DisturPloidy

https://github.com/rozeykex/ploidy

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How does disturbance on a landscape affect the establishment of new polyploid plant species?

Non-disjunction

Polyploid organisms are caused by rare meiotic/mitotic catastrophies (eg: non-disjunction) which cause an uneven distribution of chromosomes between daughter cells.

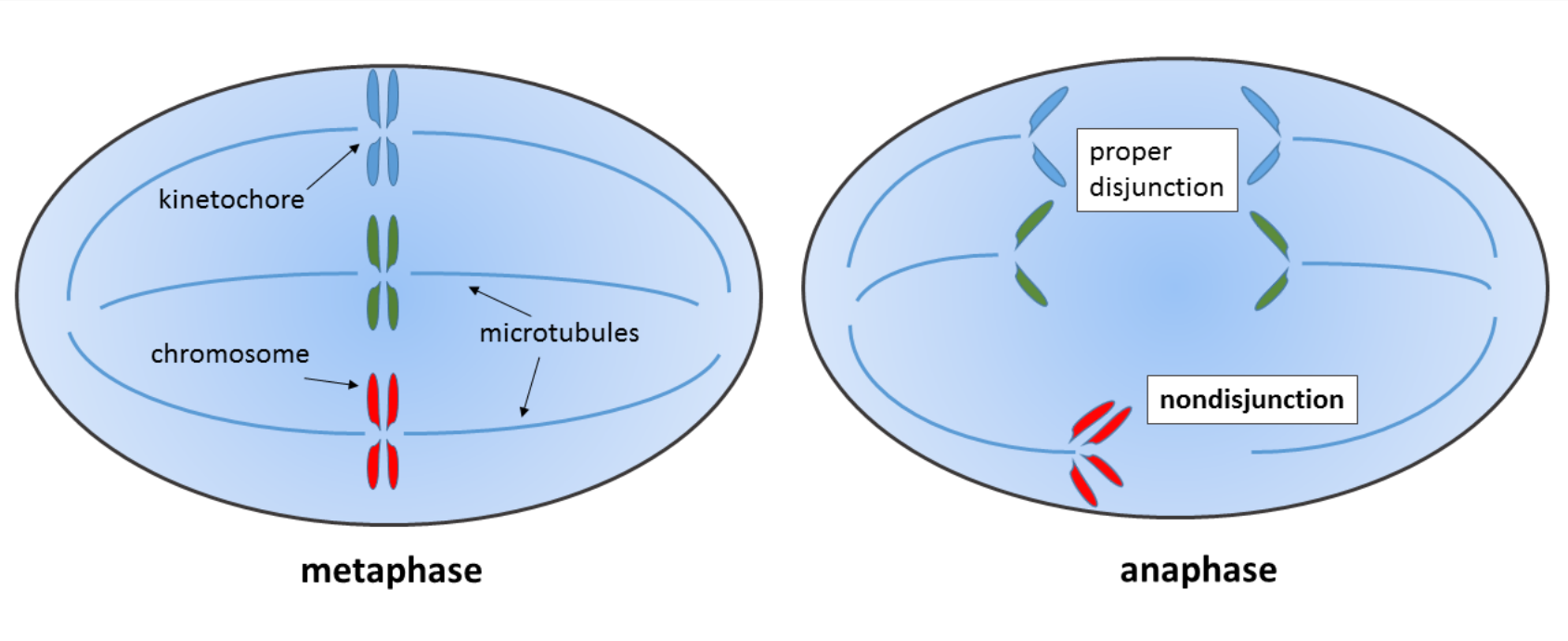


Figure 1: Non-disjunction: By Wpeissner, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=32332257

