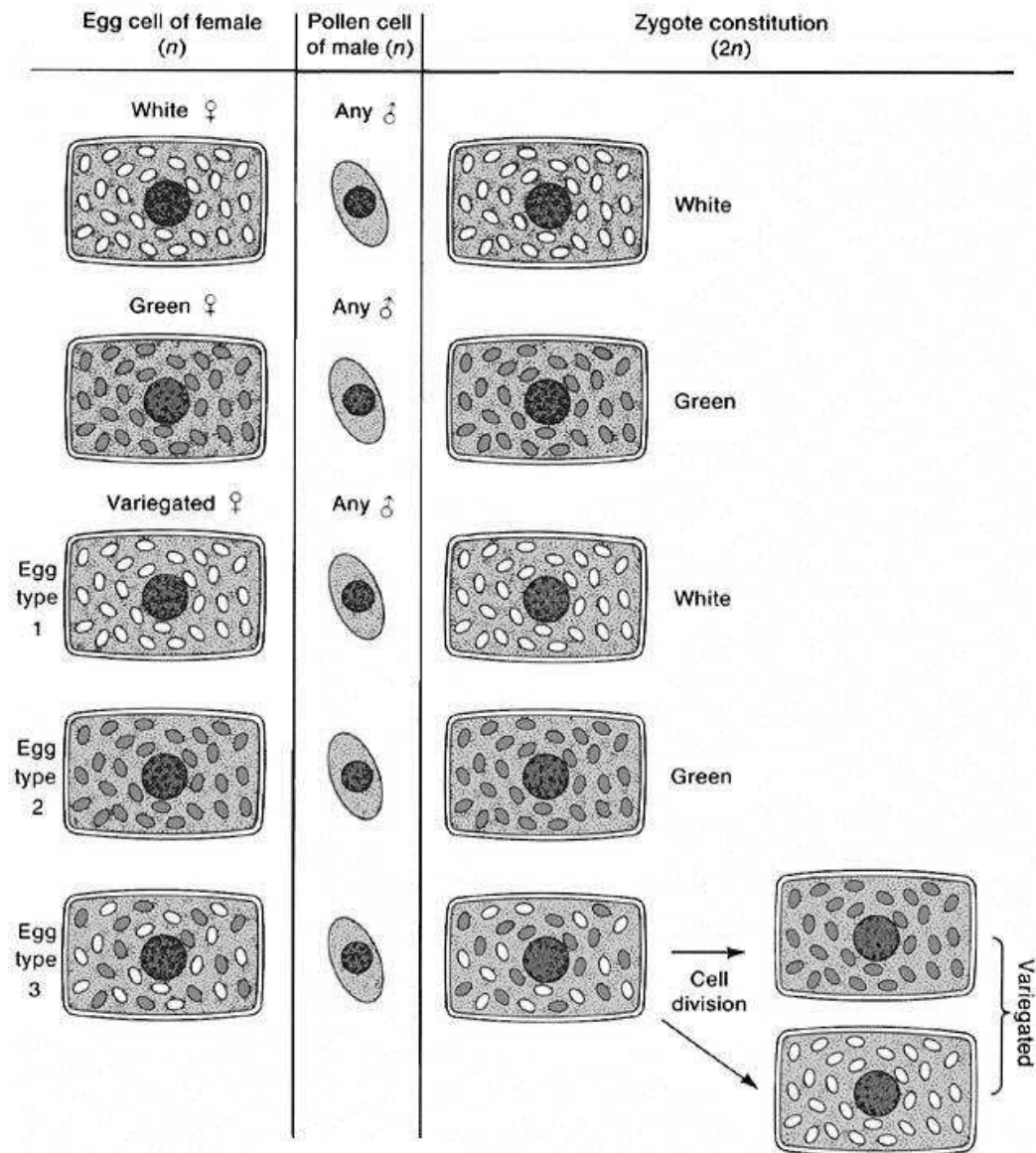
Mirabilis jalapa - nocenka jalapovitá
Carl Correns, 1909



Model for the inheritance of leaf color in the four o'clock, *Mirabilis jalapa*.

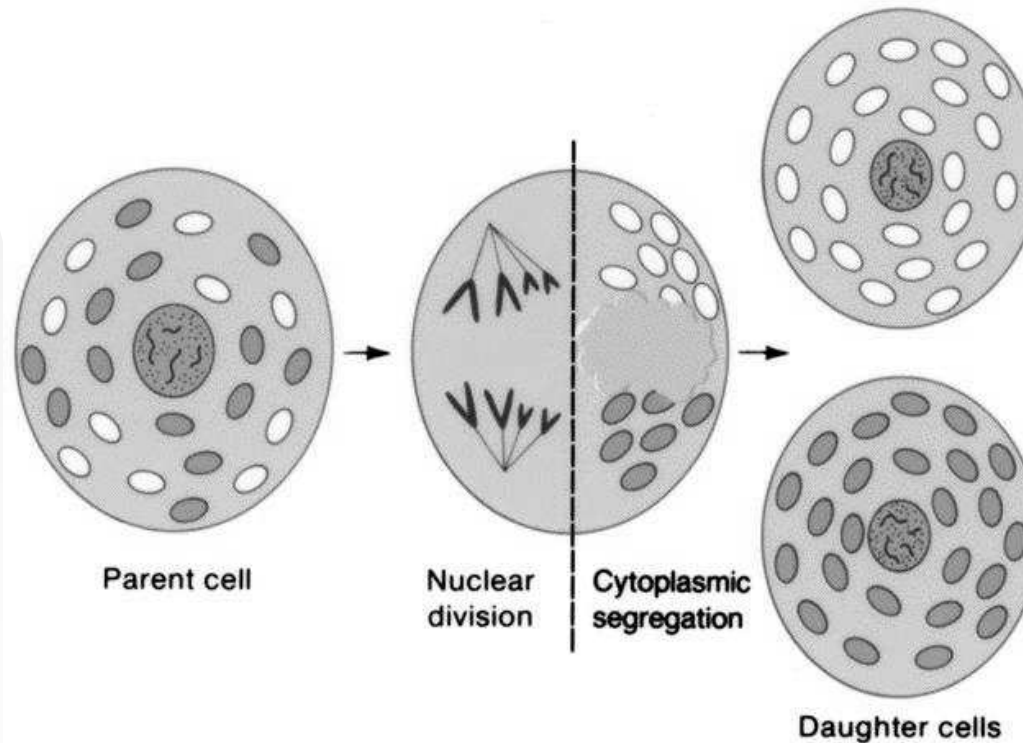


Model objasňující výsledky křížení různě zbarvených výhonů *Mirabilis jalapa*



Model objasňující výsledky křížení různě zbarvených výhonů *Mirabilis jalapa*

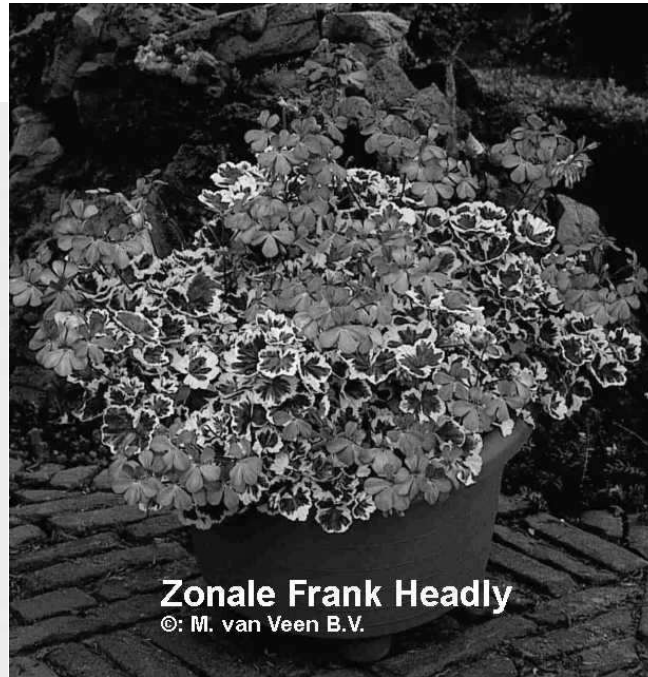
Mitóza buněk s heterogenní směsí
chloroplastových genomů



ERWIN BAUR



Erwin Baur.



Zonale Frank Headly
©: M. van Veen B.V.

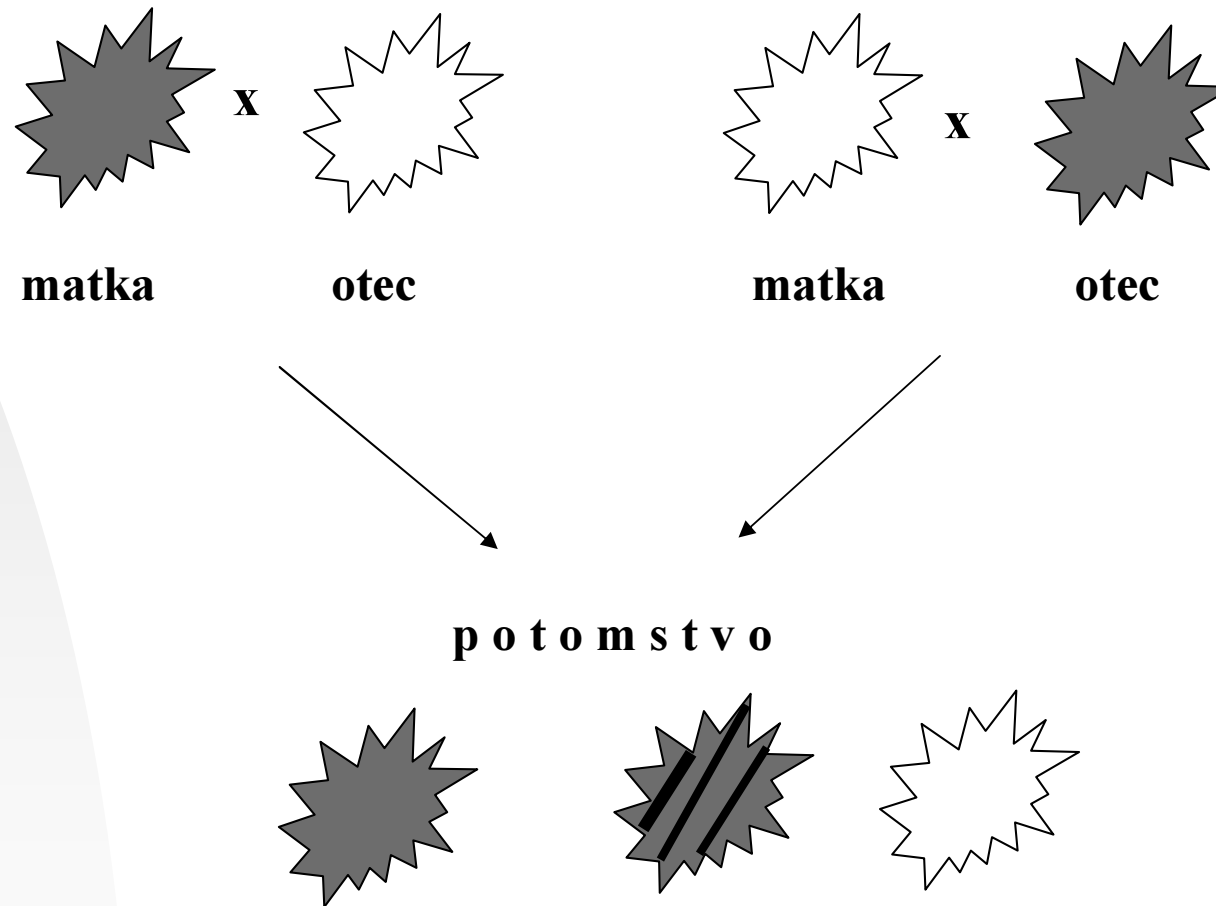


Zonale Melosilver®
©: M. van Veen B.V.

