PLANTS THERMOREGULATION

Introduction

- 3 plants have thermoregulation activities:
  - *Philodendrum selloum*
  - *Symplocarpus foetidus* (skunk cabbage)
  - *Nelumbo nucifera* (sacred lotus)

Philodendrum selloum

- Flower temperature: 38 – 46 °C
- In air temperature: 4 – 39 °C
- Period of regulation: 18 – 24 hours

Symplocarpus foetidus (skunk cabbage)

- Flower temperature: 15 – 22 °C
- In air temperature: -15 – 10 °C
- Period of regulation: > 2 weeks

Nelumbo nucifera (sacred lotus)

- Flower temperature: 30 – 37 °C
- In air temperature: 10 – 35 °C
- Period of regulation: 2 – 4 days

WHY THERMOREGULATE?

Why should plants produce heat?

- Scent vaporization

→ Partial explanation

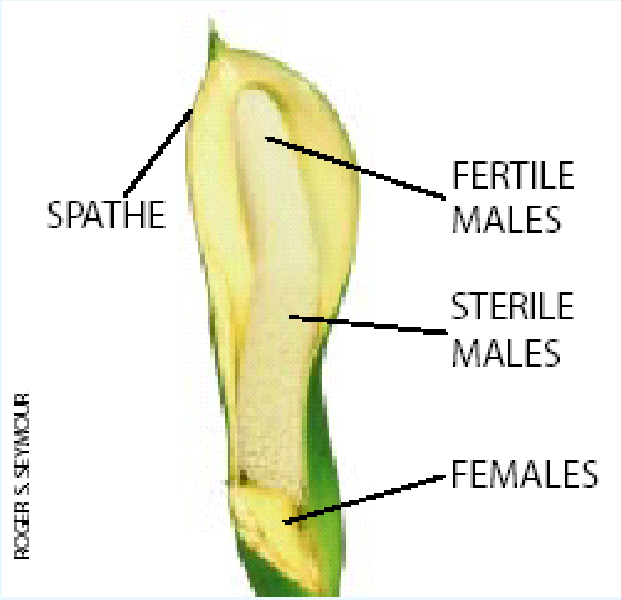
- Plants reproduction

Insects prefer warm environment

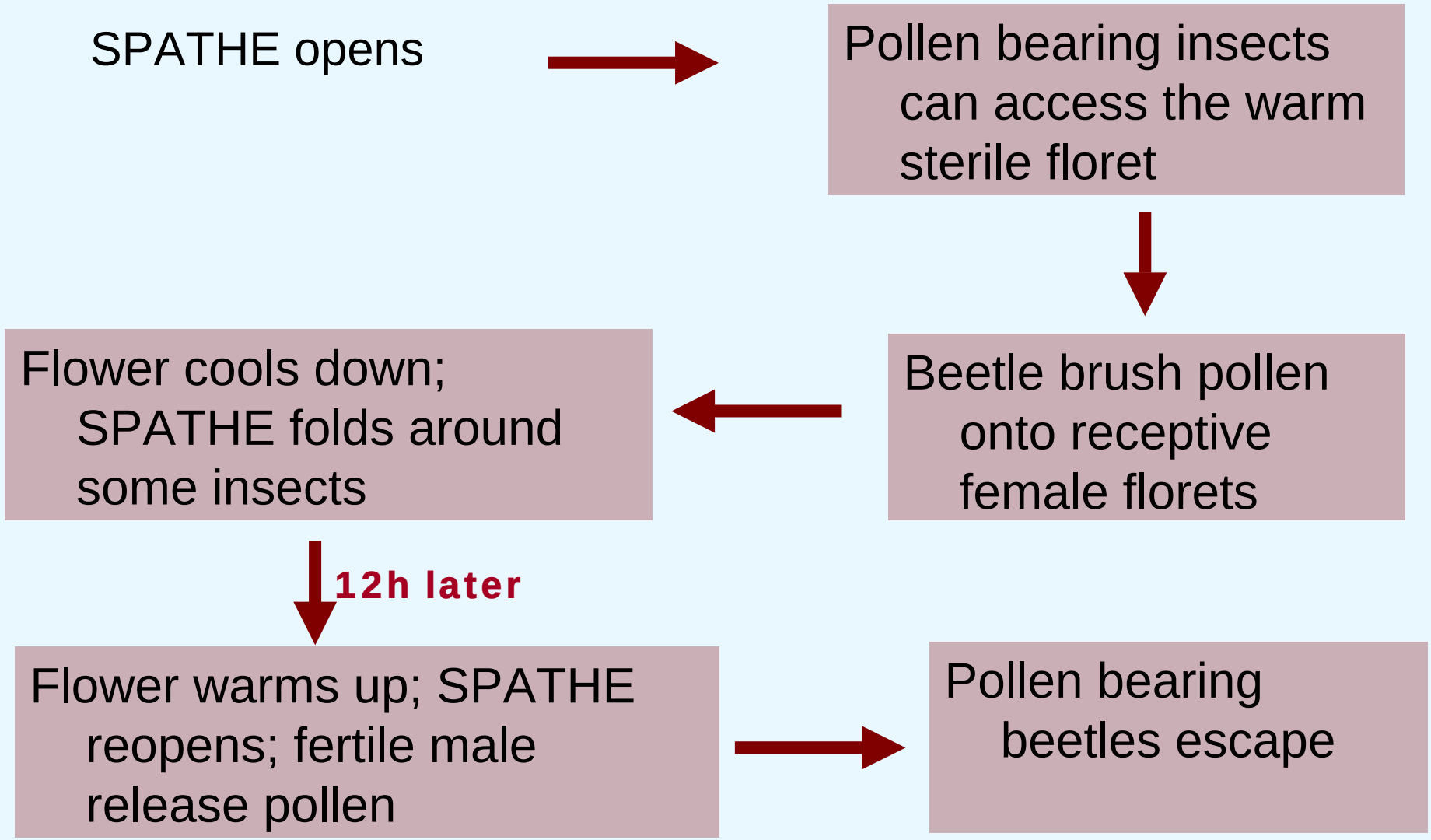
Plants may require constant temperature for proper development

