

# **Evolution of SEX, SEXES AND SEX-DETERMINATION SYSTEMS**

Bart Nieuwenhuis

# SEMINAR

- Tuesday 17:00 – 19:00
  - Not:** 24 April and 1 May
- Biozentrum - room B 01.015
- 2 people present shortly on the topic
- Everyone discusses the paper(s)
- Credits: 3 ECTS, 2 SWS

# CONTACT

[http://evol.bio.lmu.de/\\_teaching/Seminar\\_EvolSex/](http://evol.bio.lmu.de/_teaching/Seminar_EvolSex/)

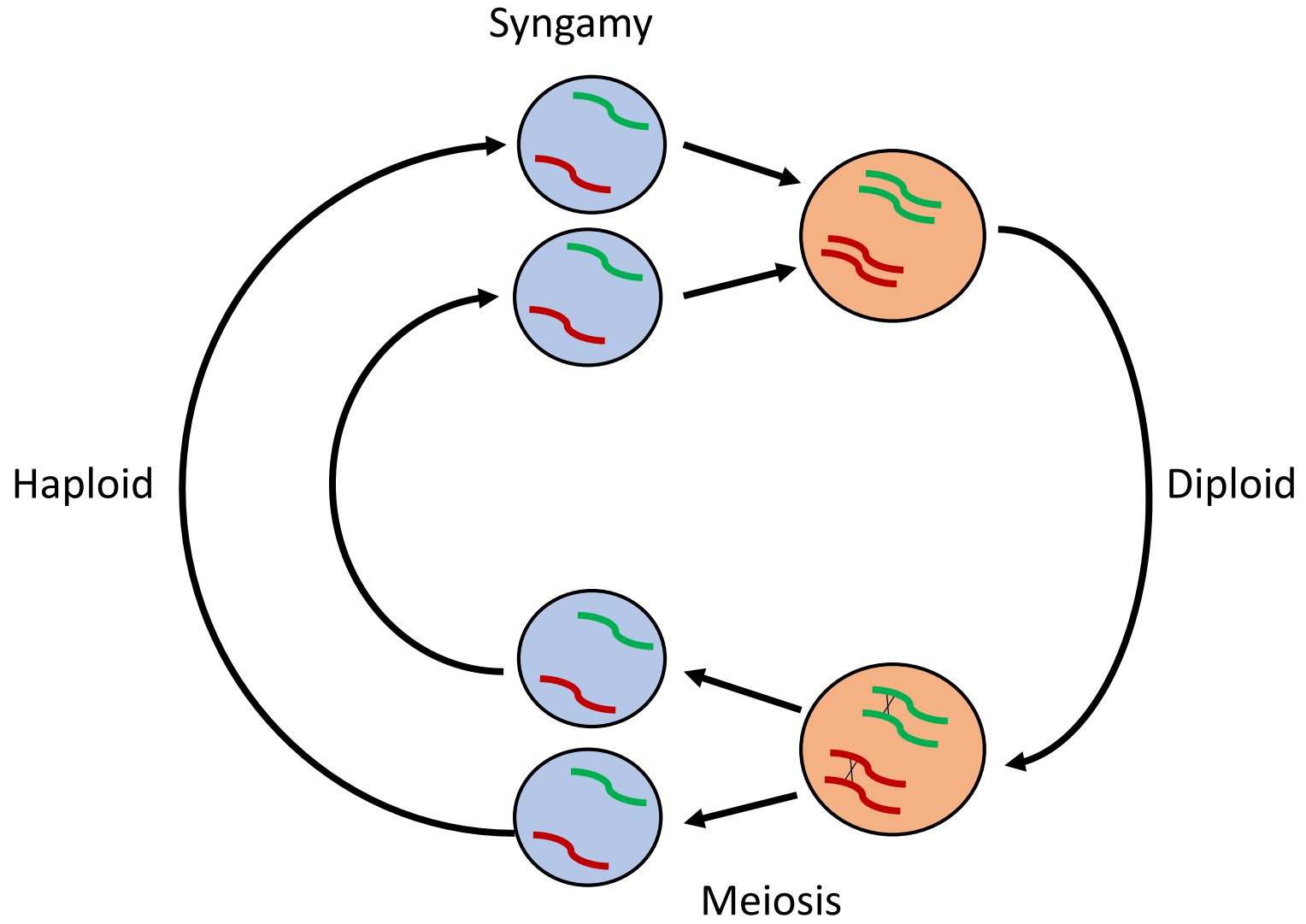
[nieuwenhuis@bio.lmu.de](mailto:nieuwenhuis@bio.lmu.de)

Office: B01.005

# **WHAT IS SEXUAL REPRODUCTION?**

Sex is the coming together of two  
genomes in the same individual

EVOLUTION, Barton 2007



**"Sex is the queen of problems in evolutionary biology.**

**Perhaps no other natural phenomenon**

**has aroused so much interest;**

**certainly none has sowed so much confusion."**

**- Graham Bell, 1982**



# COSTS of SEXUAL REPRODUCTION

- Two-fold cost of sex
- Meiosis is complicated and takes much more time than mitosis
- Finding a mate: complicated and costly!
- Sexual selection is costly
- Recombination breaks up combinations of genes that are well adapted