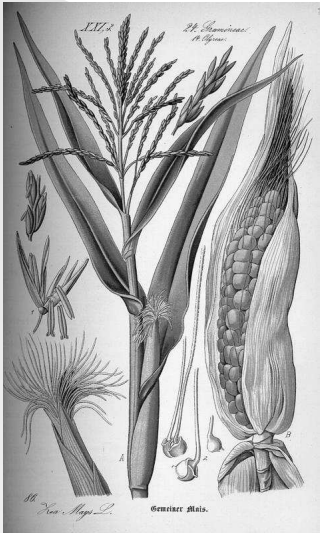


Zonale Occold Shield®
©: M. van Veen B.V.

Křížení *Pelargonium zonale* - biparentální dědičnost



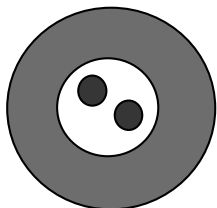
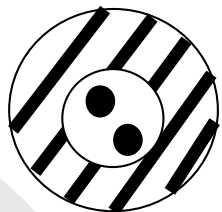
Interakce jaderného a chloroplastového genomu u *Zea mays*



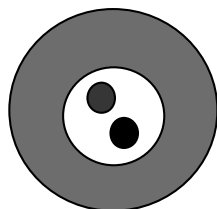
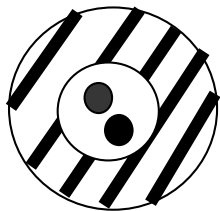
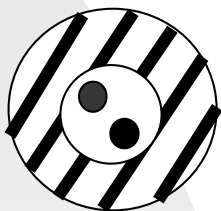
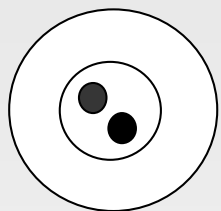
kukuřice iojap s panašovanými listy

matka

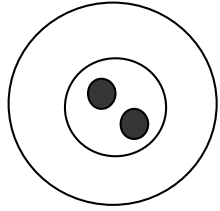
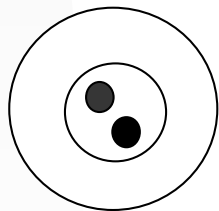
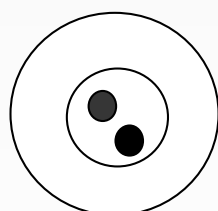
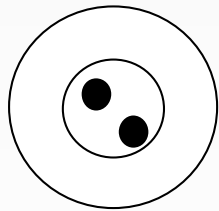
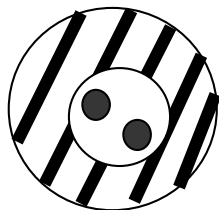
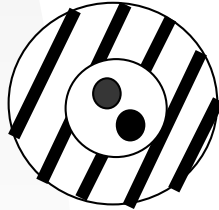
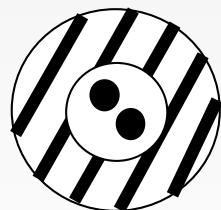
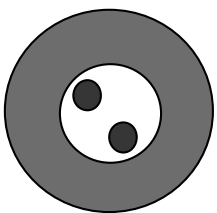
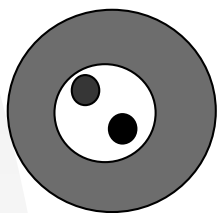
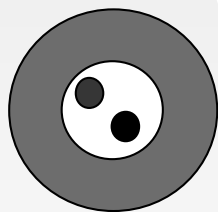
otec



x

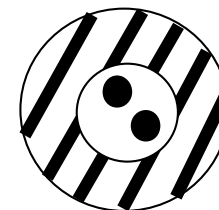
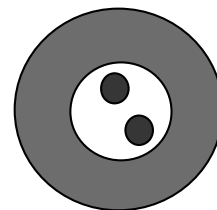


x

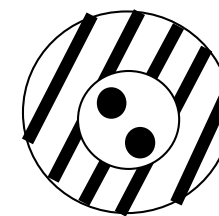
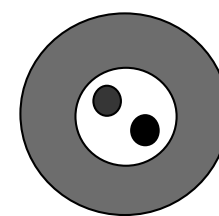
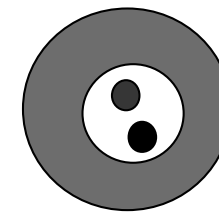
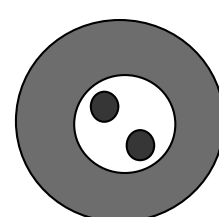
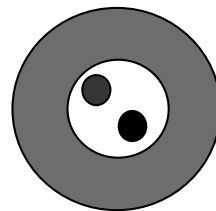


matka

otec

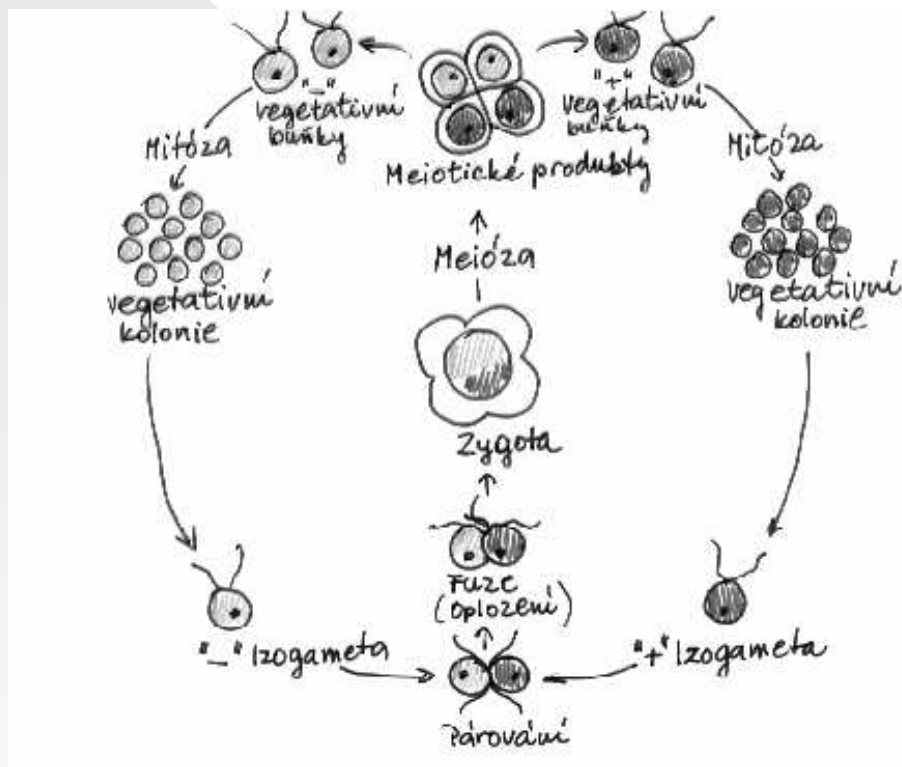


x

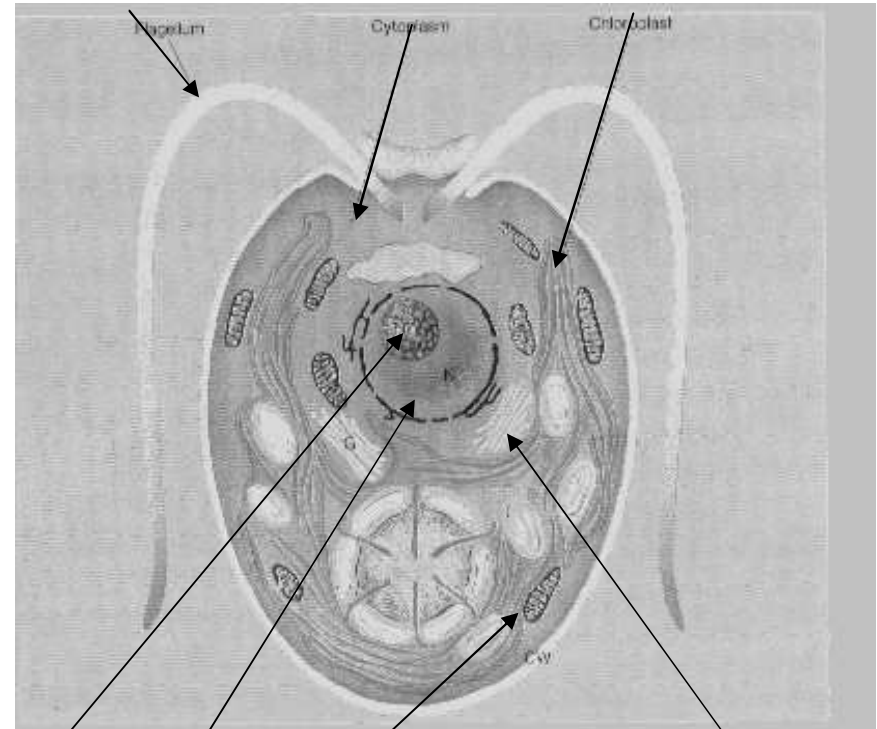


- recesivní alela iojap (*ij*)
- standardní alela (*Ij*)