Meiosis I

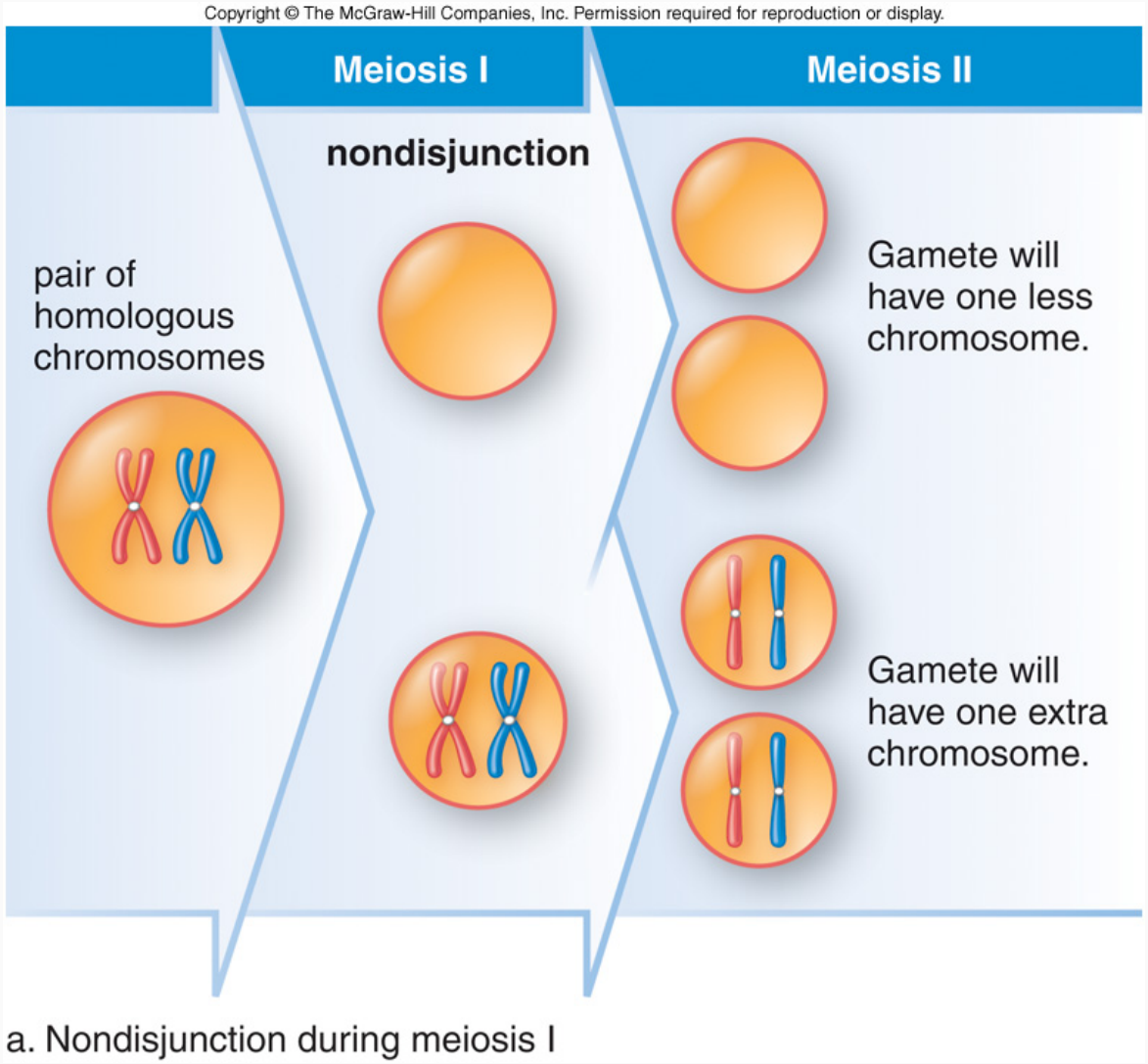


Figure 2: Meiosis one

Meiosis II

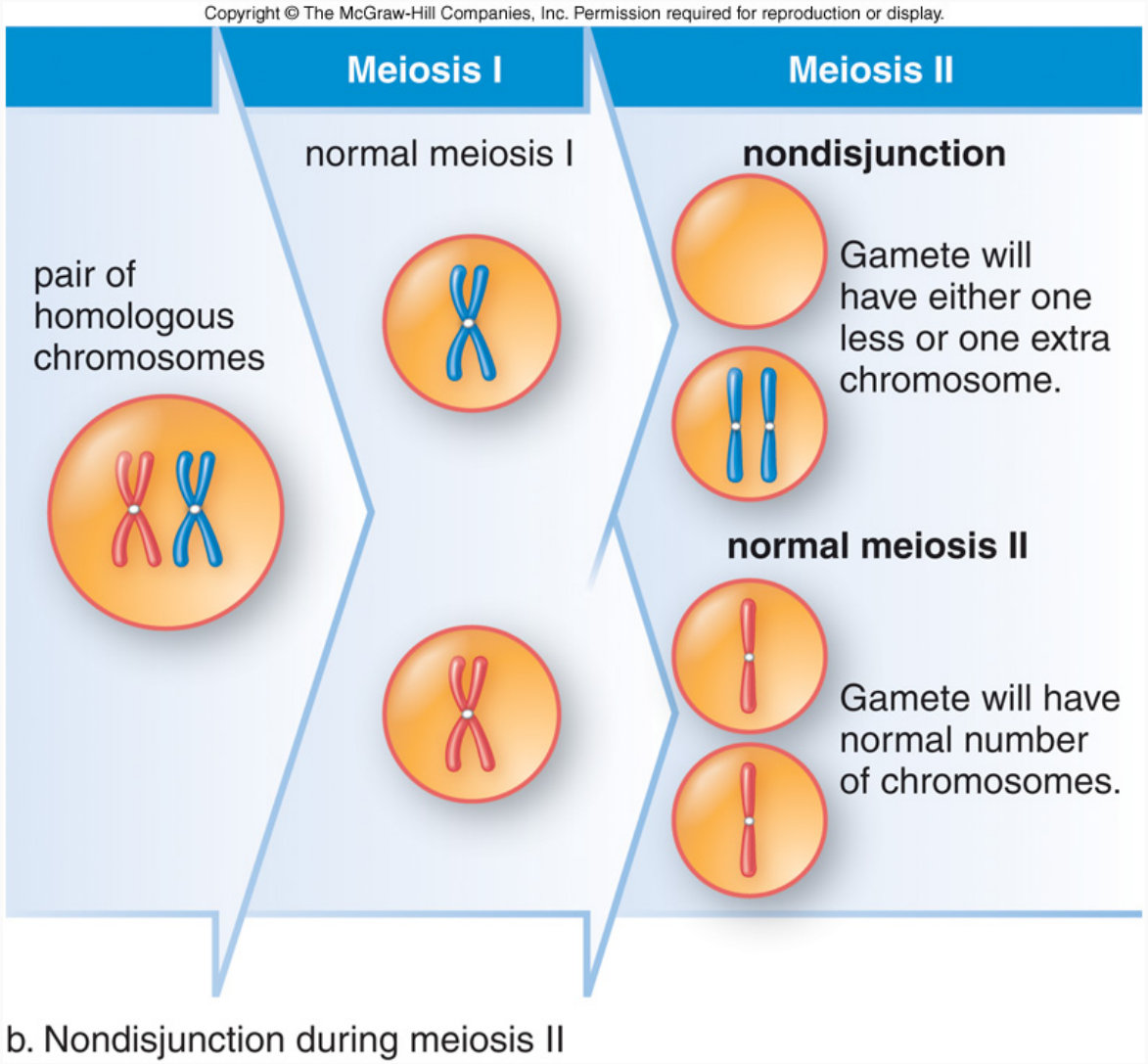


Figure 3: Meiosis two

Polyploidy

Genome duplication, is often a *saltational* event; a mutation so large that it can cause **instant speciation**.

In plants it's estimated that the probability of polyploidisation occurring is around 10^{-5}.

How much diversity is it responisble for?
Speciations that coincide with genome duplication have been estimated:

- Around **15%** in angiosperms.
- And **30%** in ferns.

LOADS.

Benefits

- Resistant to the deleterious effects of inbreeding.
- Able to flip the inhibition to selfing switch.
- Often display *gigas-effects*.
- Or, *hybrid vigour*.

Costs

- Reduced access to compatible mates via outcrossing.