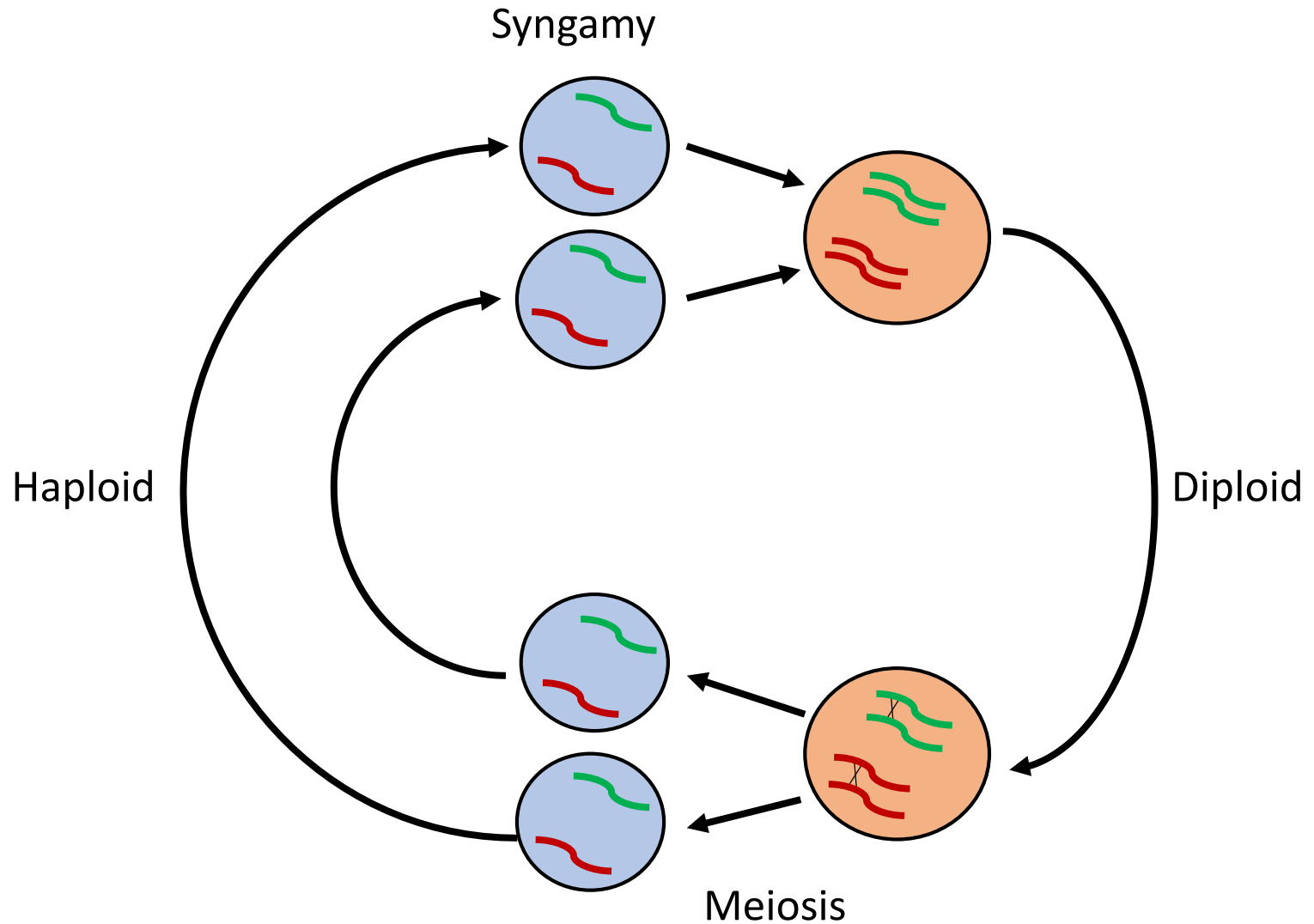
>> 2x more costly than asexual reproduction