Thermoregulation & Pollination

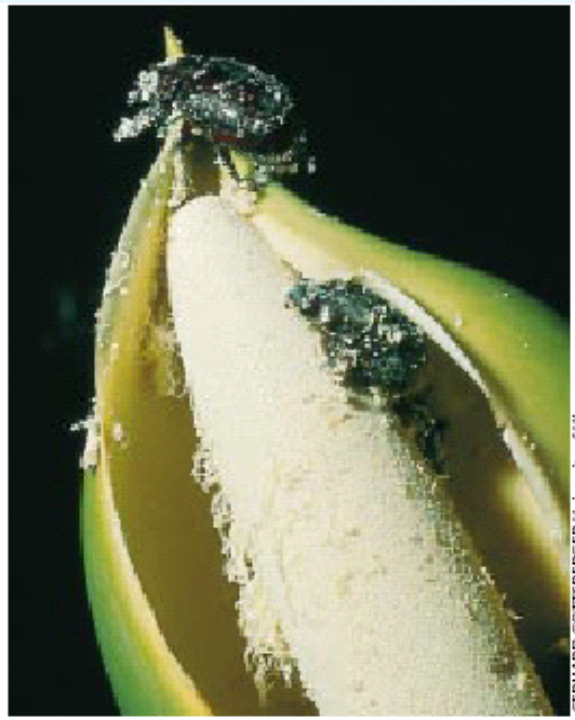
- *Philodendrum selloum* florets:
  - fertile males
  - female
  - Sterile males



Thermoregulation & Pollination



Thermoregulation & Pollination



Thermoregulation & Pollination

- Advantages of this process:
  - Promoting cross-pollination
  - Prevents self-pollination

INCREASED GENETIC DIVERSITY

HOW IS IT BEING DONE?

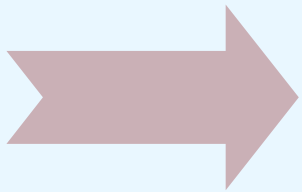
Which part of the plant?