Chlamydomonas reinhardtii

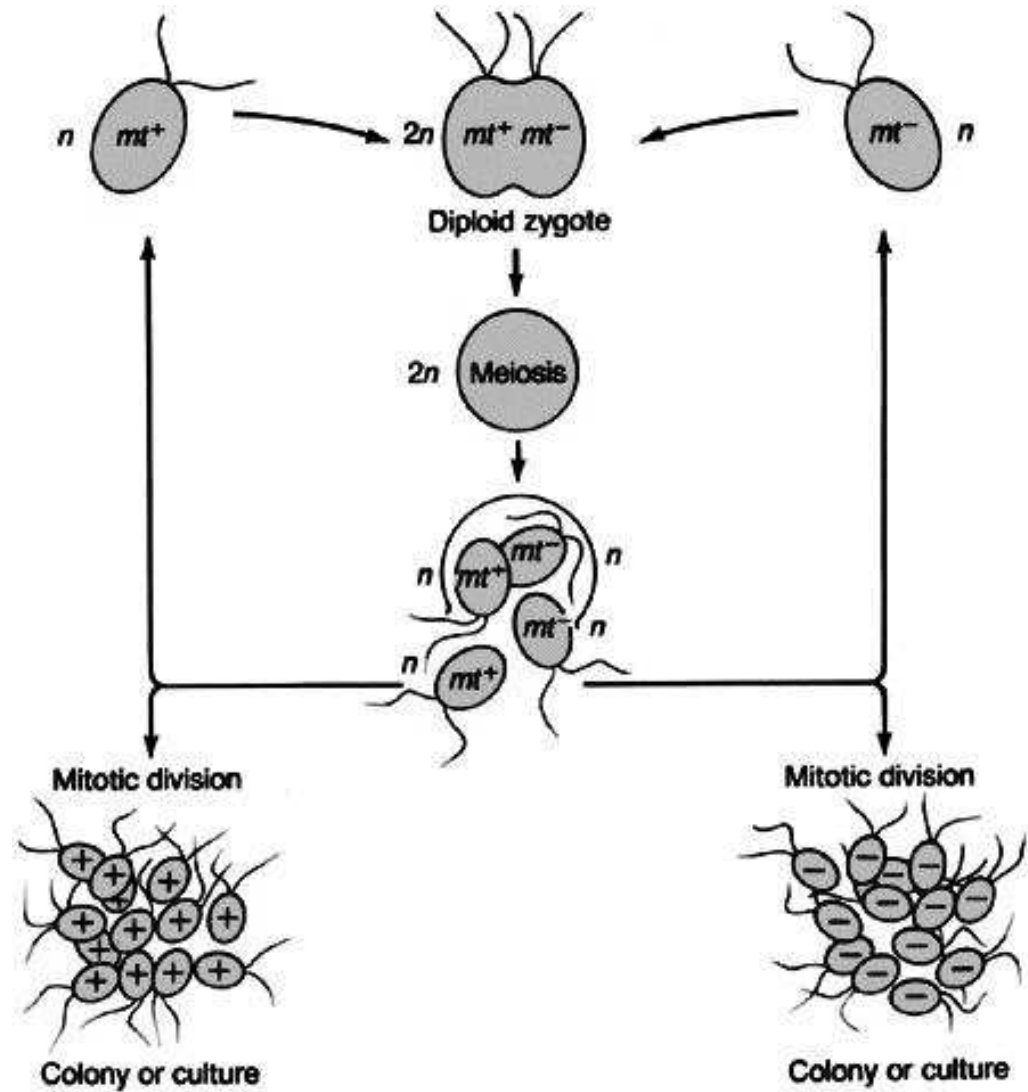
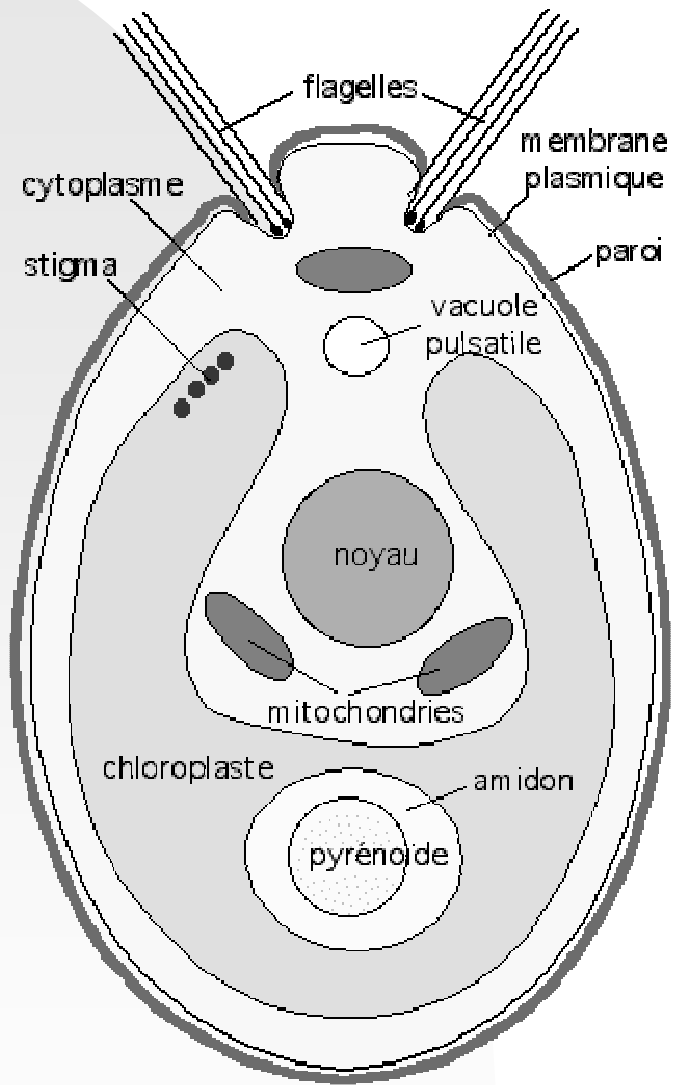


bičiek cytoplazma chloroplast



jadérko jádro mitochondrie Golgiho aparát

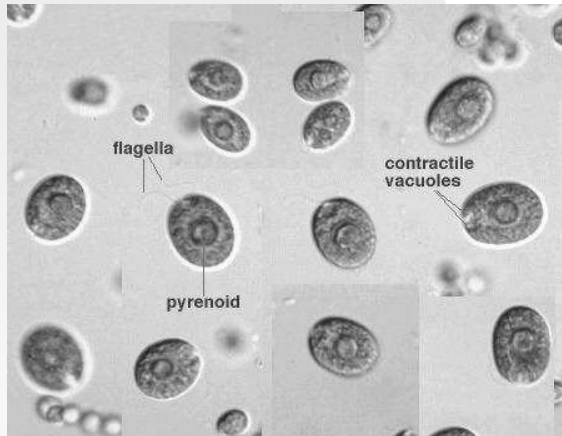
Chlamydomonas reinhardtii



Křížení *Chlamydomonas reinhardtii*

jaderný gen mt^+/mt^- (mating type)

chloroplastový gen str^R/str^S (rezistence resp. senzitivita ke streptomycinu)



$str^R mt^+ \times str^S mt^-$



$str^R mt^+/mt^-$



$1/2 mt^+ : 1/2 mt^-$
všechny str^R

$str^S mt^+ \times str^R mt^-$



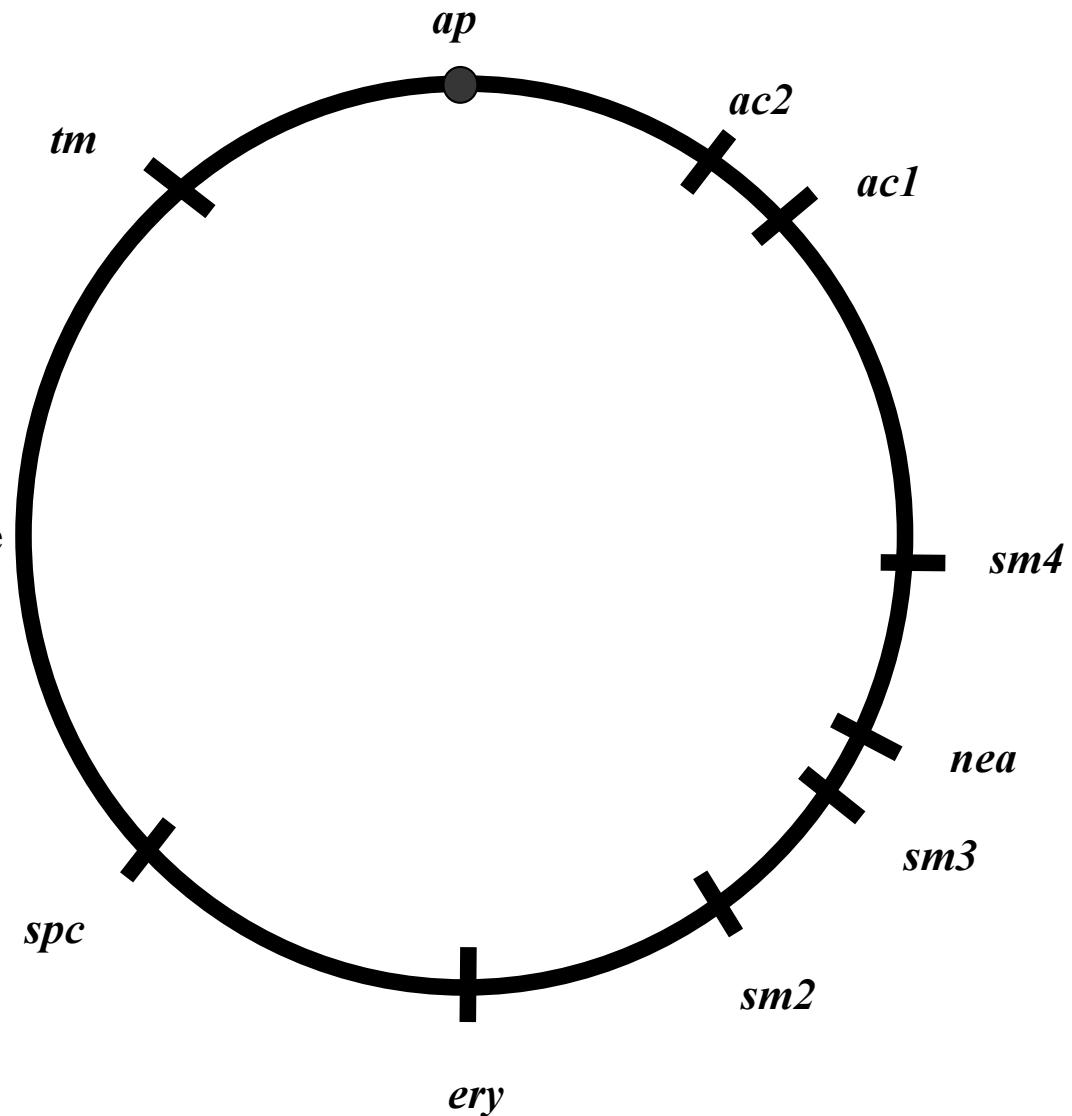
$str^S mt^+/mt^-$



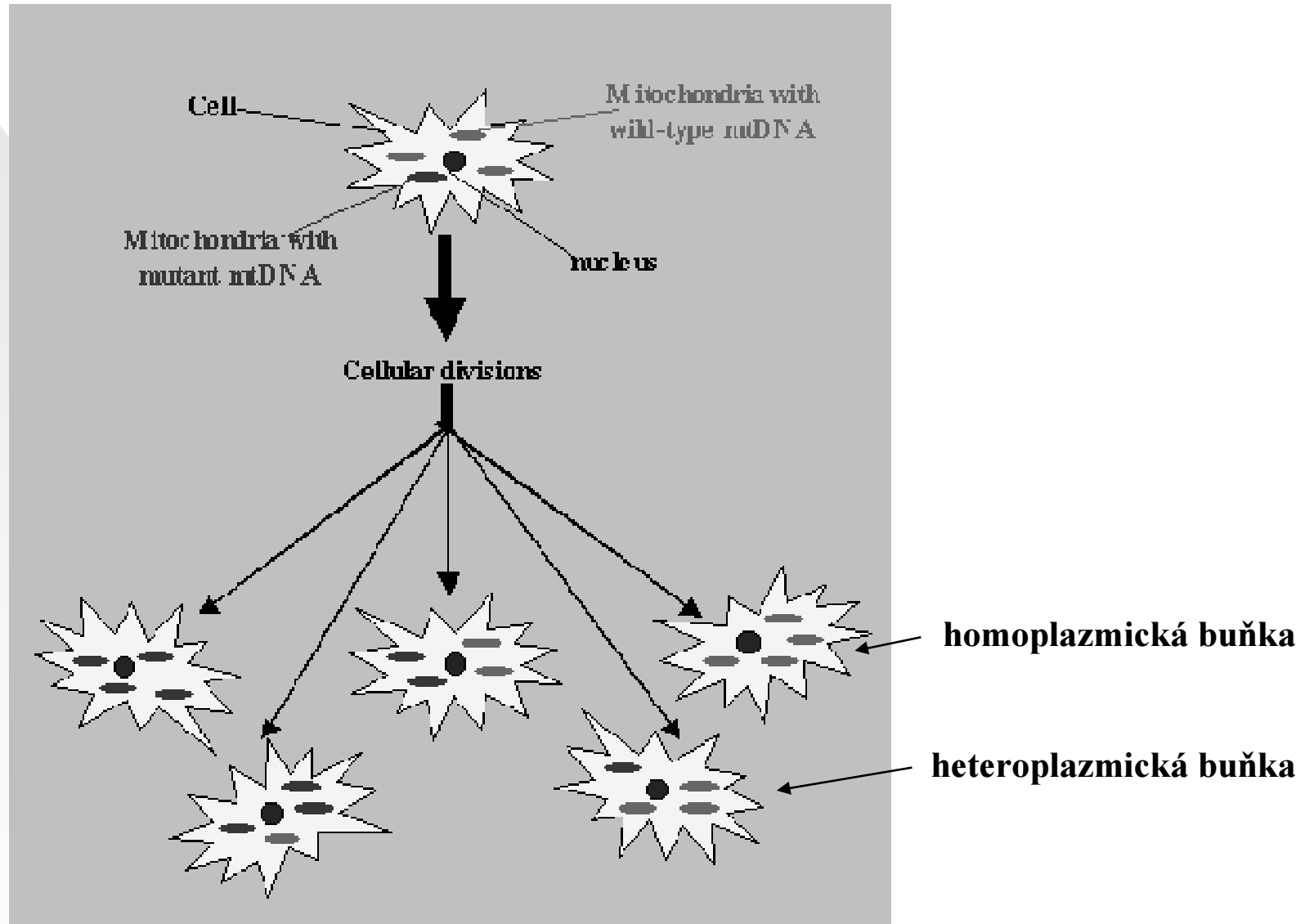
$1/2 mt^+ : 1/2 mt^-$
všechny str^S

Schematické znázornění genetické mapy cpDNA u *Chlamydomonas* (Sager a Ramanis)

ap attachment point
ac1, ac2 vyžaduje octan
sm4 závislost na streptomycinu
nea rezistence k neaminu
sm3, sm2 nízká/vysoká rezistence
ke streptomycinu
ery rezistence k erytromycinu
spc rezistence k spectinomycinu
tm teplotní senzitivita