# CONCEPTS of THE SEMINAR

- Sex
- Sexes
- Sex determination systems



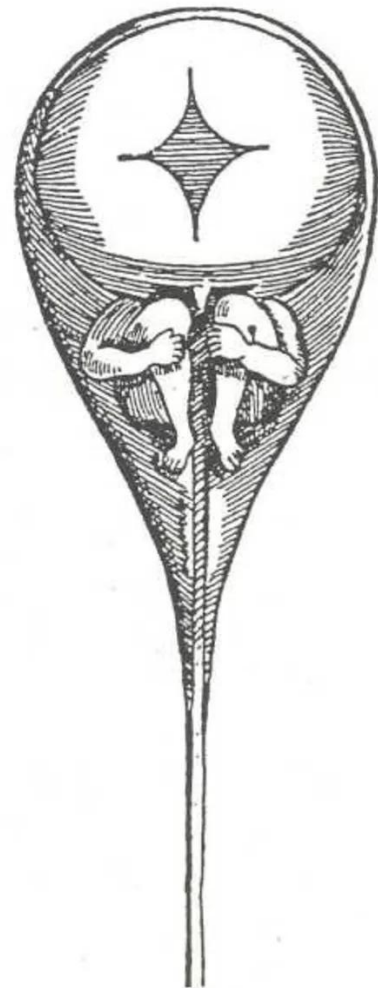
# SEXUAL REPRODUCTION



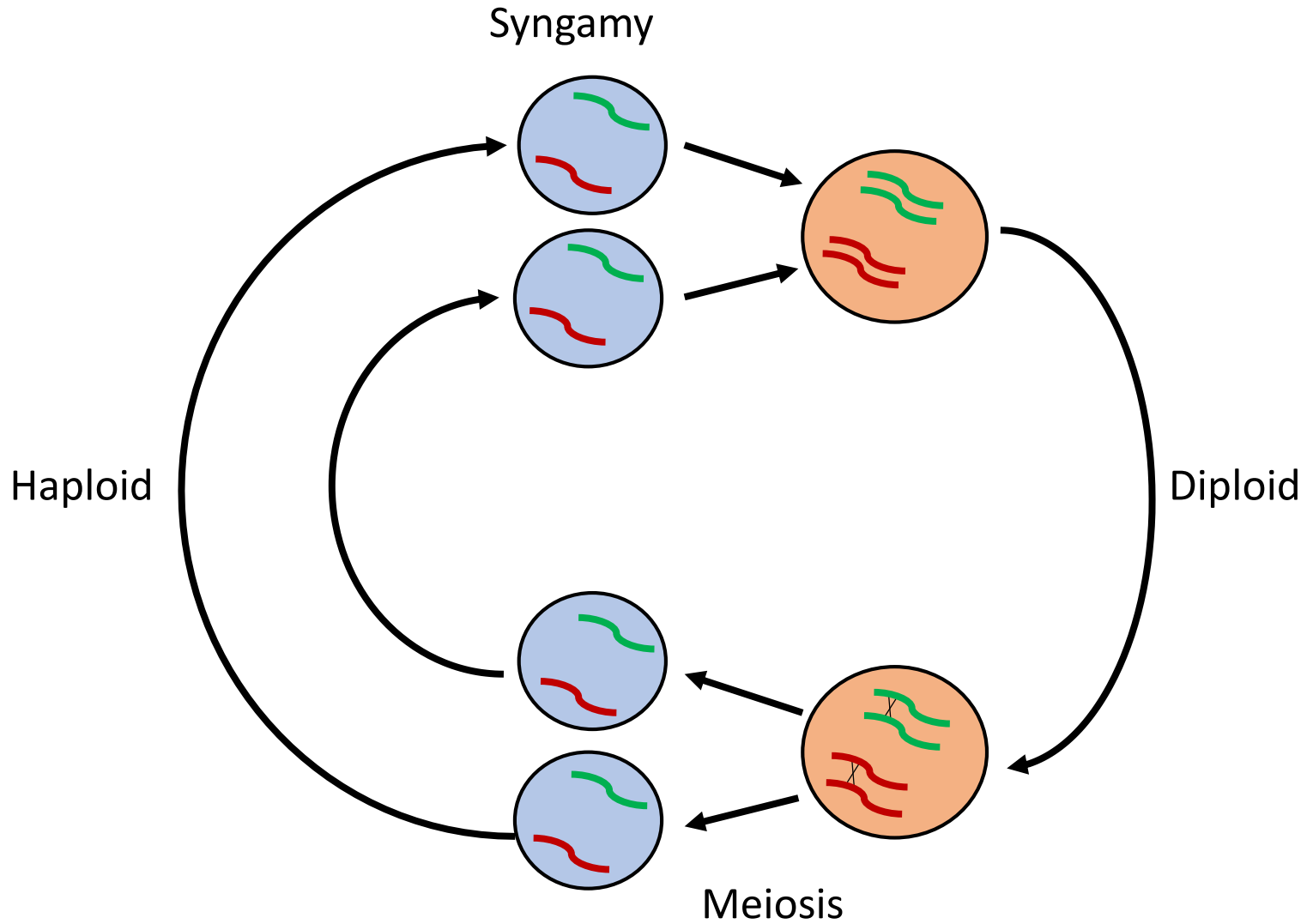
# SEXES

- Genders – Social construct
- Males and females and hermaphrodites
- Sexes – producing small or large gametes
- Mating types – gamete incompatibility