oxygen consumption rate measurements

Sterile males

Sterile males

- Electron microscopy examination:
  - Fat droplets
  - Many mitochondria

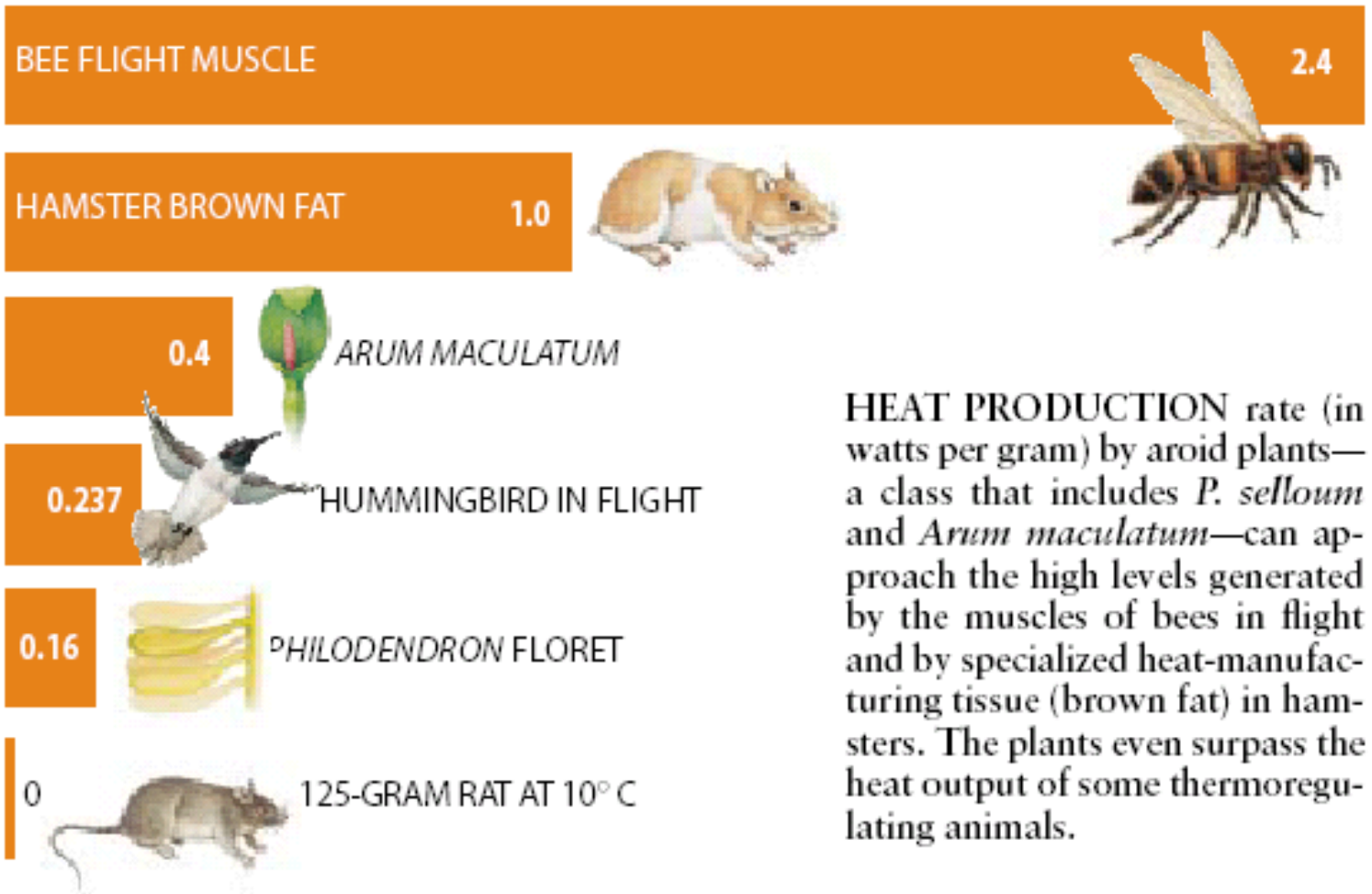


BROWN FAT TISSUE

Brown fat tissue

- No use of ATP molecules
- Direct heat production
- High rate heat production

High rate heat production



HEAT PRODUCTION rate (in watts per gram) by aroid plants—a class that includes *P. selloum* and *Arum maculatum*—can approach the high levels generated by the muscles of bees in flight and by specialized heat-manufacturing tissue (brown fat) in hamsters. The plants even surpass the heat output of some thermoregulating animals.