Heteroplazmie a mitotická segregace



Velikost mitochondriálního genomu u některých organismů

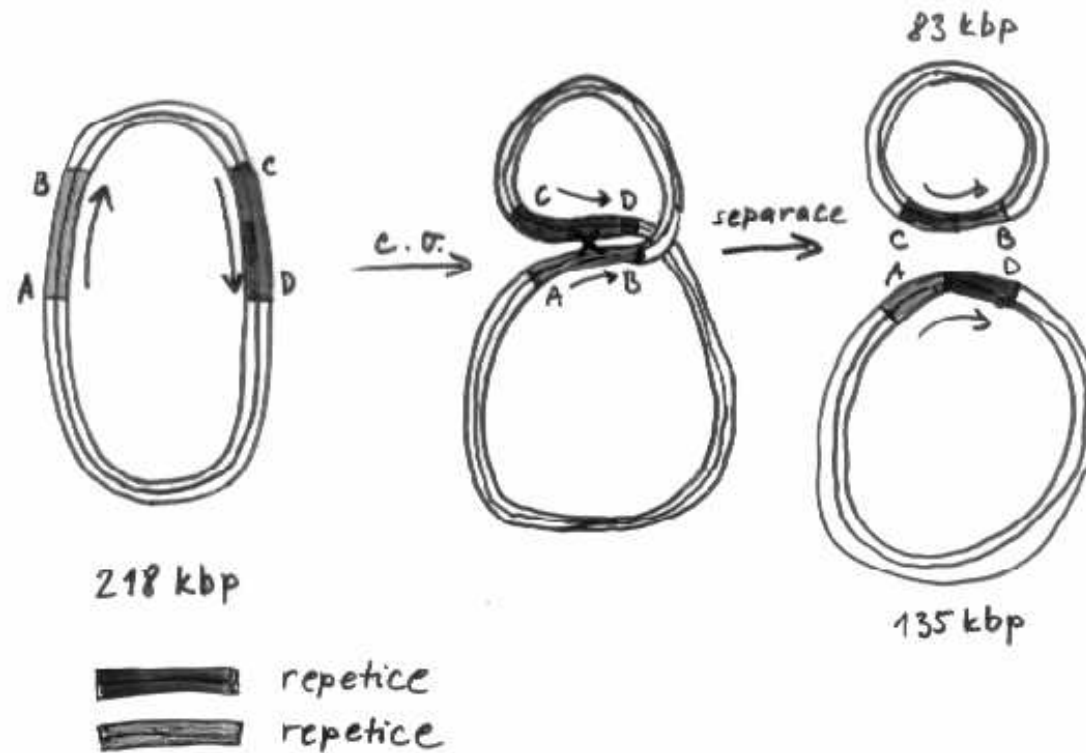
Organismus	velikost mtDNA (bp)
<i>Ascaris summ</i> (hlíst)	14.284
<i>Lumbricus terrestris</i> (červ)	14.998
<i>Chlamydomonas reinhardtii</i> (řasa)	15.758
<i>Xenopus laevis</i> (žába)	17.553
<i>Mus musculus</i> (myš)	16.295
<i>Homo sapiens</i> (člověk)	16.569
<i>Canis familiaris</i> (pes)	16.728
<i>Schizosaccharomyces pombe</i> (houba)	19.431
<i>Drosophila melanogaster</i> (moucha)	19.517
<i>Paramecium aurelia</i> (trepka)	40.469
<i>Saccharomyces cerevisiae</i> (houba)	85.779*
<i>Podospora anserina</i> (houba)	100.314
<i>Arabidopsis thaliana</i> (rostlina)	166.924
<i>Brassica hirta</i> (rostlina)	208.000
<i>Cucumis melo</i> (rostlina)	2.400.000

* variabilní velikost u různých kmenů

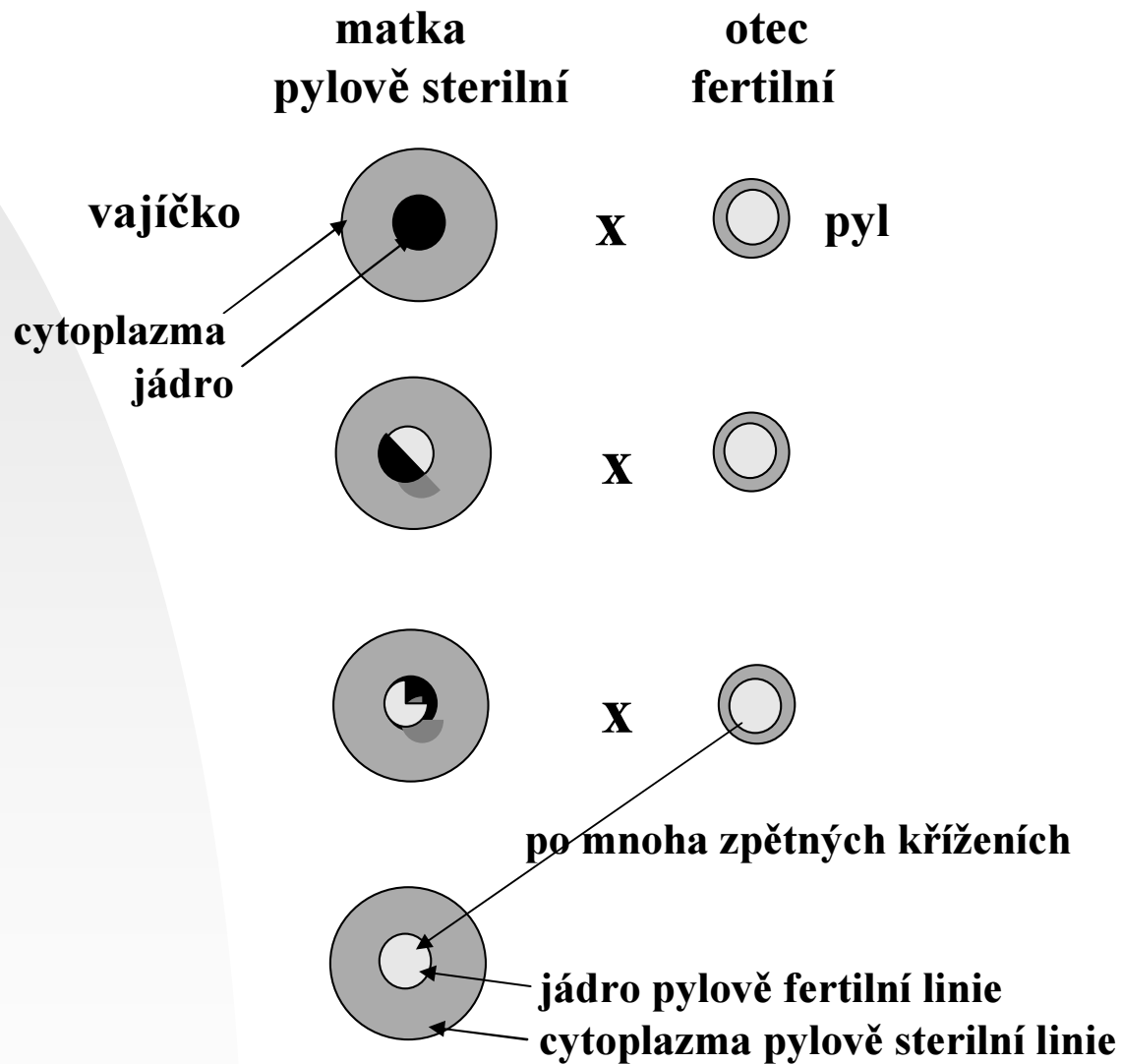
Neuniverzální kodony nalezené v mtDNA

kodon	univerzální kód	mtDNA		
		obratlovci	<i>Drosophila</i>	kvasinka
UGA	Stop	tryptofán	tryptofán	tryptofán
AUA	isoleucin	methionin	methionin	methionin
AGA	arginin	Stop	serin	arginin