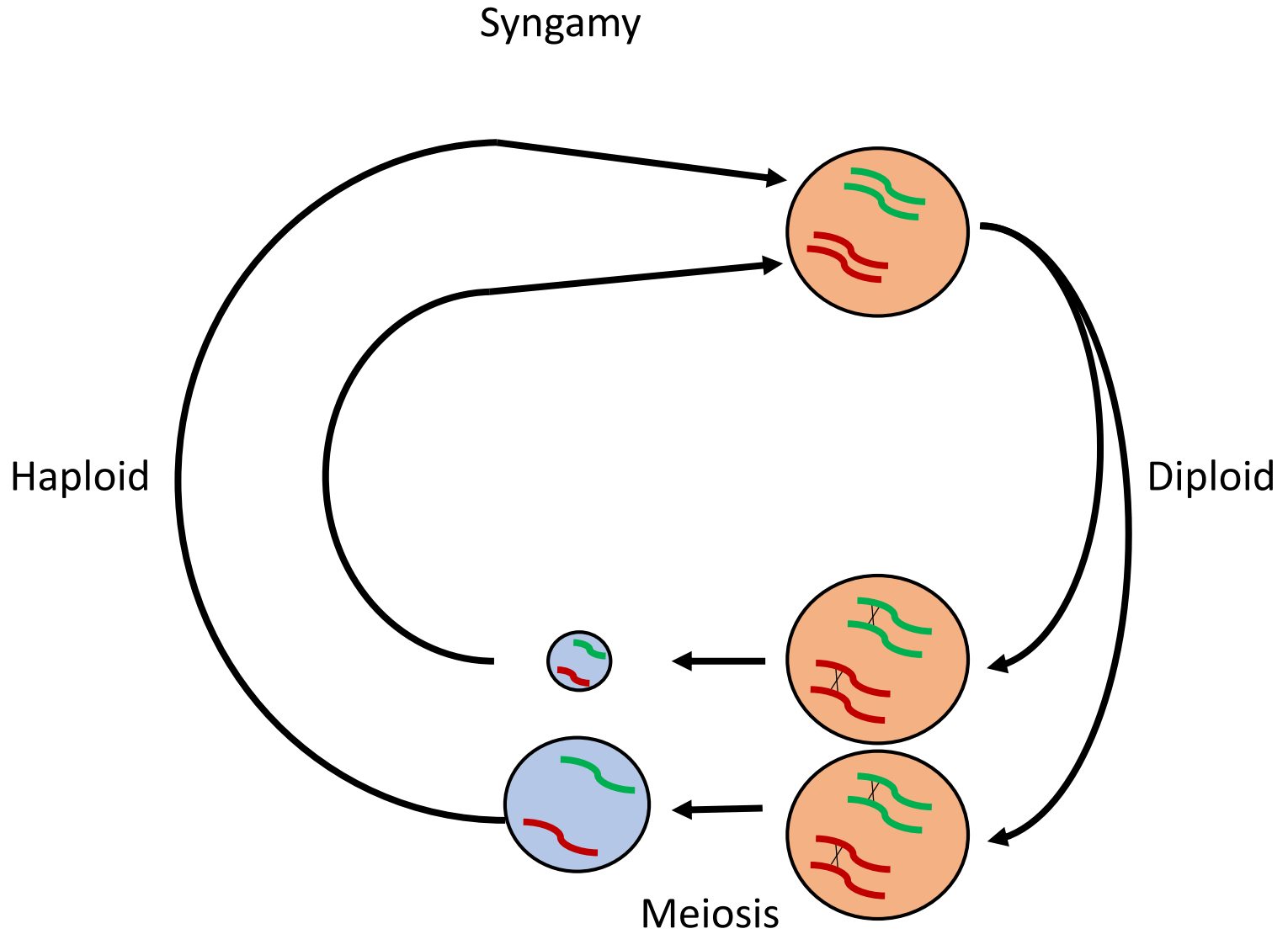
# SEXES: PRODUCING SMALL OR LARGE GAMETES



# SEXES



# SEXES



# SEPARATE SEXES

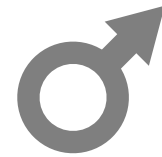


**HERMA-  
PHRODITE**