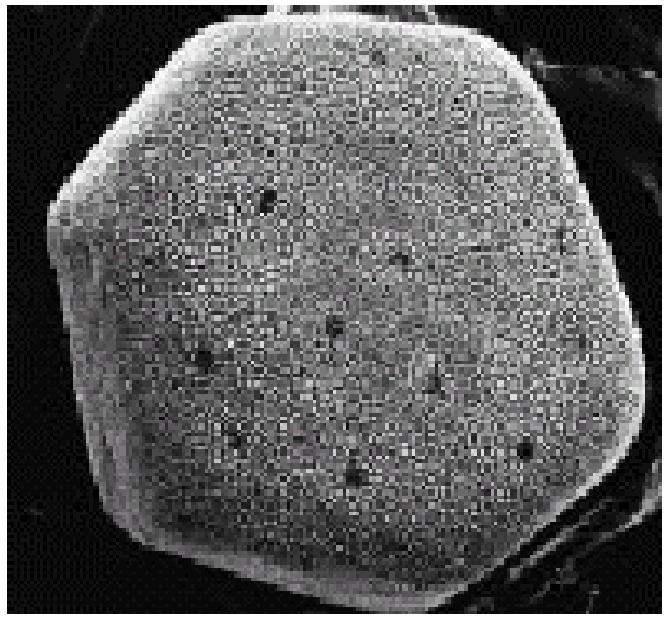
Oxygen intake

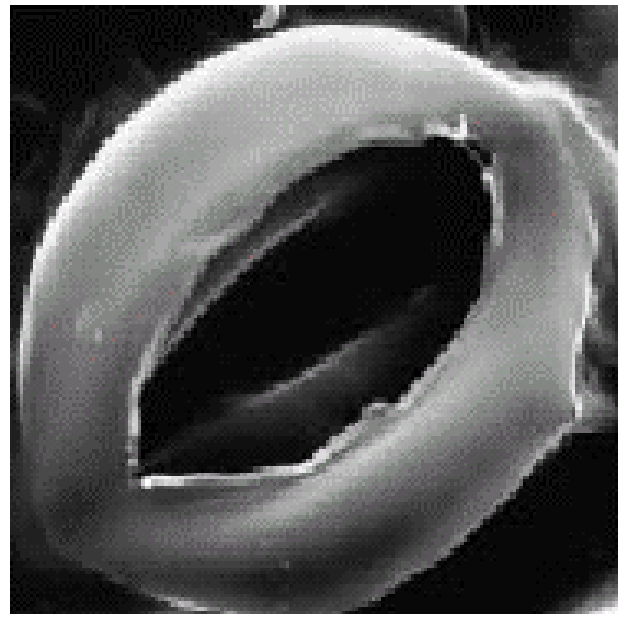
- No lungs
- No circulation

HOW DOES THE PLANT GAINS ITS OXYGEN SUPPLY?

Diffusion !!!

Oxygen diffusion





ROGER S. SEYMOUR

STERILE MALE FLORETS of *P. selloum* (*left*) take in oxygen through pores called stomates. Several stomates (*dark spheres*) are visible in the center micrograph, highlighting the tip of one floret. The micrograph at the right captures a single stomate.

ENVIRONMENTAL FACTORS

Environmental factors

- 2 environmental factors may affect thermoregulation:
  - Light cycle
  - Temperature

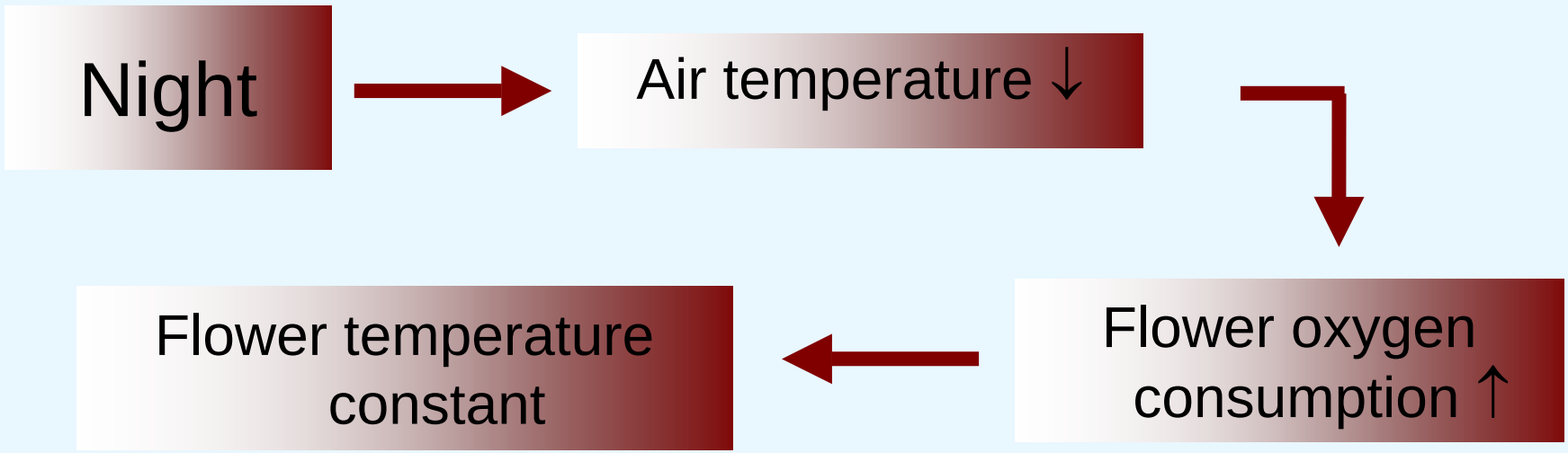
Environmental factors

- A study was designed: Intact sacred lotus flowers were studied outdoor under three conditions

1. Natural temperature and light cycles
2. Reversed temperature and constant darkness
3. Reversed temperature and natural light cycle