***Brassica campestris* - rekombinací mezi přímými repeticemi v mtDNA vznikají molekuly mtDNA o různé velikosti**

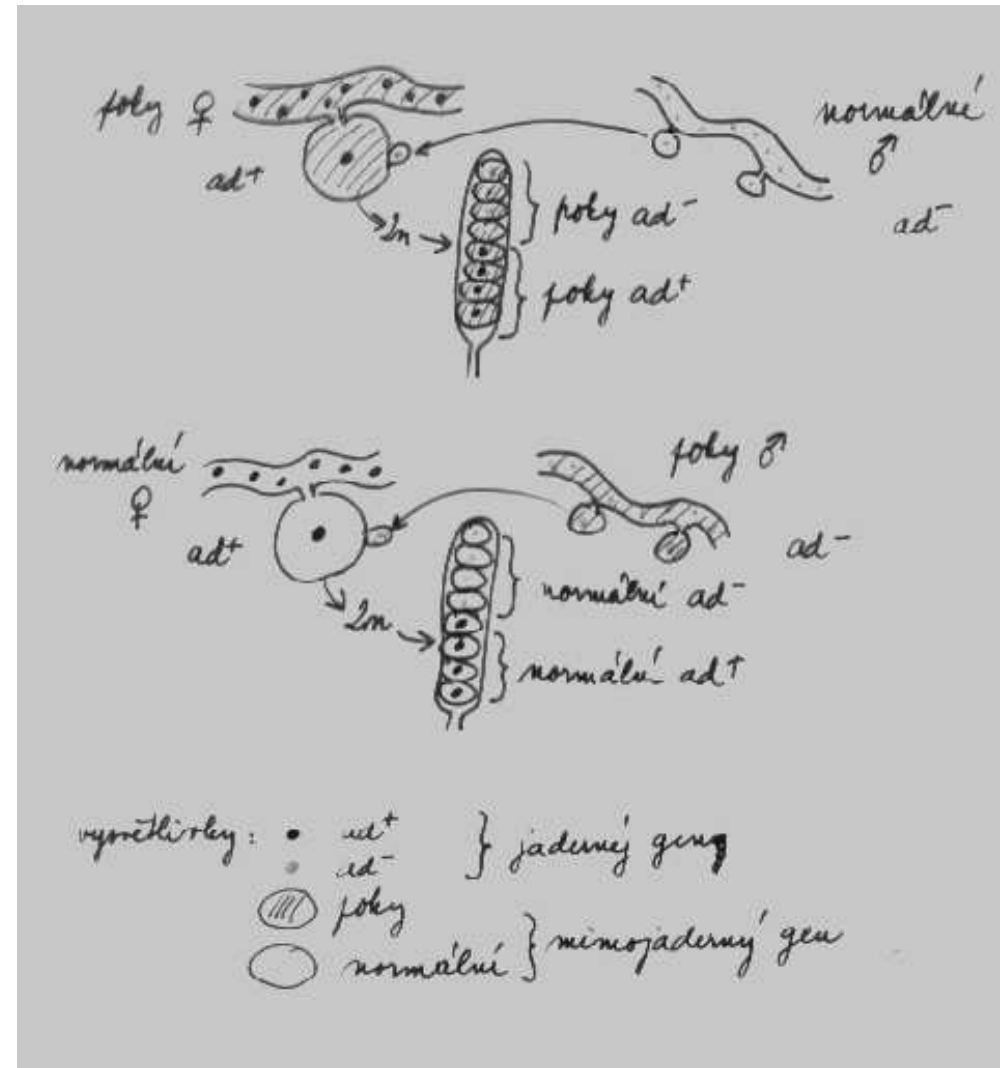
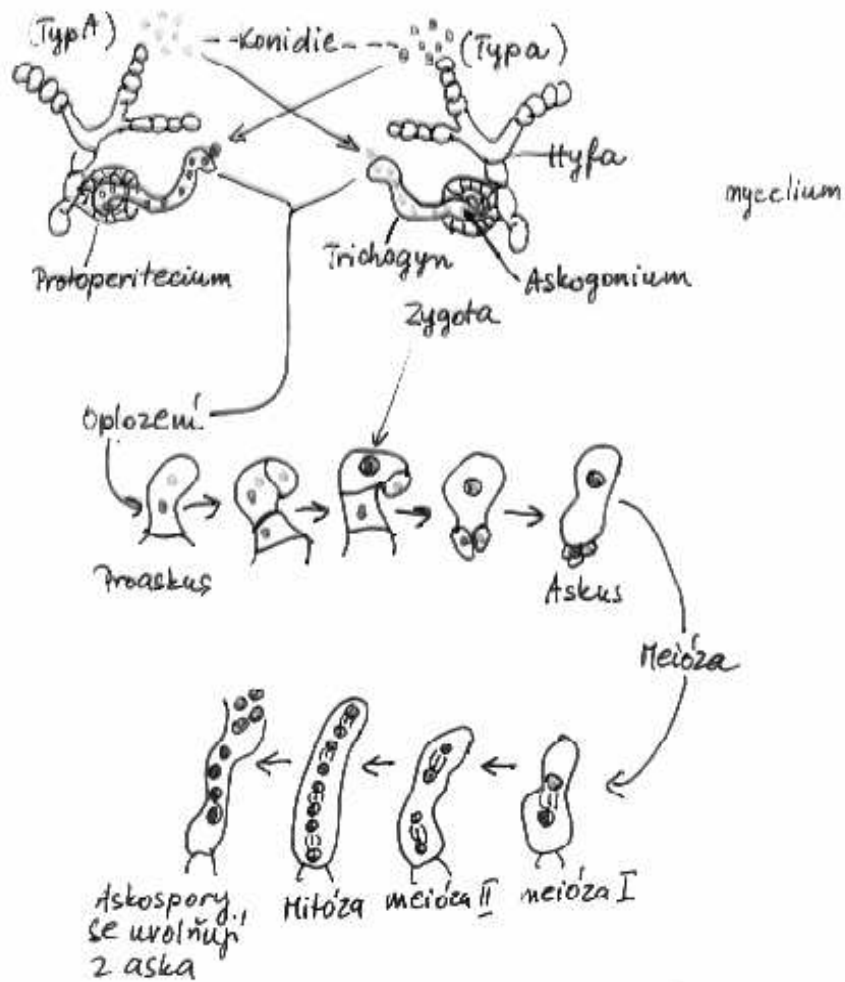


Cytoplazmatická dědičnost samčí sterility u *Zea mays*

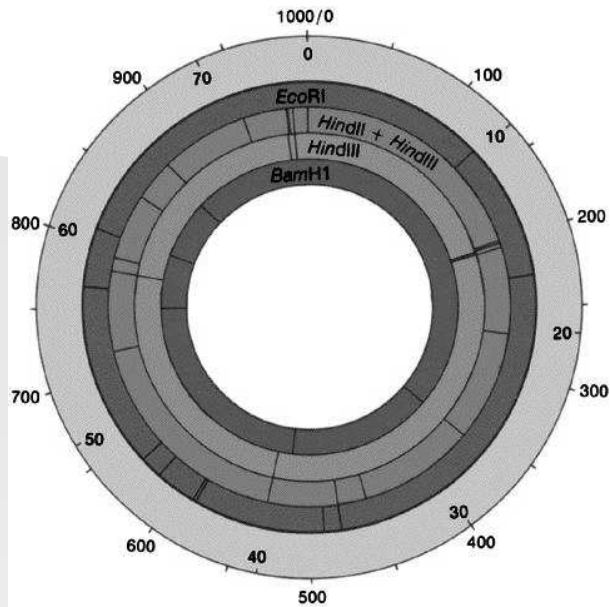


Neurospora crassa

dědičnost mutace „poky“ v mtDNA (*ad*⁺/*ad*⁻ jaderný gen)

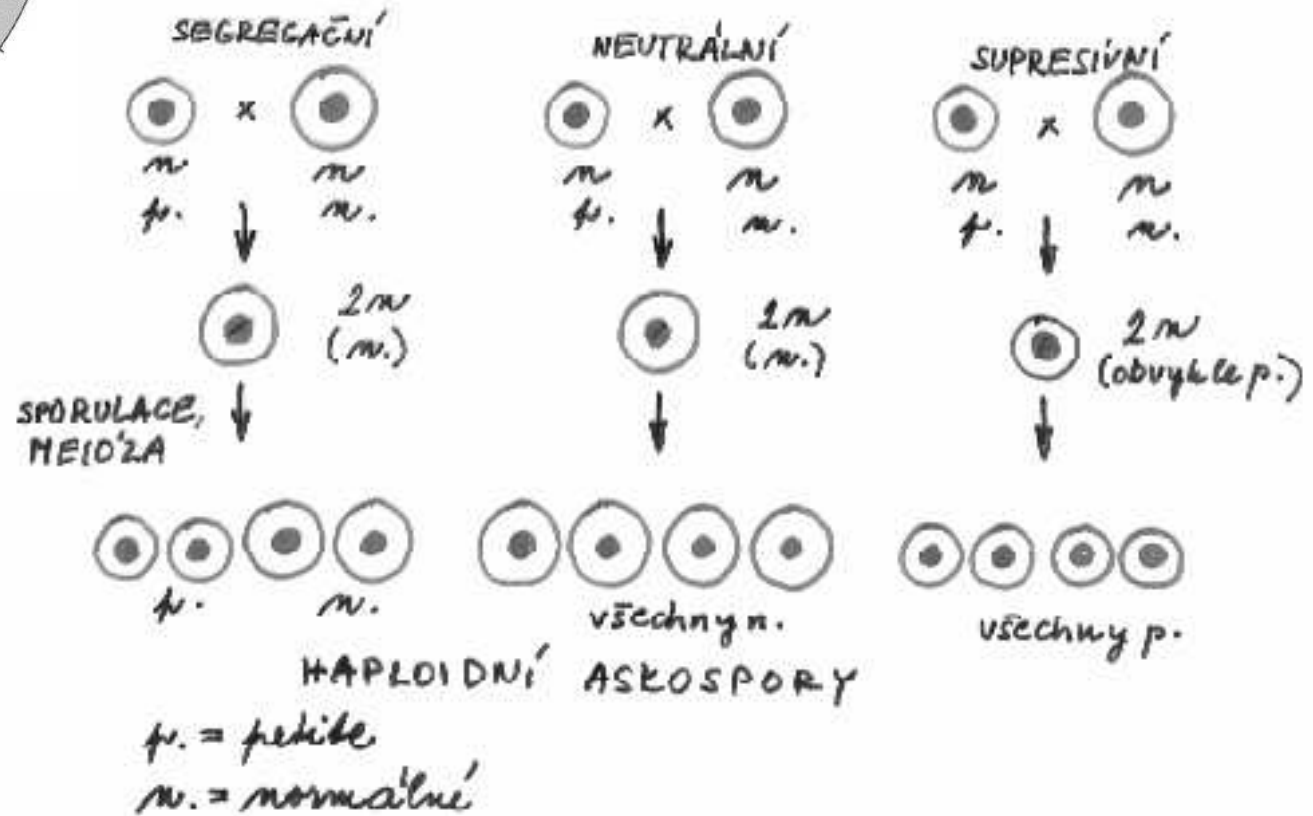


Saccharomyces cerevisiae dědičnost mutace „petite“ v mtDNA (1956 Boris Ephrussi a kol.)



restrikční mapa mtDNA

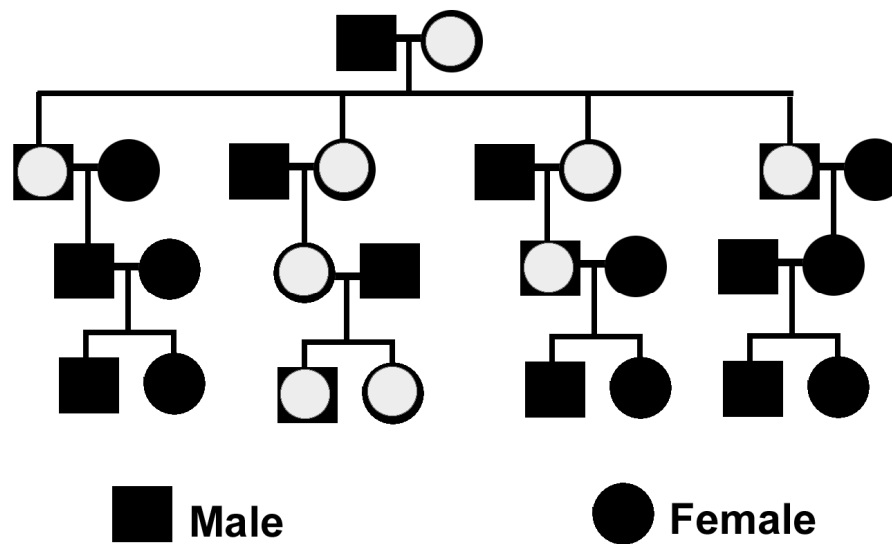
SACCHAROMYCES CEREVISIAE



Srovnání jaderného a mitochondriálního genomu člověka

	jaderný	mitochondriální
Velikost	3 000 Mb	16,6 kb
Počet různých molekul DNA (chromozomů)	23 ženy, 24 muži	1
Struktura DNA	lineární	kružnicovitá
Asociované proteiny	různé histony i nehistonové povahy	většinou bez proteinů
Počet genů	asi 30 000	37
Hustota genů na chrom.	1/40 kb	1/0,45 kb
Repetitivní DNA	velké množství	velmi málo
Introny	u většiny genů nalezeny	nevyskytují se
% kódující DNA	asi 3%	asi 93%
Rekombinace	častá v meióze	žádná
Dědičnost	mendelovská resp. paternální	maternální