**MONO-  
OECIOUS**



**FEMALE**

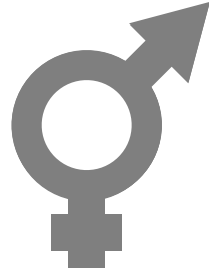


**MALE**



**DIOECIOUS (PLANTS)  
GONOGORIC (ANIMALS)**

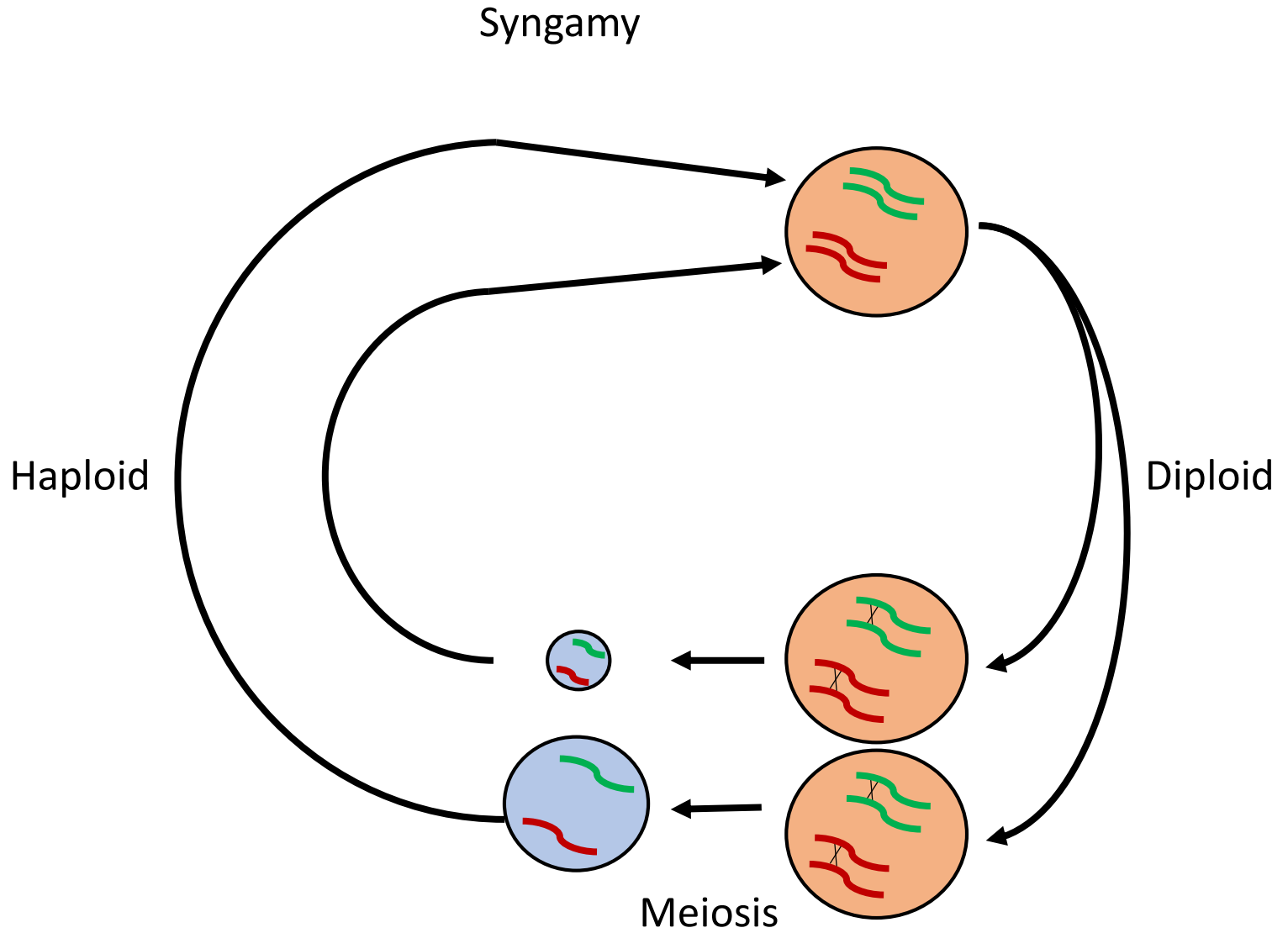
# HERMAPHRODITES



**SEPARATE