- Reduced fecundity due to *diploid pollenswamping*.
- Reduced fecundity due to *triploid sterility*.
- Extinction rates are high.

But it’s not rare

We’ve known about the prevelance of polyploidy in plants for over 100 years (it’s also common in amphibians and fish).

- Around 25% of plants in nature are polyploid.
- Frequencies are especially high at altitude, where there has been glacial retreat, and **in recently disturbed areas**.
- Frequencies vary depending on taxa. Grasses are especially polyploid, while legumes tend not to be.
- Around 30% of our crop plants are polyploid.

So why are polyploid plants so successful?

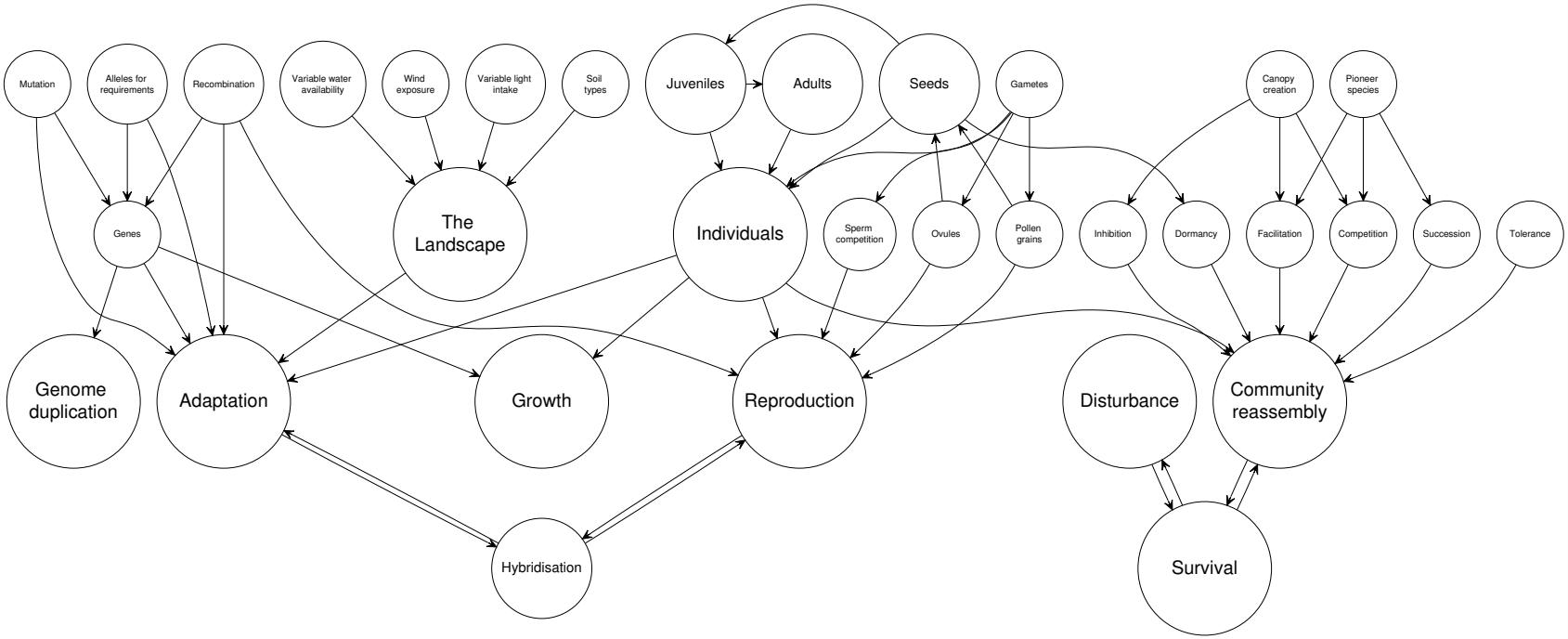
Individual-based models (IBMs)

IBMs allow for individual variation by representing all individuals in a population **explicitly**.