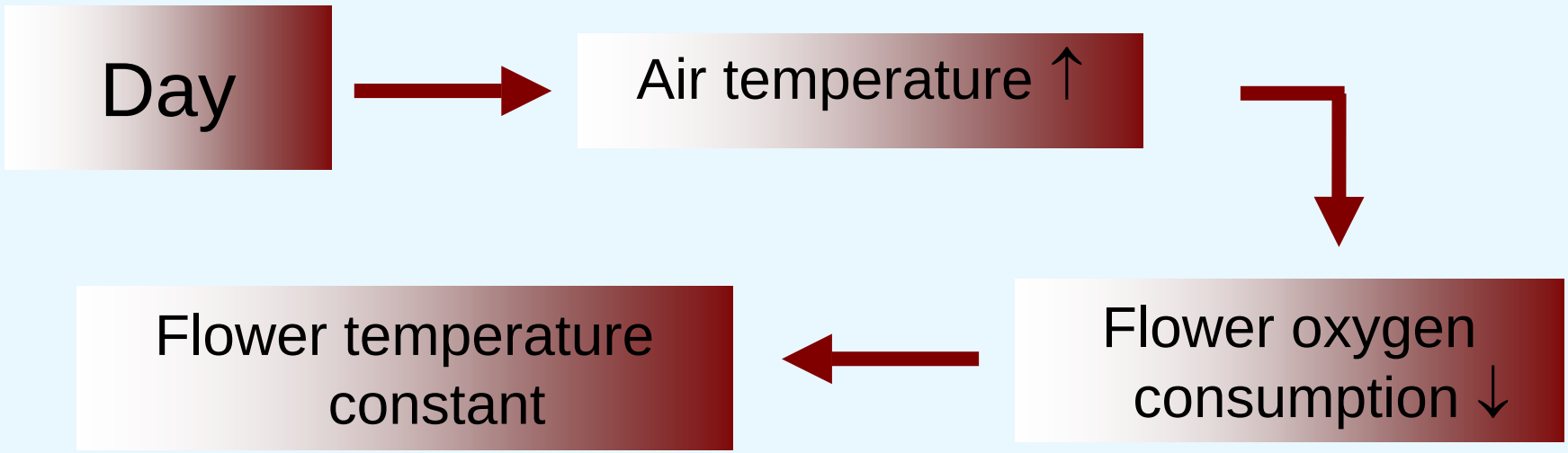
Results

Group 1:



Results

Group 1: Normal



Results

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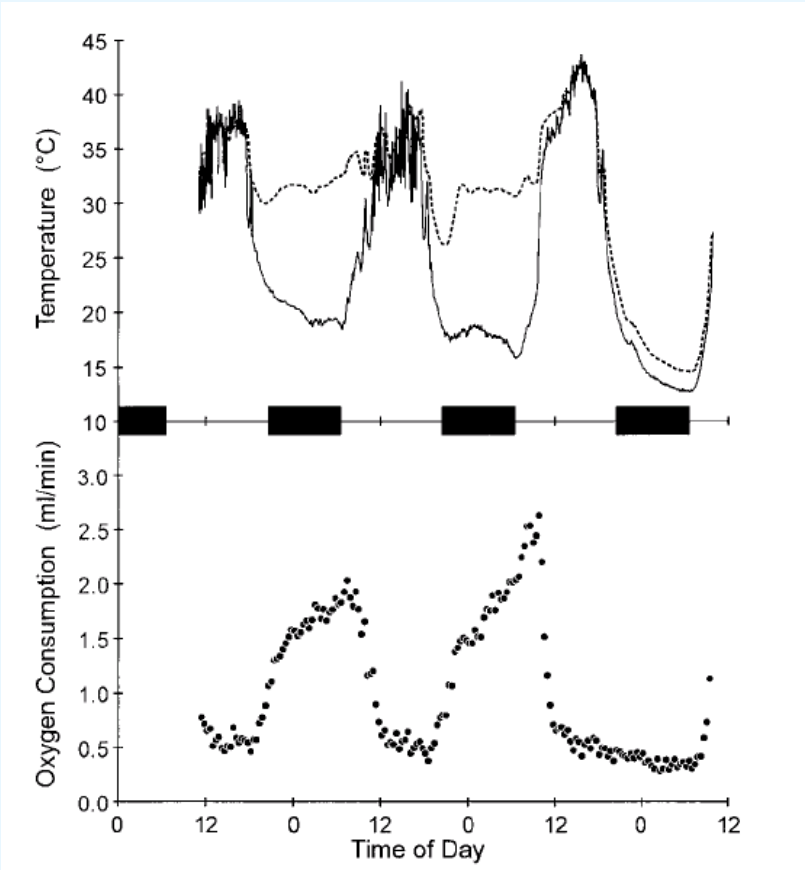
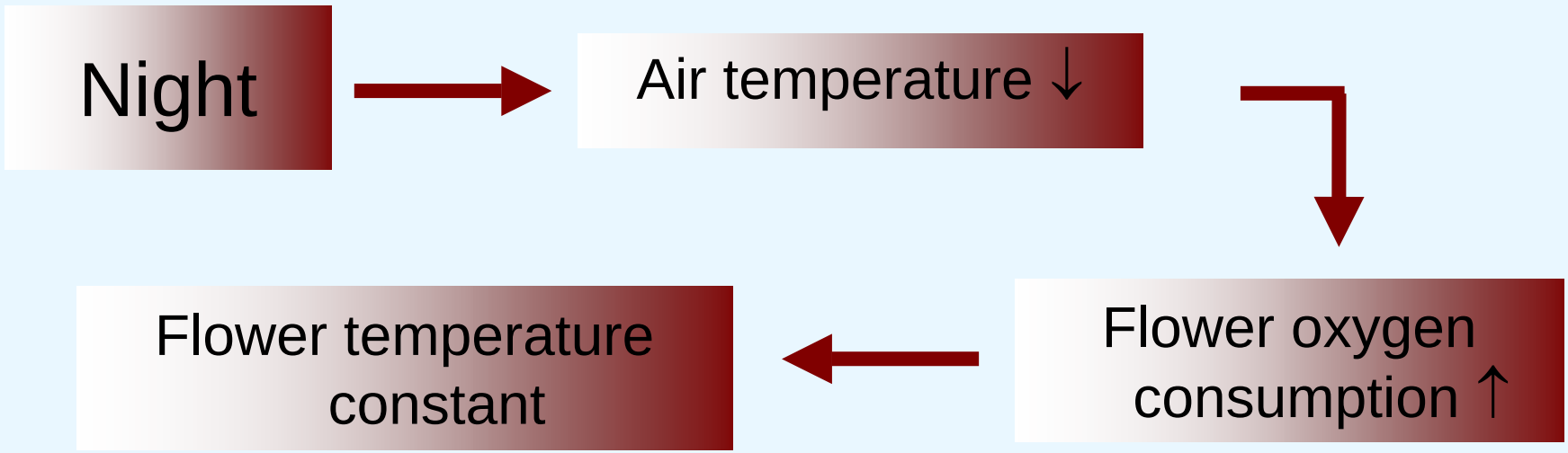