SEXES**

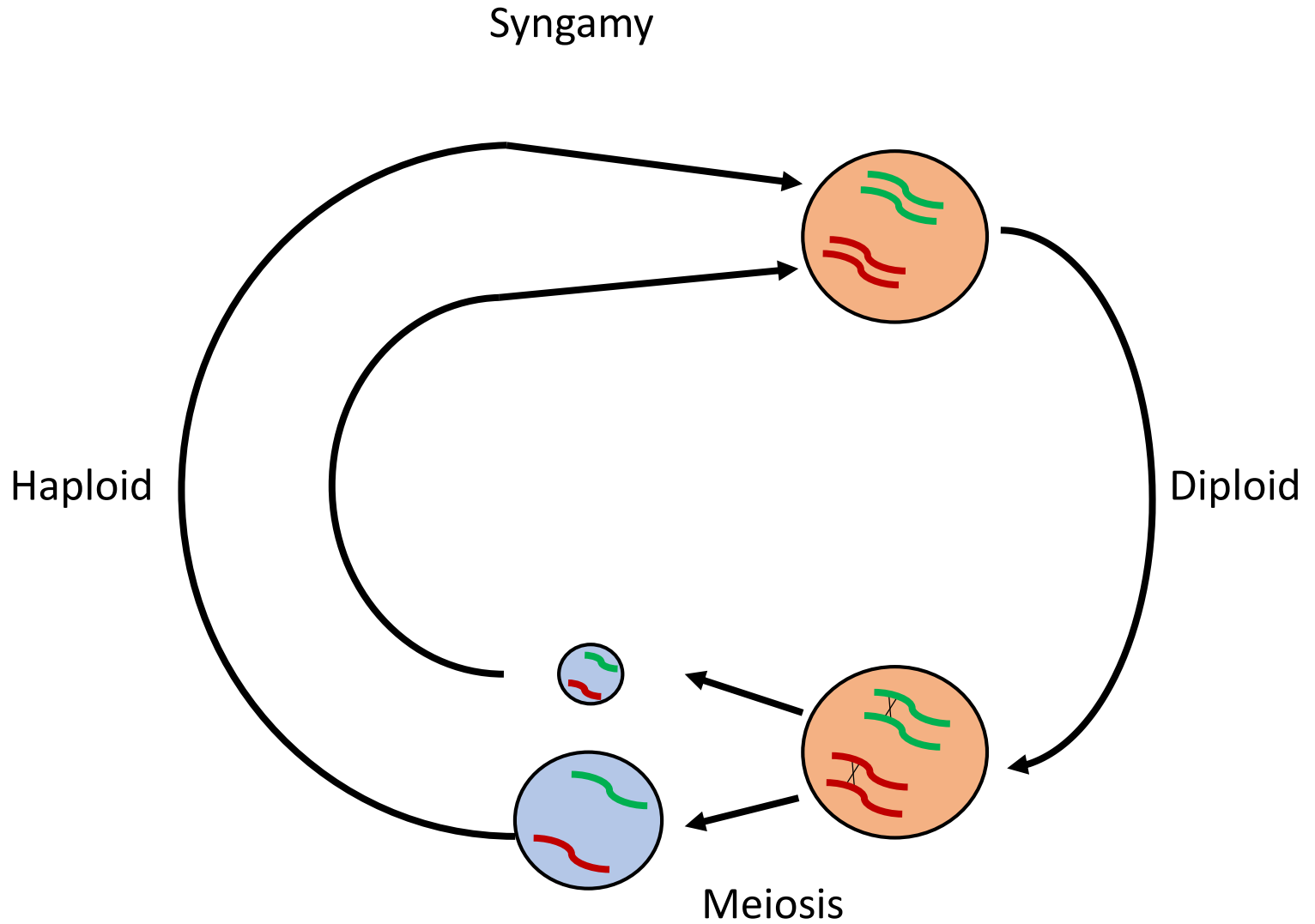
**Symposium - PLATO (c. 385-370 BC)**

# SEXES

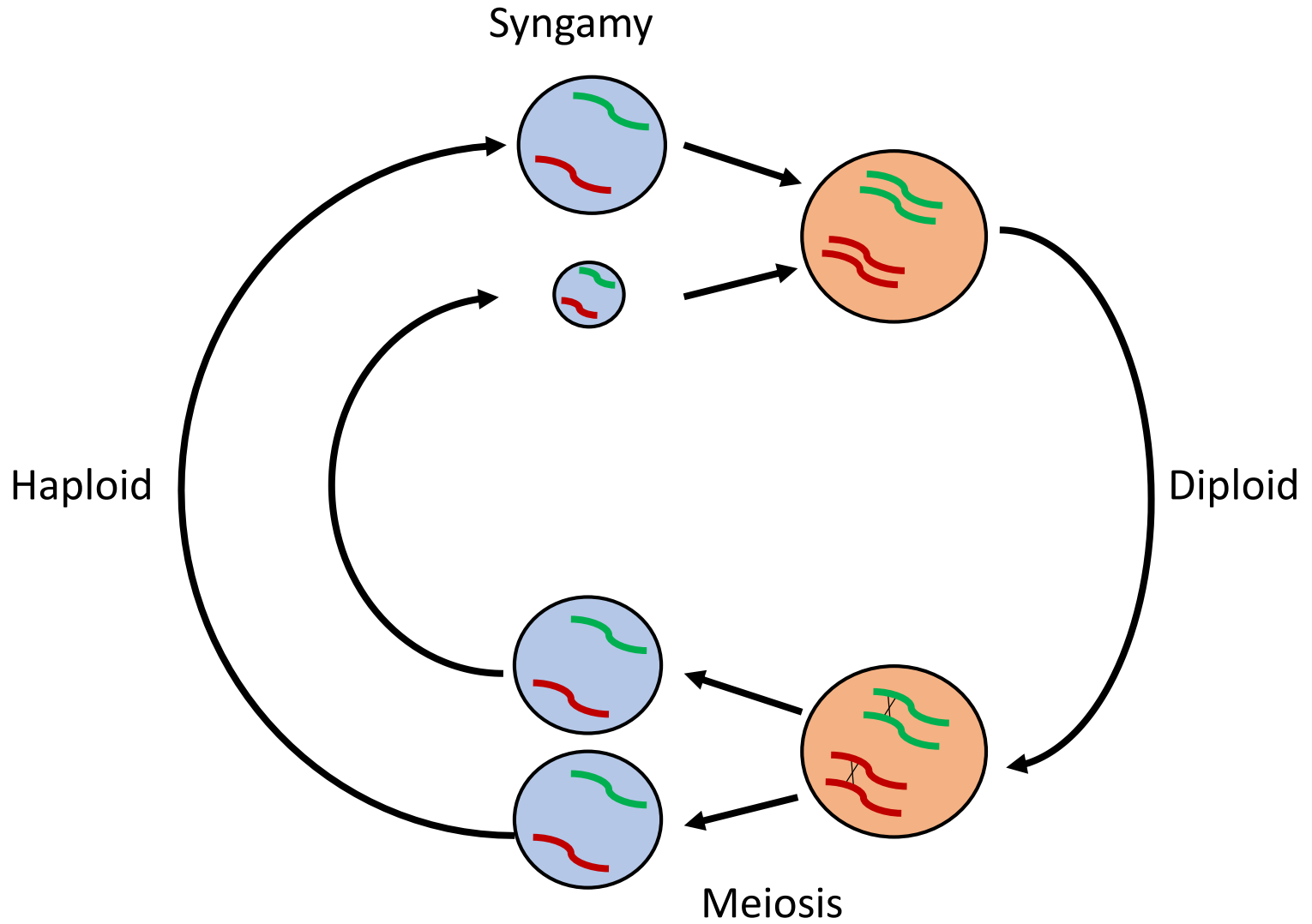




# SEXES



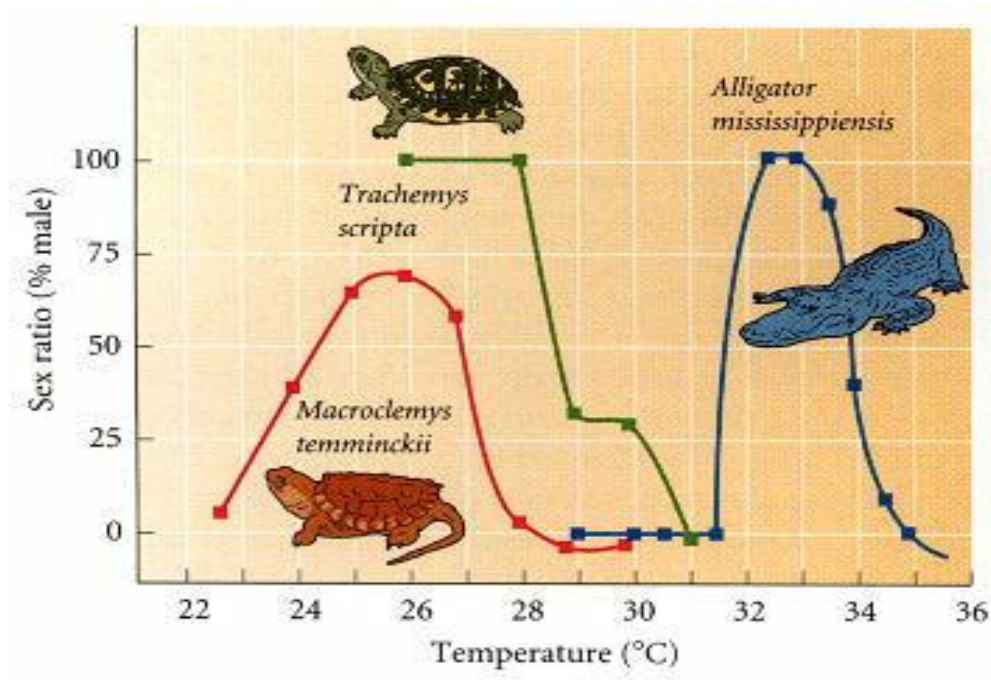