This means **fewer assumptions** about a population need to be made.

Variables we're used to seeing in mathmatical models (like **N**) become **emergent properties** of the simulation.

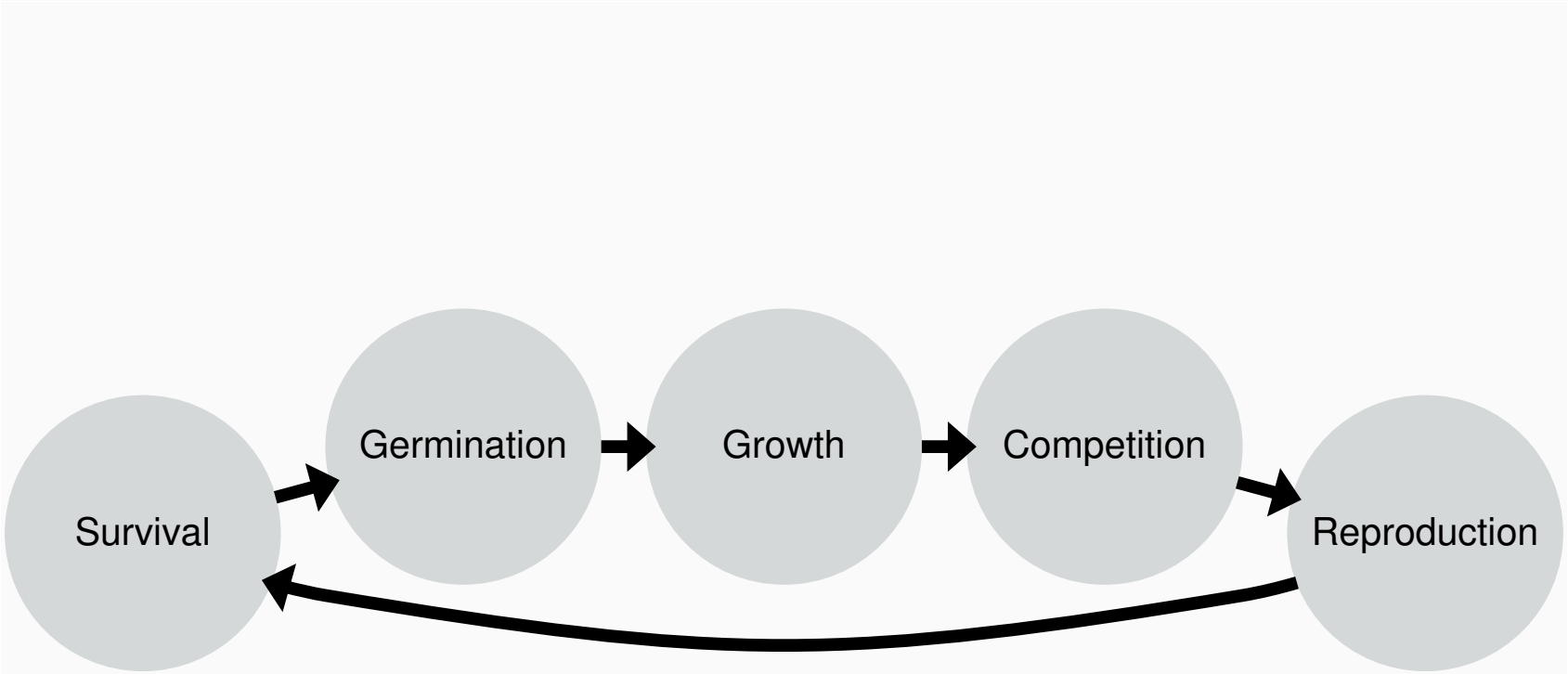
What I thought the model had to do