Results

Group 2: Constant darkness



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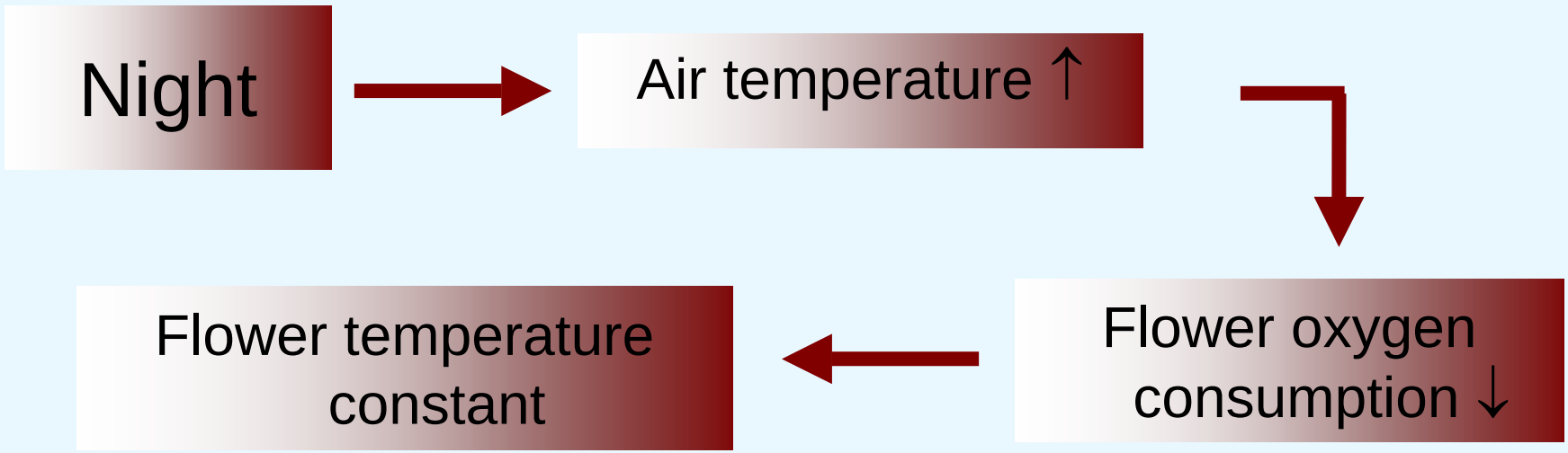