# SEXES



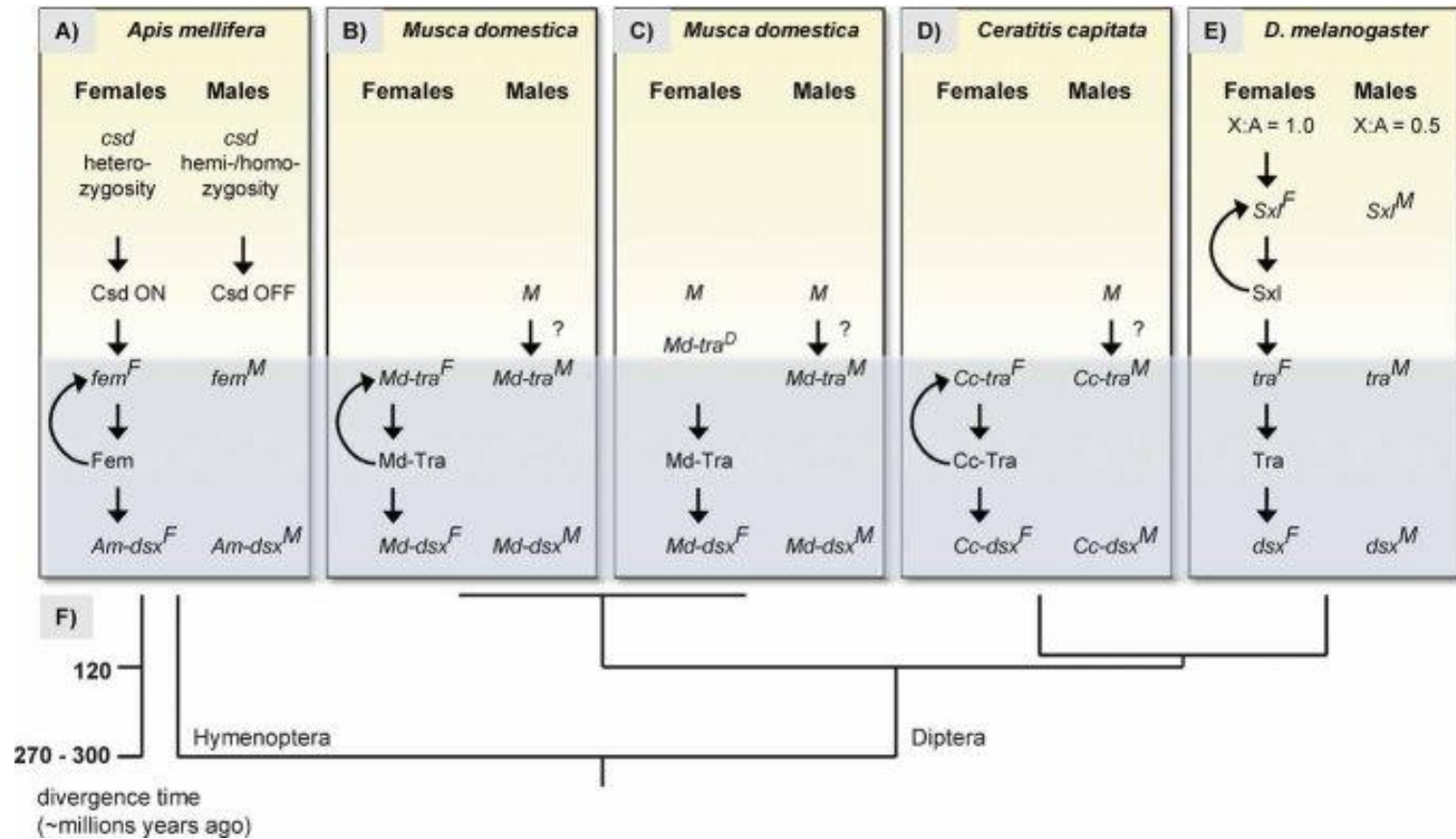
# **Modes of REPRODUCTION**

- Sexual or asexual
- Obligate or facultative sexual
- Self-fertilizing or outcrossing
- Separate sexes or hermaphrodites