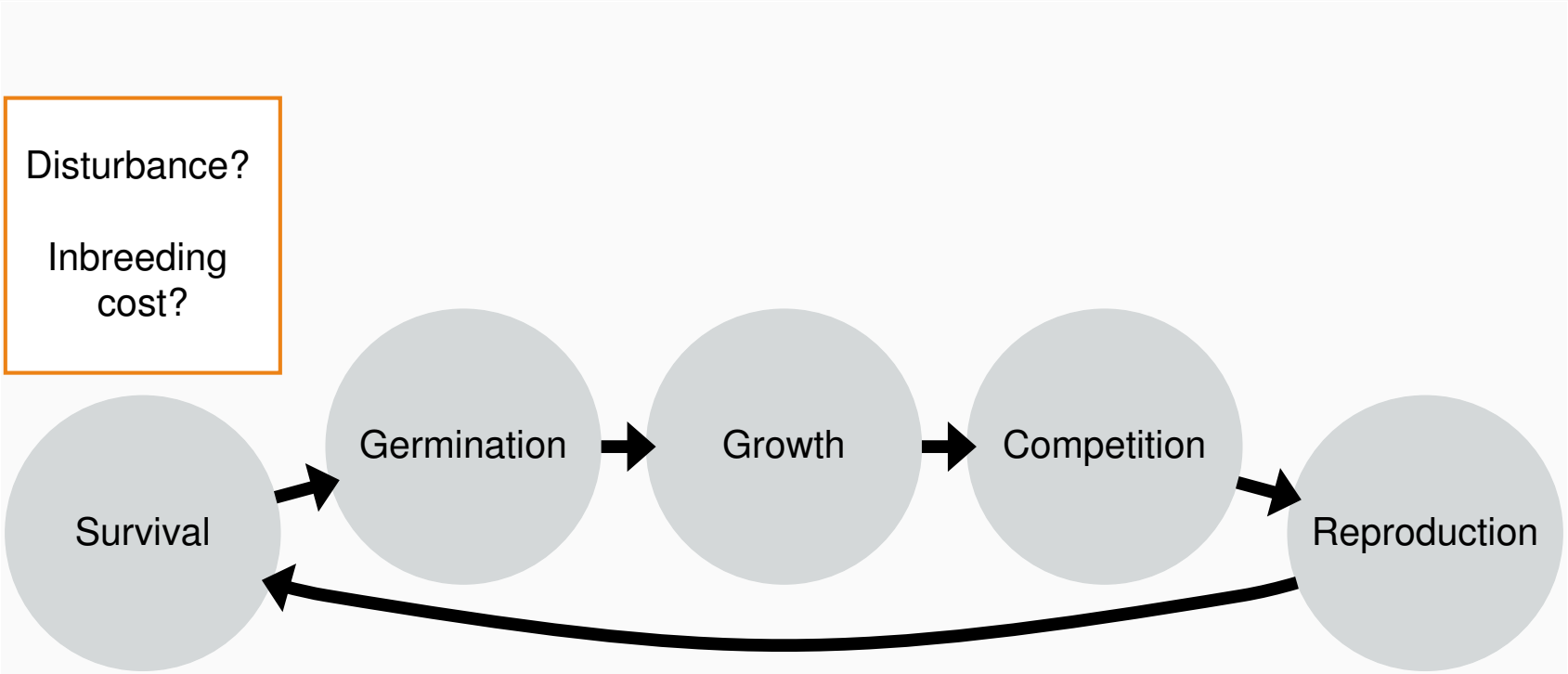
I thought nearly **every variable** in plant and community ecology, as well as **all the mechanisms** for inheritance and mutation had to be explicitly represented.

Instead, I learned models work by keeping things really simple.