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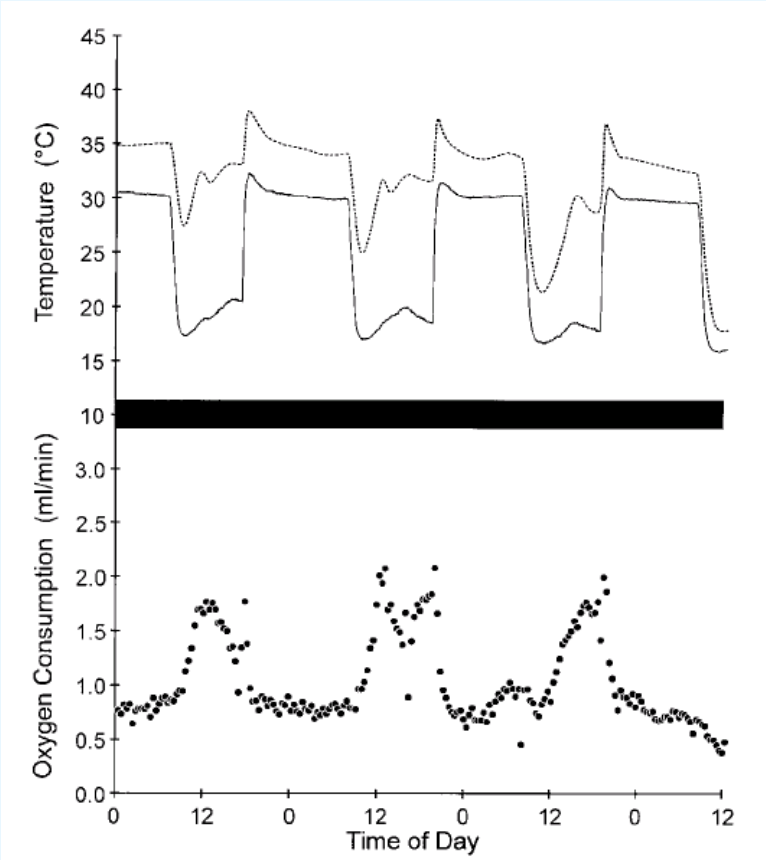
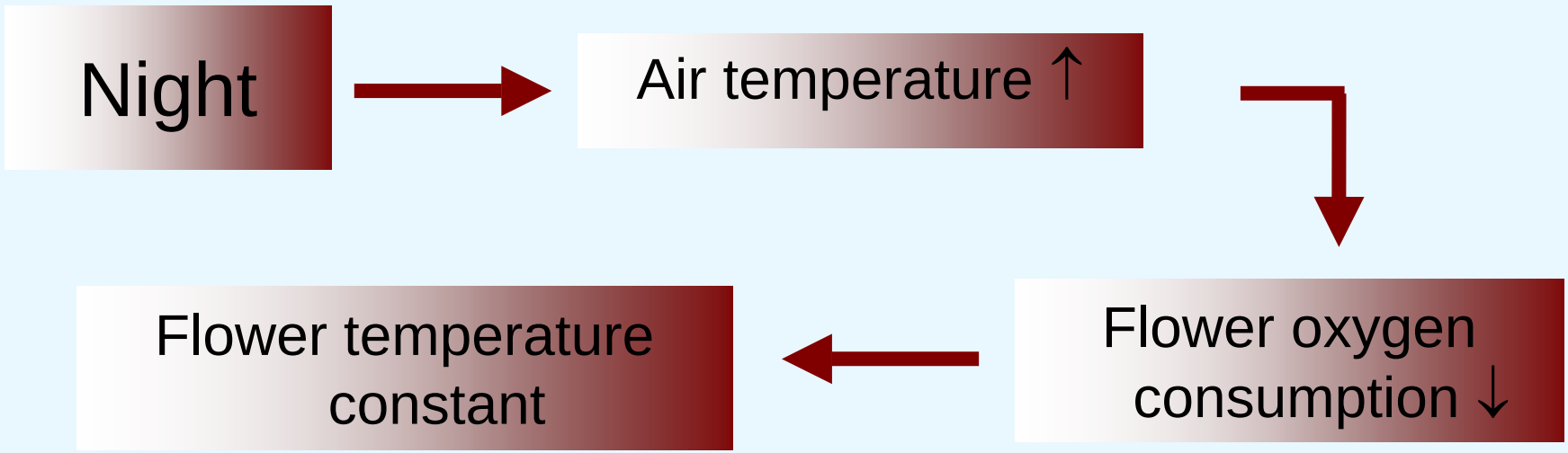
Group 2: Constant darkness