Rodokmen s mitochondriální dědičností



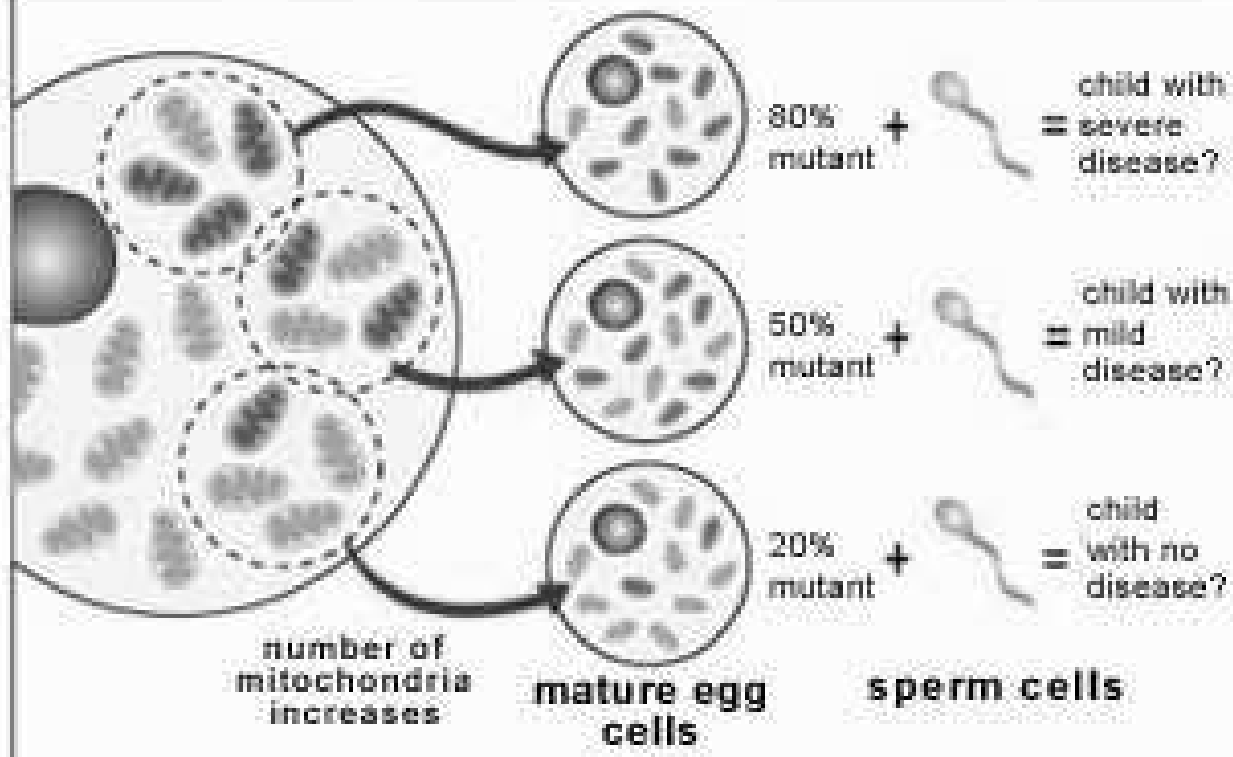
MATERNAL INHERITANCE OF MITOCHONDRIAL DNA MUTATIONS

mother with mild
or no symptoms

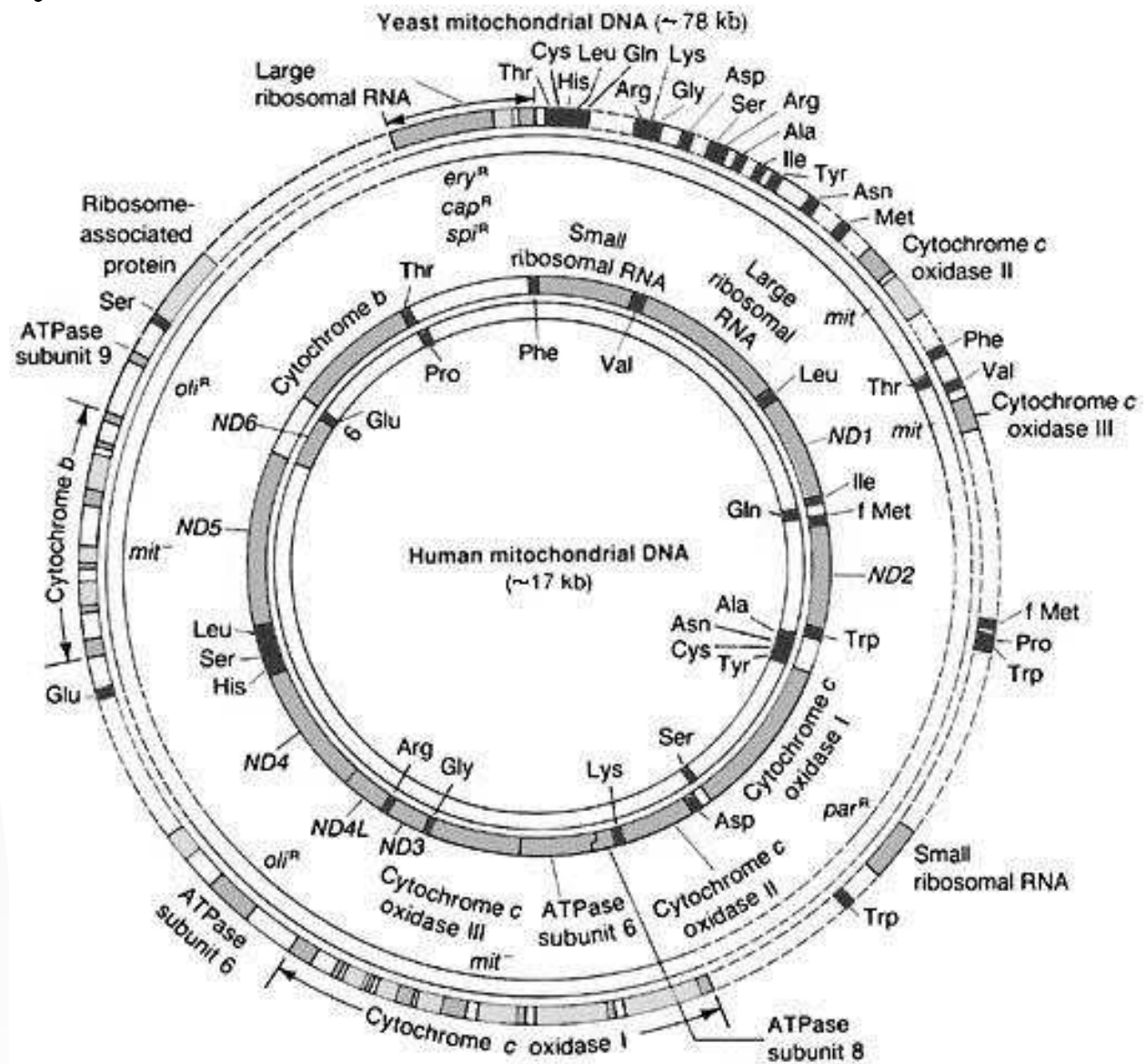
contribution
from mother

contribution
from father

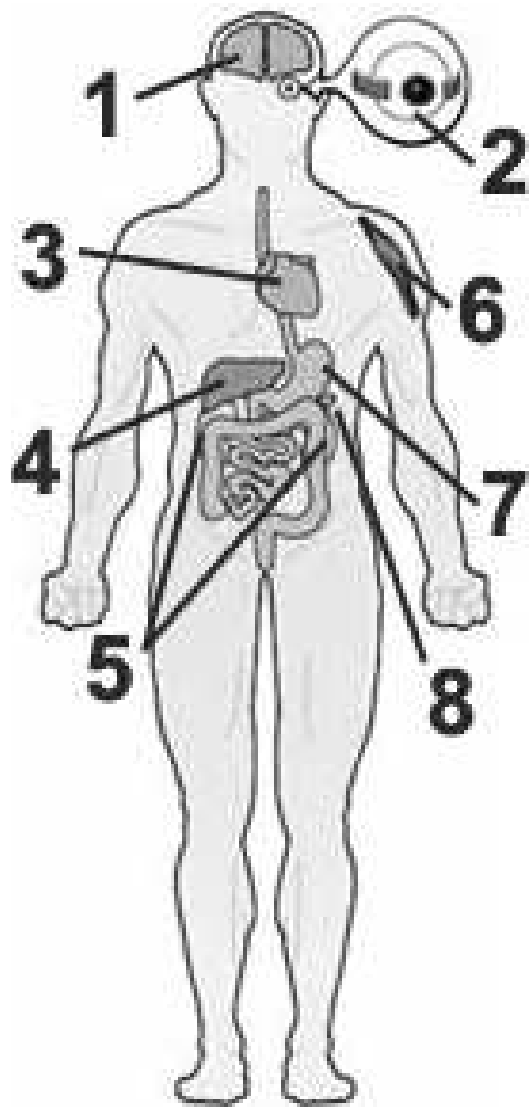
possible
outcome



mt DNA kvasinky a člověka



Orgány postižené mitochondriálními chorobami



1 nervový systém

2 oči

3 srdce

4 játra

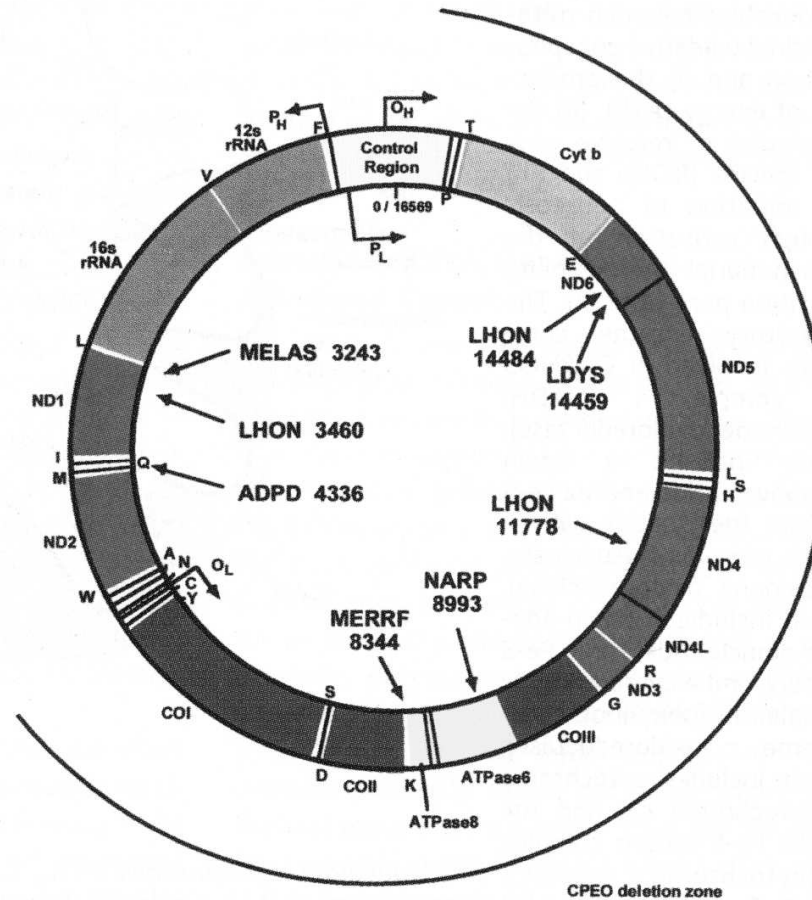
5 ledviny

6 kosterní svalstvo

7 zažívací trakt

8 slinivka

Lokalizace mitochondriálních chorob na mtDNA



Příklady mitochondriálních chorob

LHON - Leber's hereditary optic neuropathy

KSS - Kearns - Sayre sndrome

MERRF - myoclonic epilepsy associated with ragged red fibres

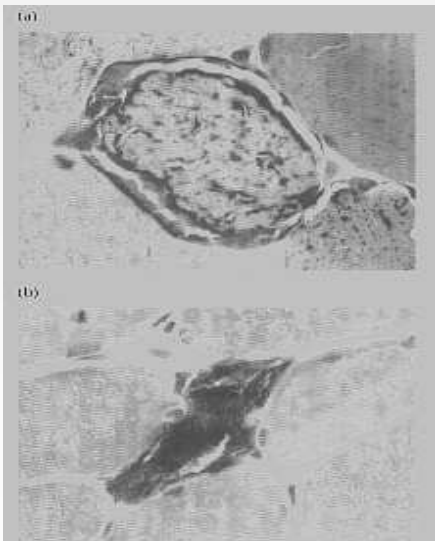
MELAS - mitochondrial encephalopathy with lactic acidosis sndrome

Pearson marrow - pancreas syndrome

PEO - progressive external ophthalmoplegia

MILS - maternally inherited Leigh's sndrome

MDS - mitochondrial DNA depletion sndrome



Buňky kosterního svalstva

nahoře - normální

dole - u pacienta s MERRF

Family Tree DNA

certifies that a mitochondrial DNA (mtDNA) sample taken from:

Richard Steadham

differs from the Cambridge Reference Sequence (CRS) at the numbered positions indicated, by presence of the base designated A, C, G or T:

16224C 16311C

The letters designate the base--adenine, cytosine, guanine or thymine--that occurs at each of those positions in place of the one shown in the 400-base portion of the CRS printed below. These are distinctive characteristics of this sample that can be compared to those of other people to confirm or rule out descent from a common ancestor, thereby providing genetic evidence regarding genealogical relationships.