# ENVIRONMENTAL SEX DETERMINATION



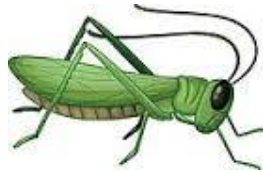
# GENETIC SEX DETERMINATION



# CHROMOSOMAL SEX DETERMINATION



Homo-/hemizyosity



XX

X0

Haplo-/Diploidy



2n

n

Male heterogamety



XX

XY

Female heterogamety



XY (ZW)

XX (ZZ)

# Insects

## Sex determination

X0 Male heterogamety

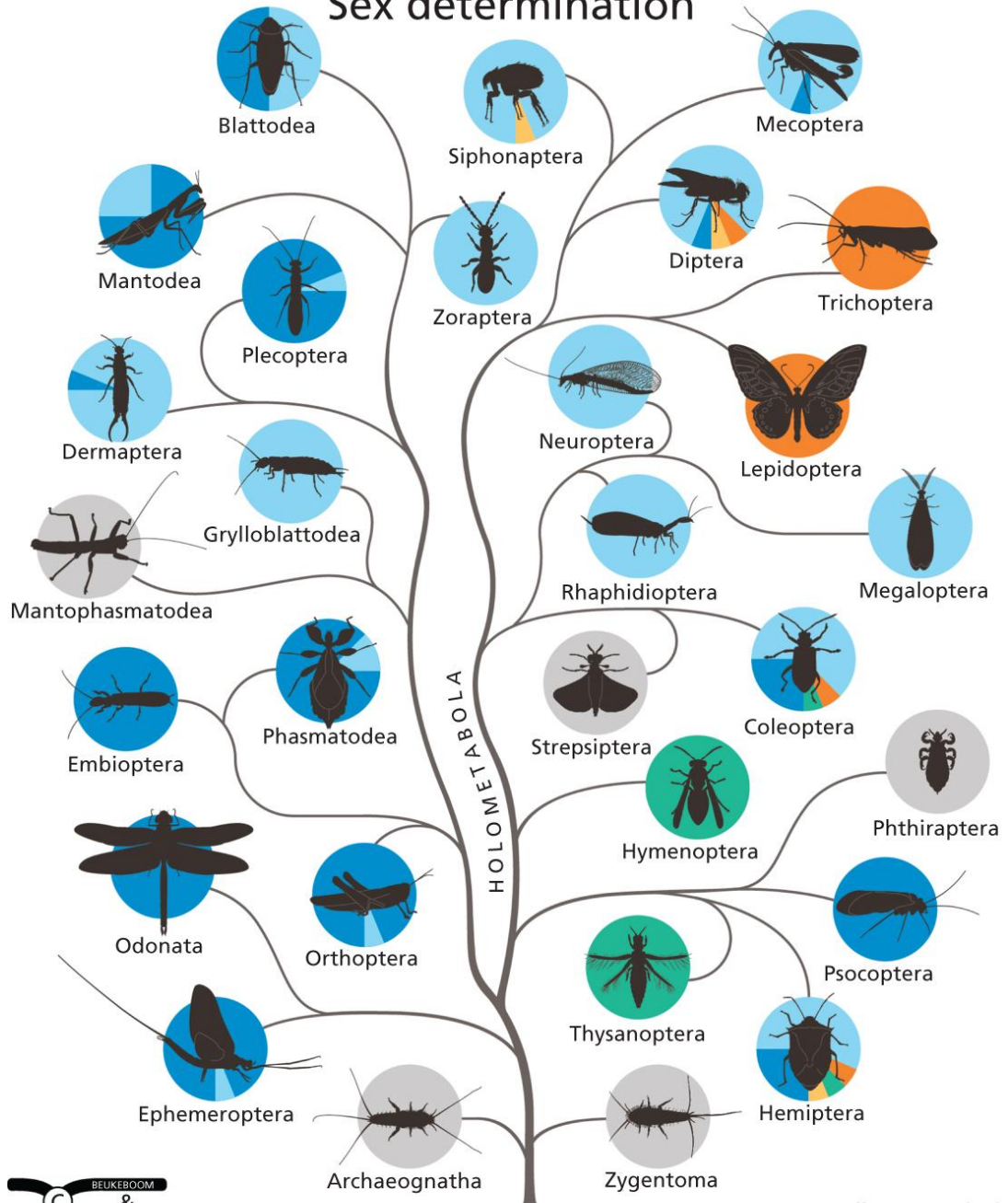
Haplodiploidy

XY Male heterogamety

ZW/Z0 Female heterogamety

Miscellaneous

Unknown



Beukeboom & Perrin (2014)

# A GENERAL SCENARIO FOR SEX CHROMOSOME EVOLUTION