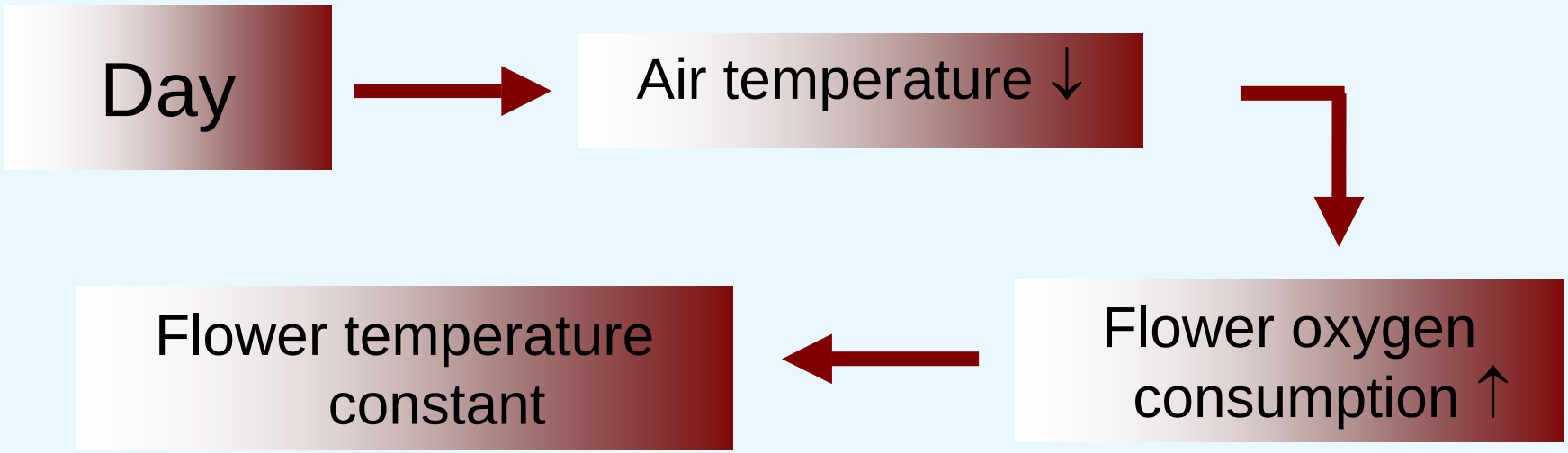
Results

Group 2: Reverse temperature



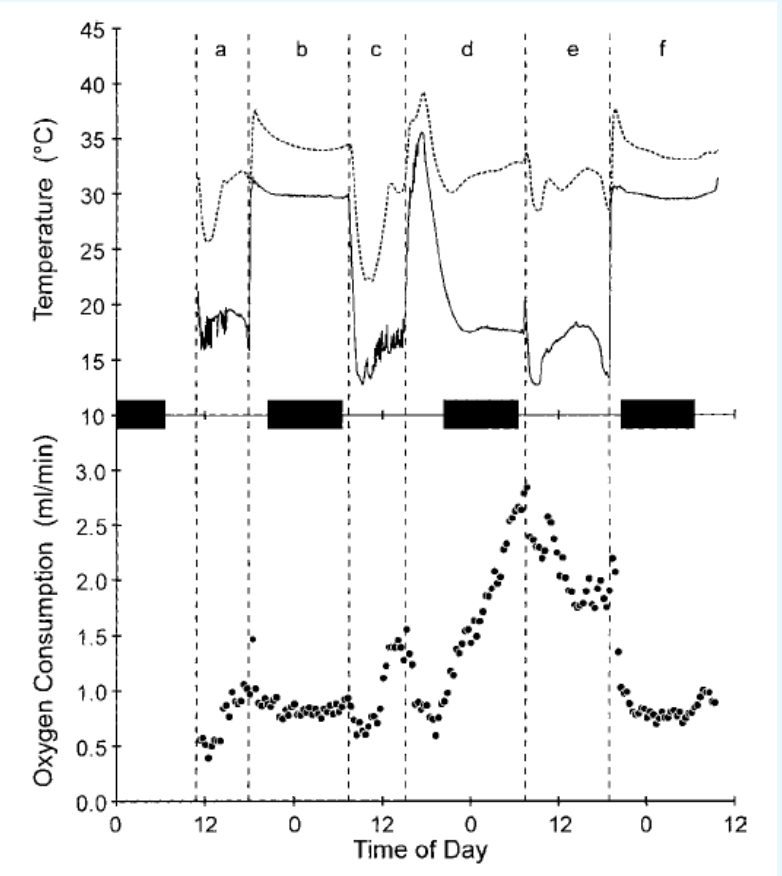
Results

Group 3: Reverse temperature



Results

Group 3: Reverse temperature



Conclusion

Thermoregulation responses of the sacred lotus depend on temperature and are not influenced by photoperiod

References

- **Seymour RS.** 1997. Plants that warm themselves. *Scientific American* March 1997, 104-109.
- **Seymour RS, Schultze-Motel P and Lamprecht I.** 1998. Heat production by sacred lotus flowers depends on ambient temperature, not light cycle. *Journal of Experimental Botany*, vol. 49, No. 324, 1213-1217.