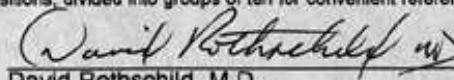
10	20	30	40	50	60	70	80	90	100
ATTCTAATTT	AAACTATTCT	CTGTTCTTTC	ATGGGGAAGC	AGATTGGGGT	ACCACCCAAG	TATTGACTCA	CCCATCAACA	ACCGTATGT	ATTTCGTACA
TACTGCCAG	CCACCATGAA	TATTGTACGG	TACCATAAAT	ACTTGACCAC	CTGTAGTACA	TAAAAACCGA	ATCCACATCA	AAACCCCTG	CCCATGCTTA
CAAGCAAGTA	CAGCAATCAA	CCCTCAACTA	TCACAGATCA	ACTGCAACTC	CAAAGCCACC	CCTGACCCAC	TAGGATACCA	AGAAACCTAC	CCACCCCTAA
CAGTACATAG	TACATAAAGC	CATTACCGT	ACATAGGACA	TTACAGTCAA	ATCCCTTCTC	GTCCCATGG	ATGACCCCCC	TCAGATAGGG	GTCCCTTGAC

The Cambridge Reference Sequence is the accepted mtDNA standard. Each of the four lines above lists 100 of the bases that occur in the CRS, starting at position 16,001 and ending with 16,400. Each line lists 100 positions, divided into groups of ten for convenient reference. Each column is headed by the number for the last position in that group.

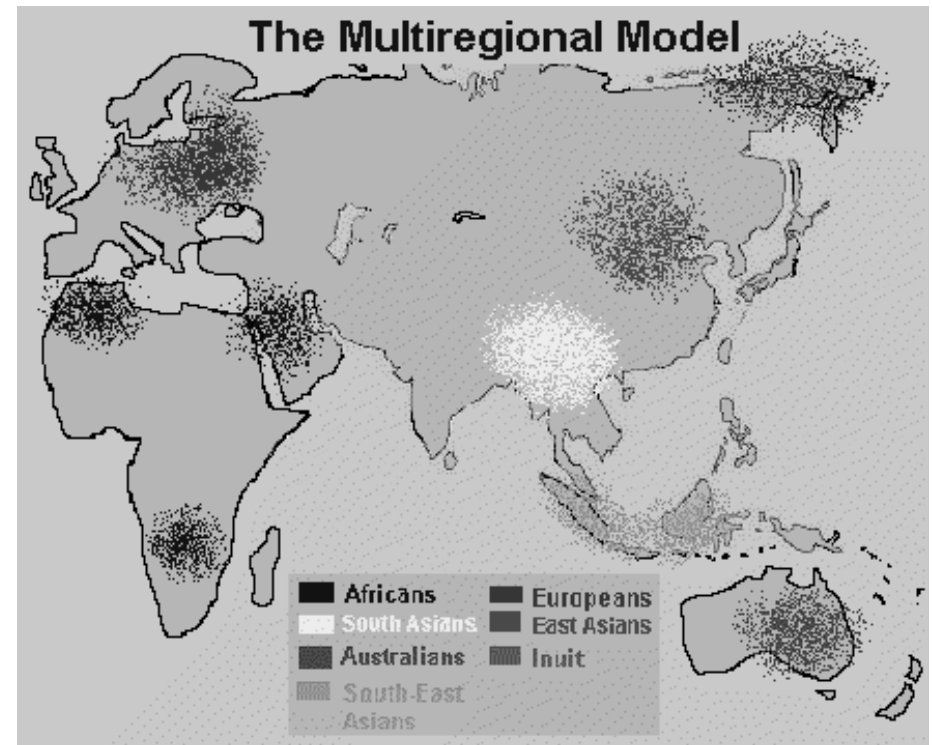
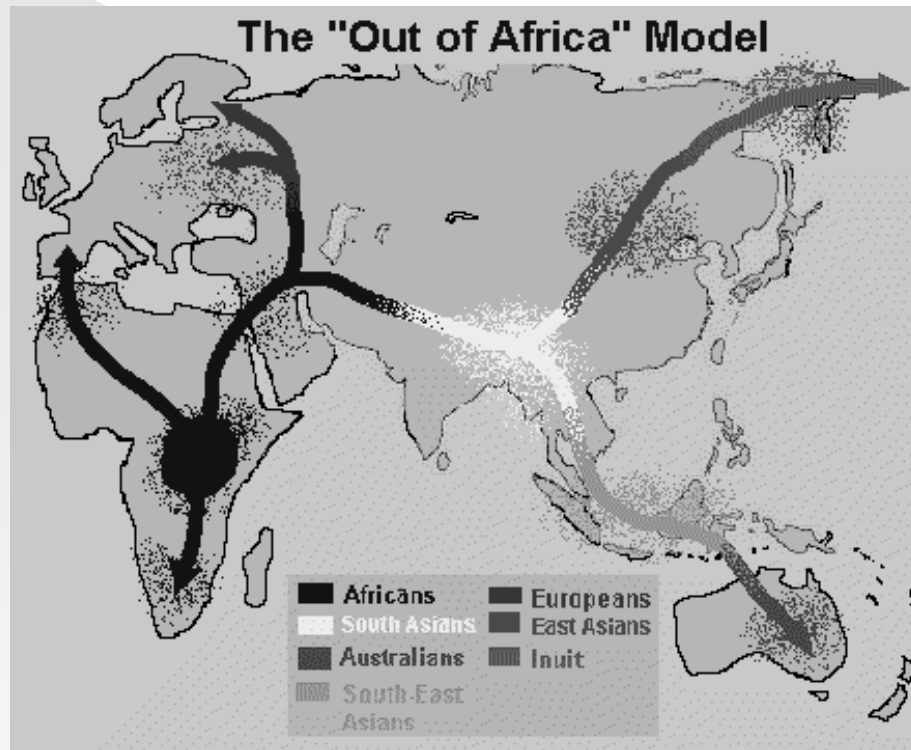
Date:

3/25/01

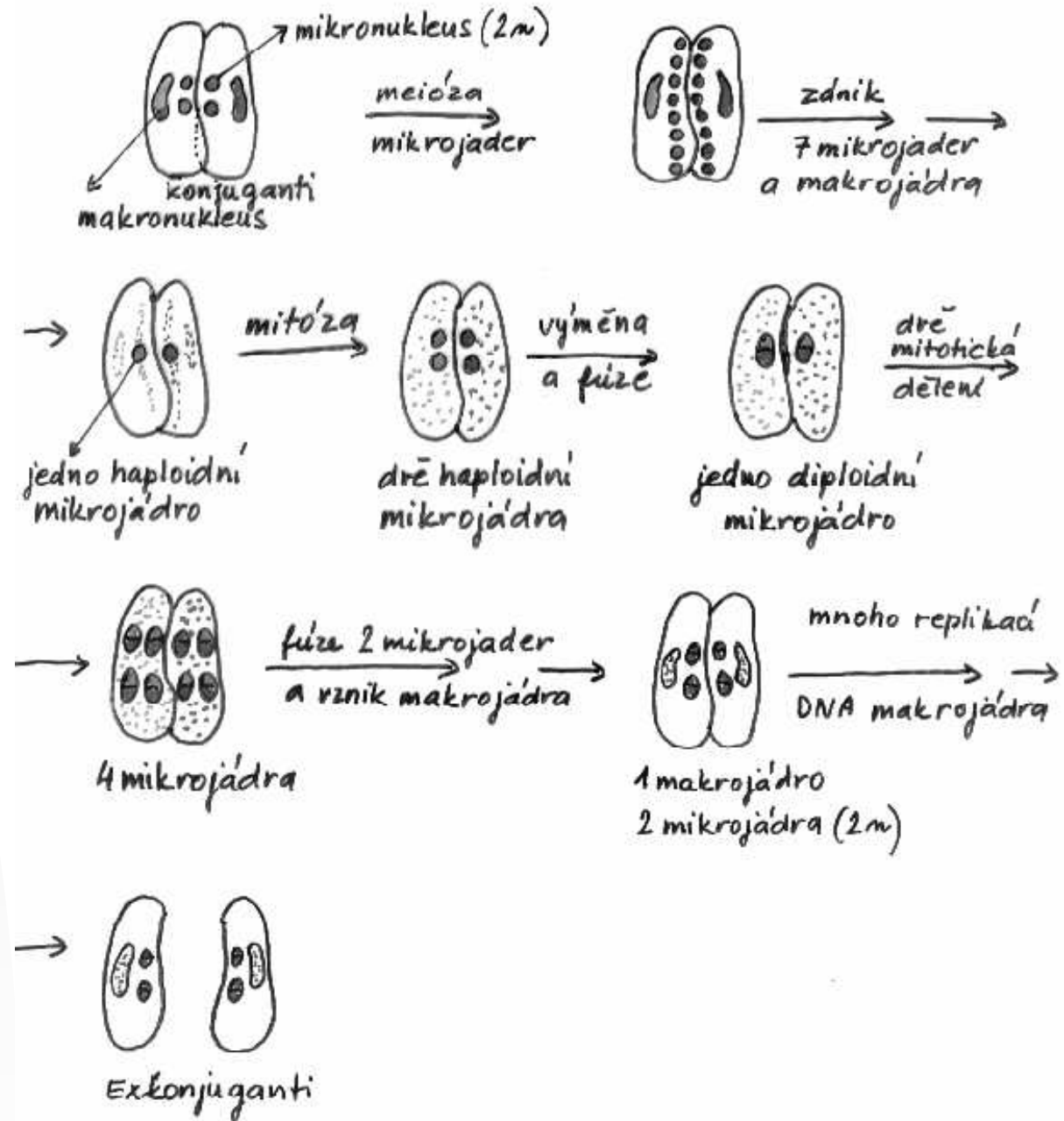
David Rothschild, M.D.