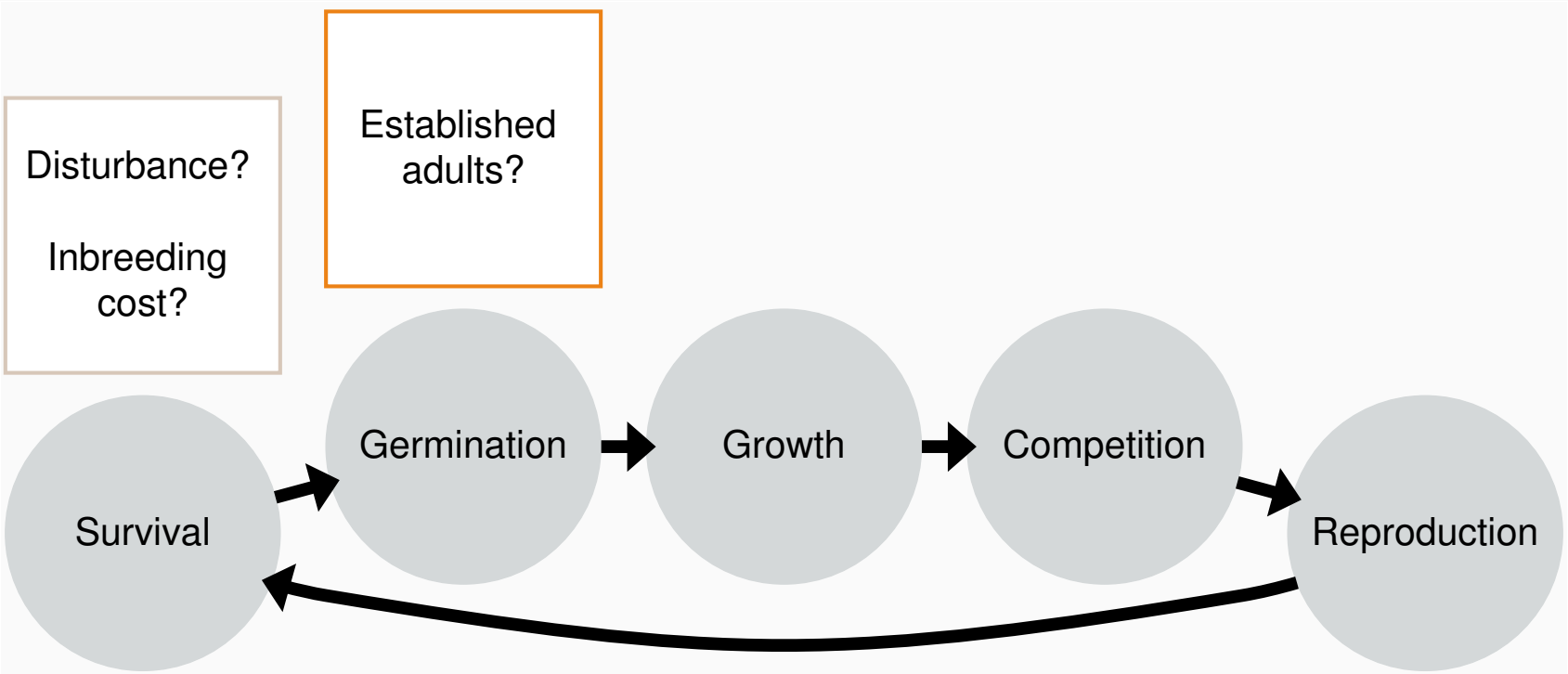
All the model actually needed



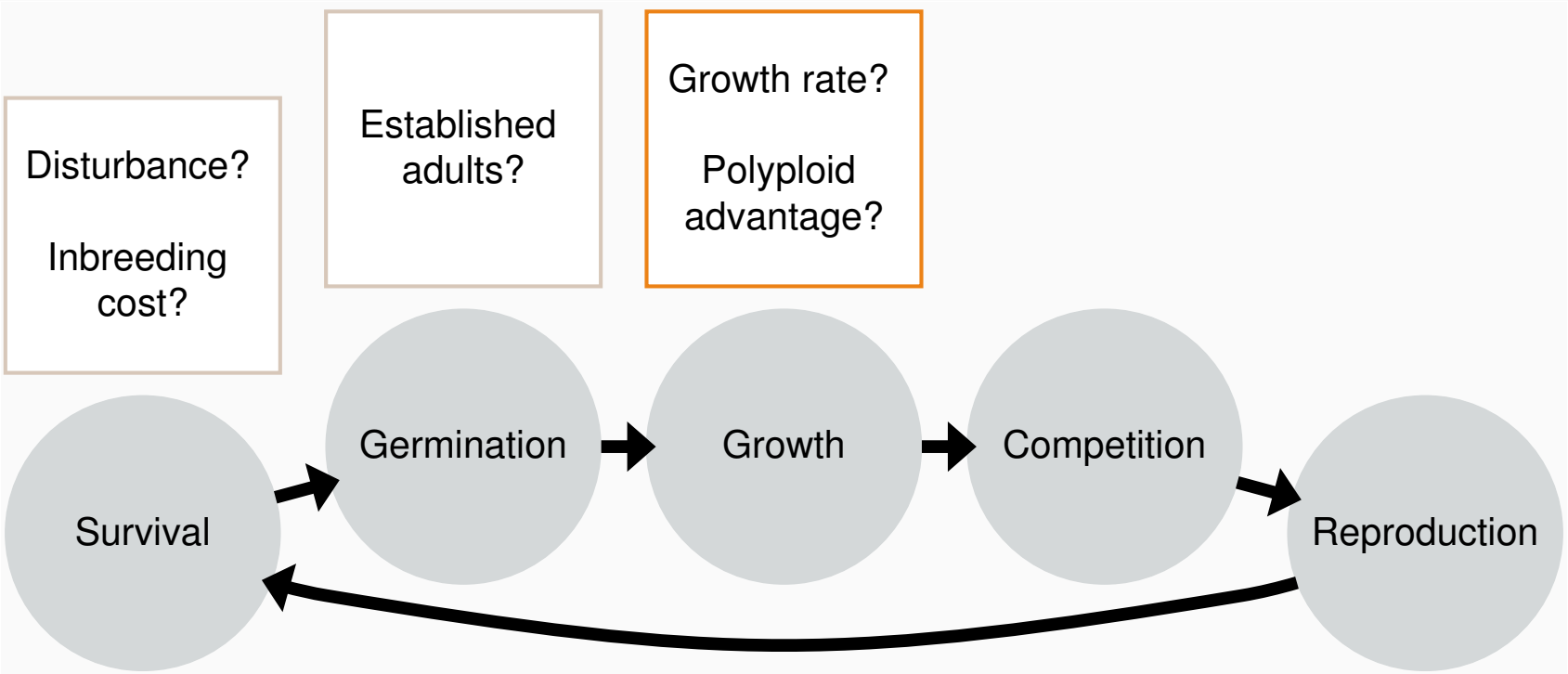
Survival


Disturbance?
Inbreeding cost?
Survival
Germination
Growth
Competition
Reproduction