„Mitochondriální Eva“



KONJUGACE U PARAMECIUM

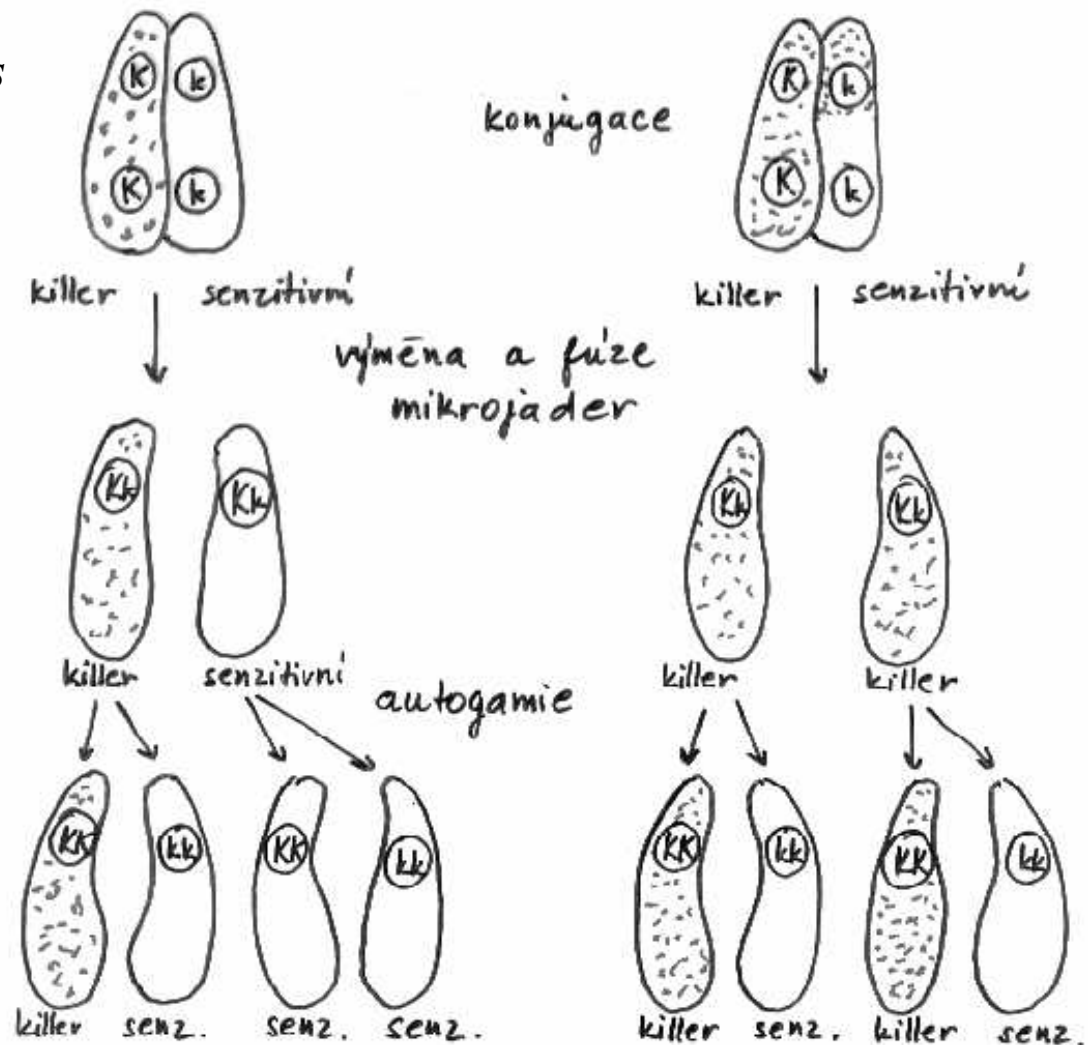


PARAMECIUM
 KRÍŽENÍ MEZI KMENY KILLER (KK) A
 KMENY SENZITIVNÍMI (kk)

bez výměny cytoplazmy

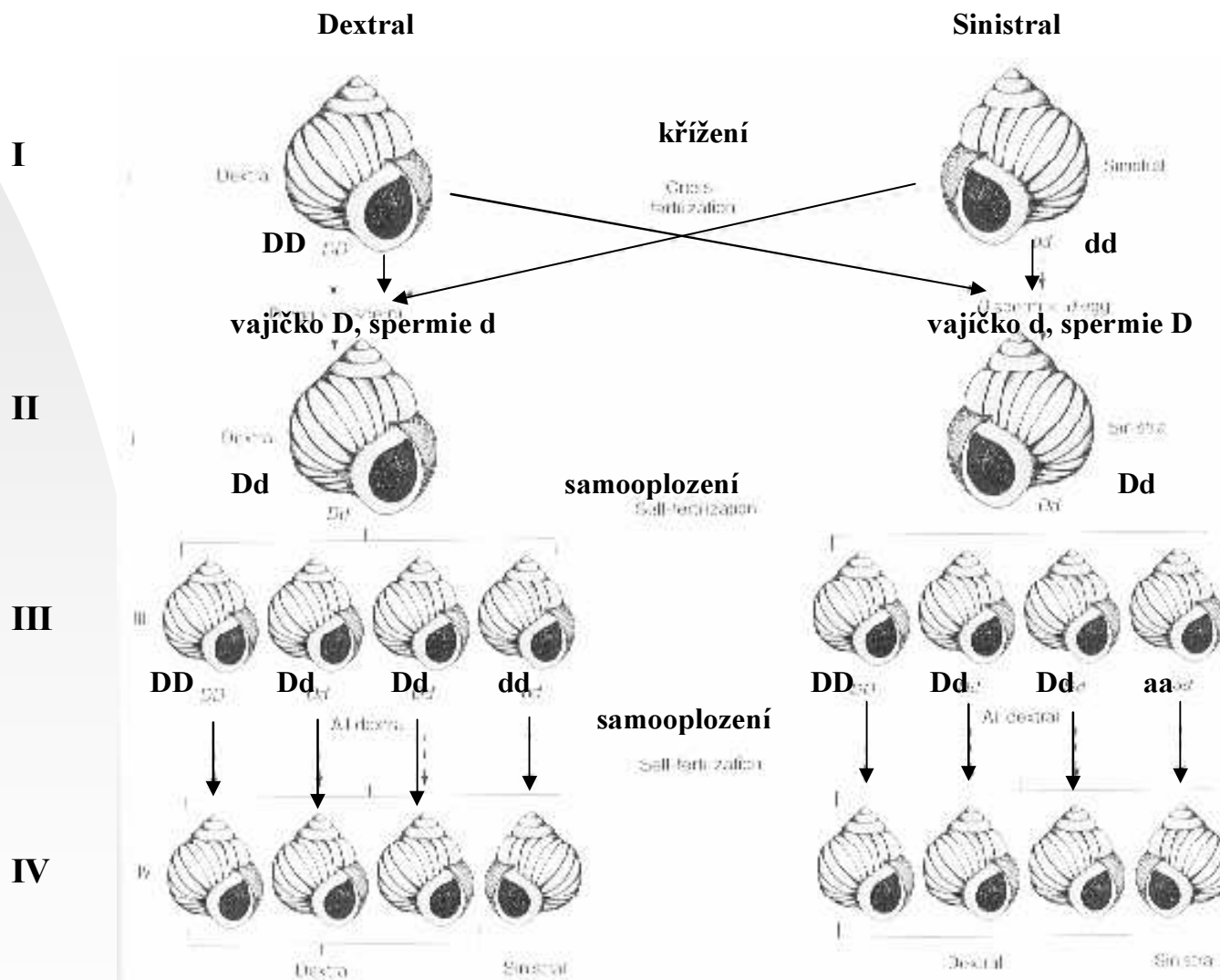
s výměnou cytoplazmy

Částice kappa =
 = *Caedobacter taeniospiralis*



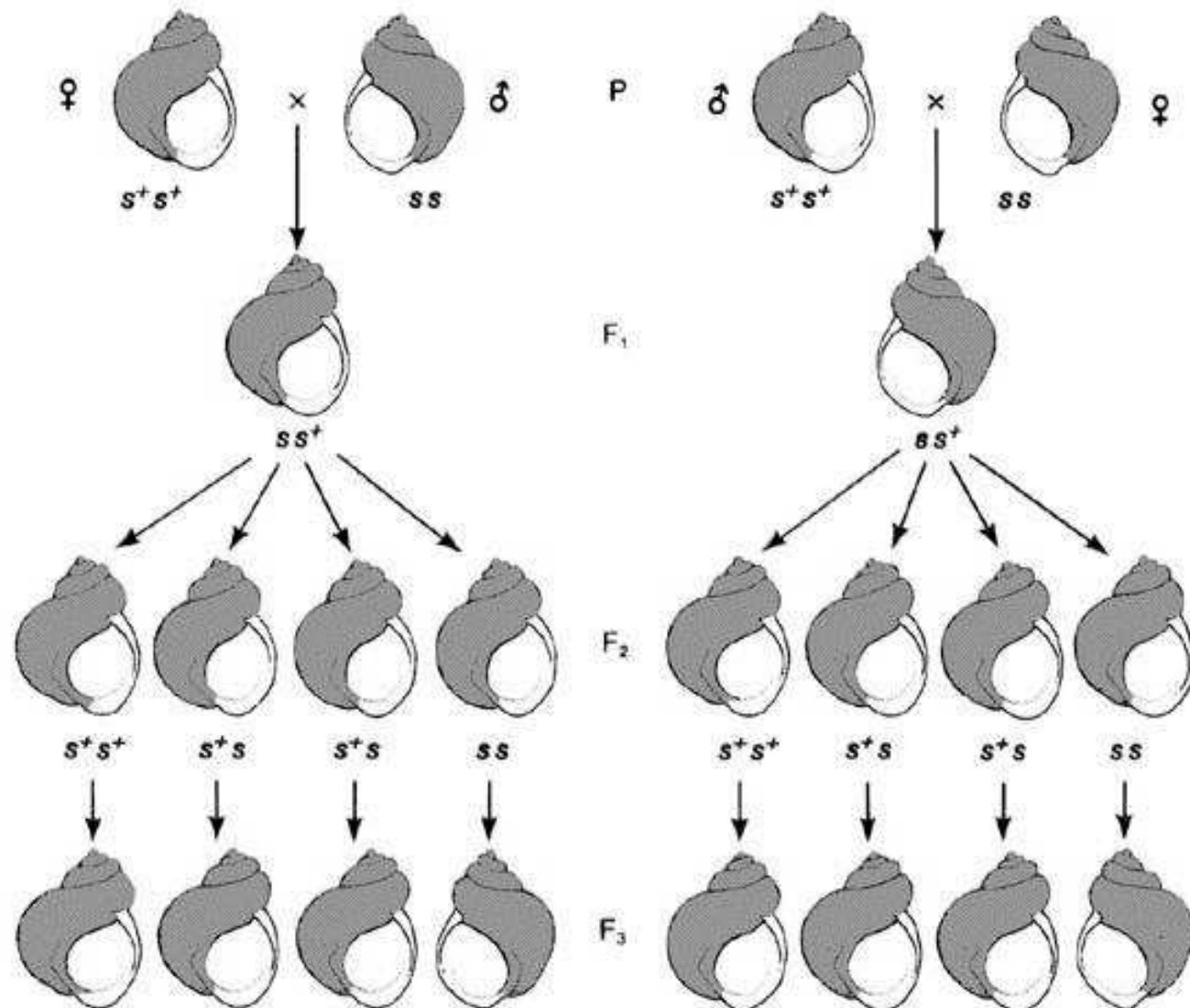
Limnaea peregra

vinutí ulity



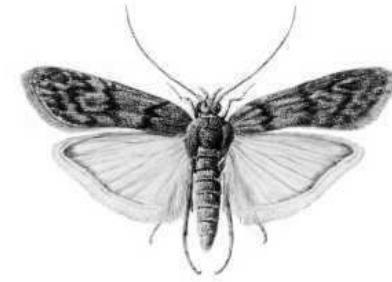
Limnaea peregra

vinutí ulity



Ephestia kuehniella Zeller

dědičnost zbarvení



♀ **aa** x ♂ **Aa**
červená x hnědá

↓
larvy

↙ ↘
Aa **aa**

obě pohlaví:

hnědá **červená**

♀ **Aa** x ♂ **aa**
hnědá x červená

↓
larvy

↙ ↘
Aa **aa**

hnědá **hnědá**