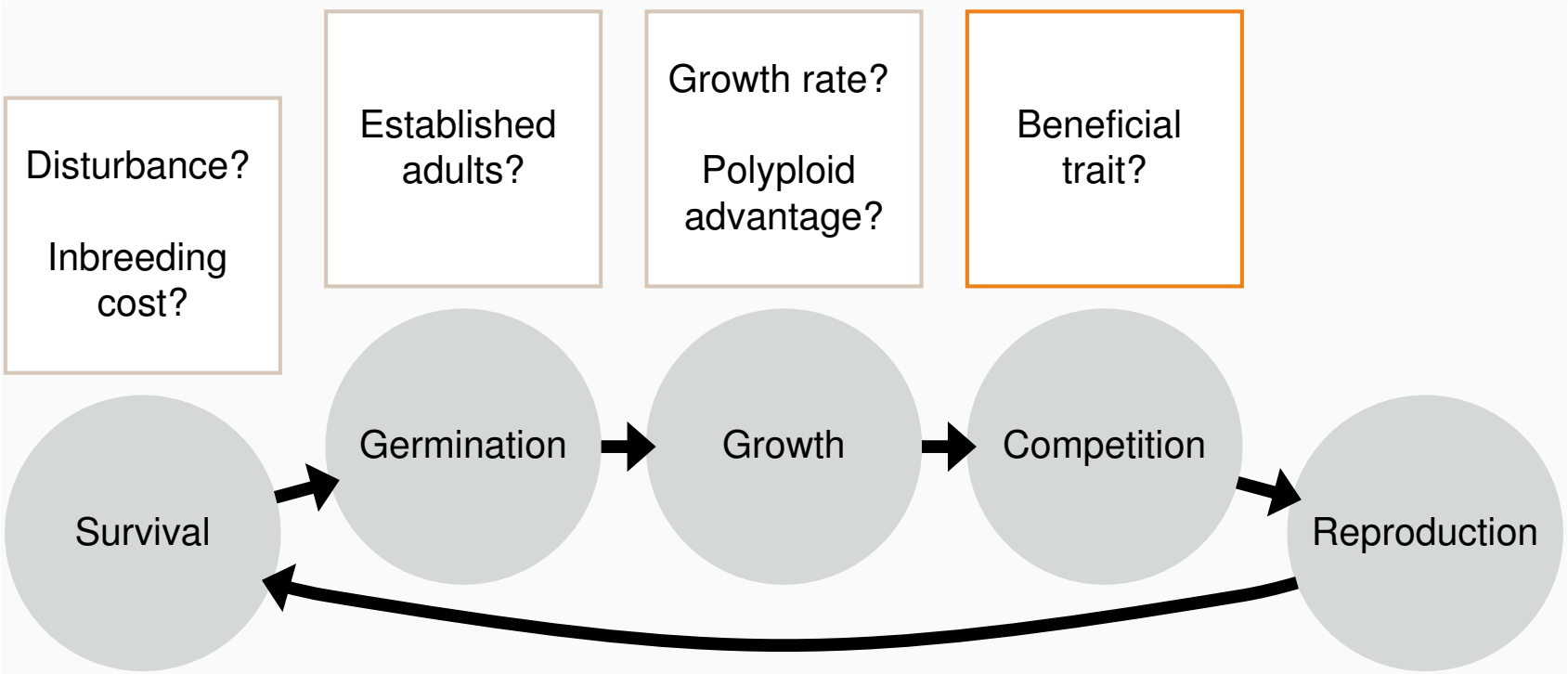
Germination



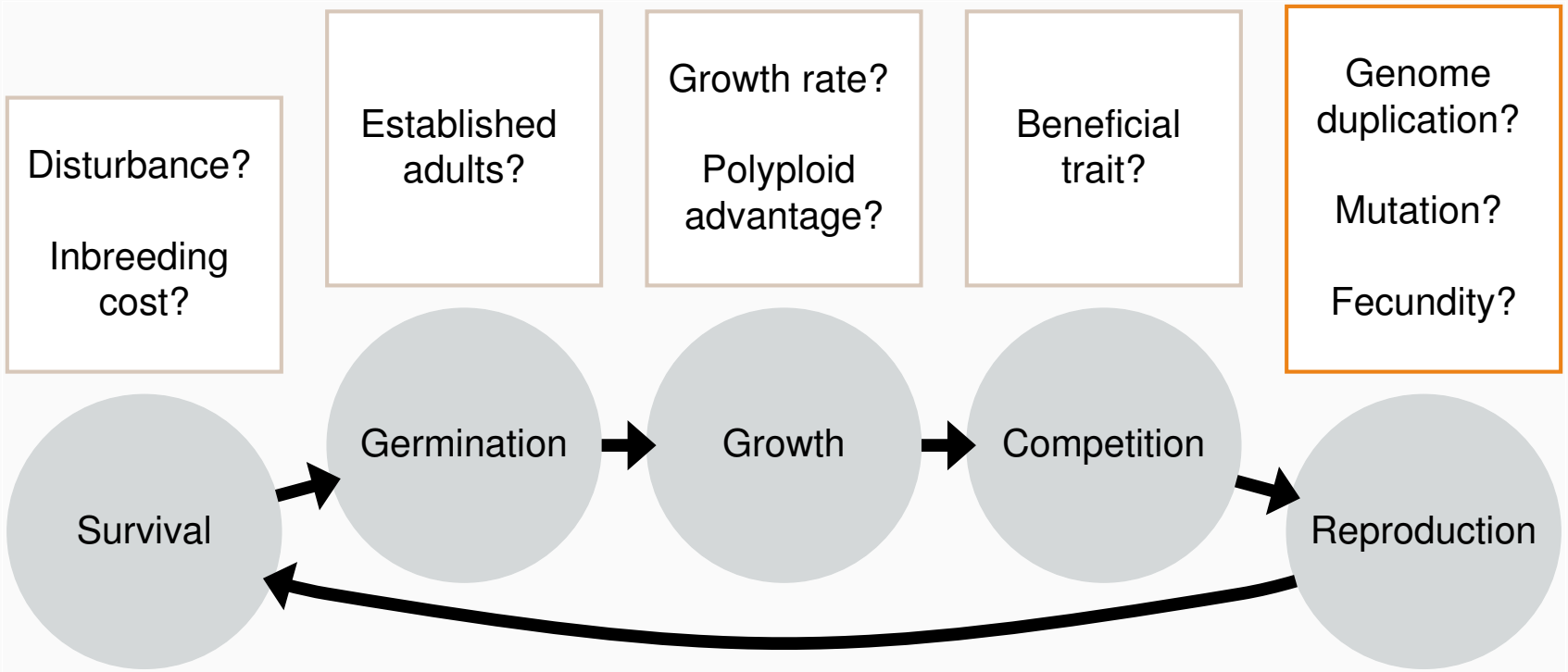
Growth


Disturbance?
Inbreeding cost?
Established adults?
Growth rate?
Polyploid advantage?
Survival
Germination
Growth
Competition
Reproduction

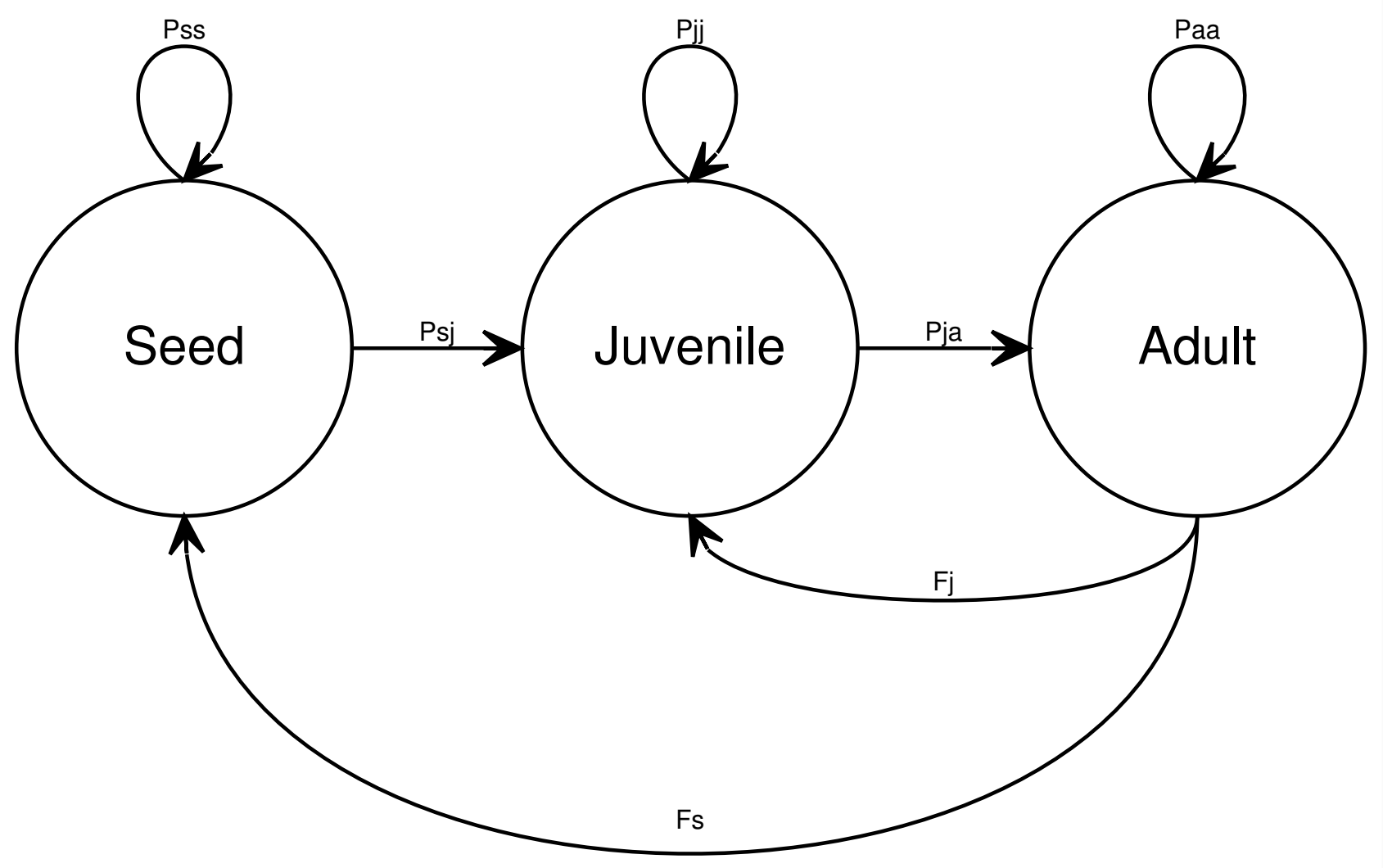
Competition



Reproduction



The Life Cycle



The transition probabilities shown here are controlled by parameters in the model and the interactions which occur during the simulation.

The Individuals

ID	X	Y	life_stage	size	ploidy	gen	growth_rate	inbreeding
0_94	4	5	2	4.219	2	3	1.615935	FALSE
0_23	6	3	2	7.233	2	3	1.933908	FALSE
0_62	7	0	2	3.004	2	3	1.442703	FALSE
0_78	9	1	2	4.299	2	3	1.625779	FALSE
0_23	6	3	2	13.988	2	4	1.933908	FALSE
0_78	9	1	2	6.989	2	4	1.625779	FALSE

allele	locus	value
1	1	48.64990
1	2	60.69052
2	1	89.82384
2	2	83.90019