Pattern Formation in Development

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Complex Systems

A system is said to be complex if its emergent properties are unpredictable.

Evolution of Complexity

Evolution has produced remarkably complex organisms

BUT

Complexity is NOT a measure of evolutionary success

Selection can occur for Simplicity OR Complexity

Simplicity: Simple organisms require less resources to reproduce and gain competitive advantage
E.g.: some parasites

Complexity: Organisms evolve elaborate mechanisms to garner competitive edge
E.g.: Evolution of the brain

Evolution of Complexity

Complexity is often a result of co-evolution between competing species

e.g.: host-parasite interactions

Measures of Biological Complexity

Structural complexity

- no. of cell types

Functional complexity

- no. of different functions an organism can perform

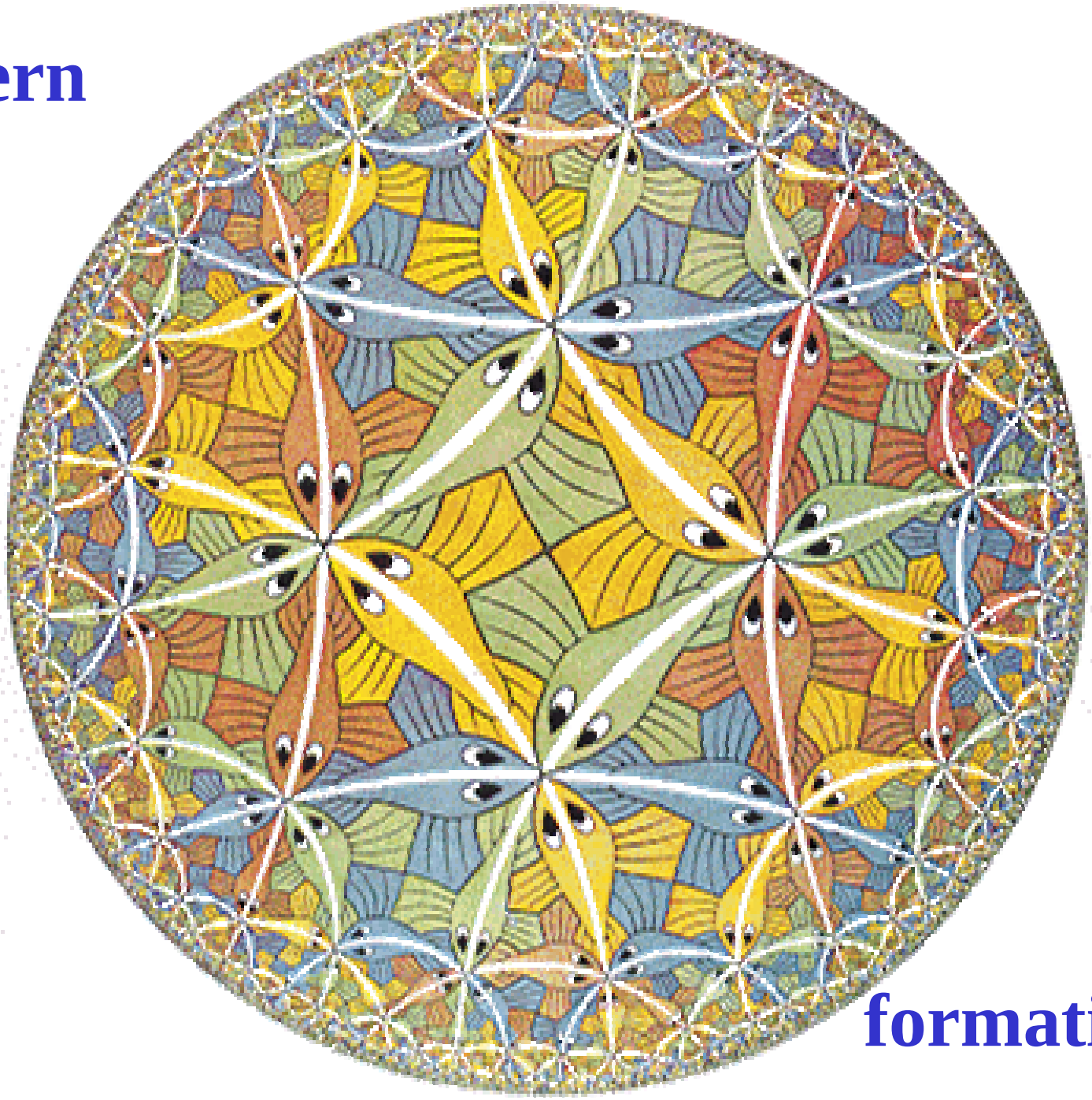
Hierarchical complexity

- no. of lower-level entities nested in higher-order entities

Sequence complexity

- complexity of the genomes

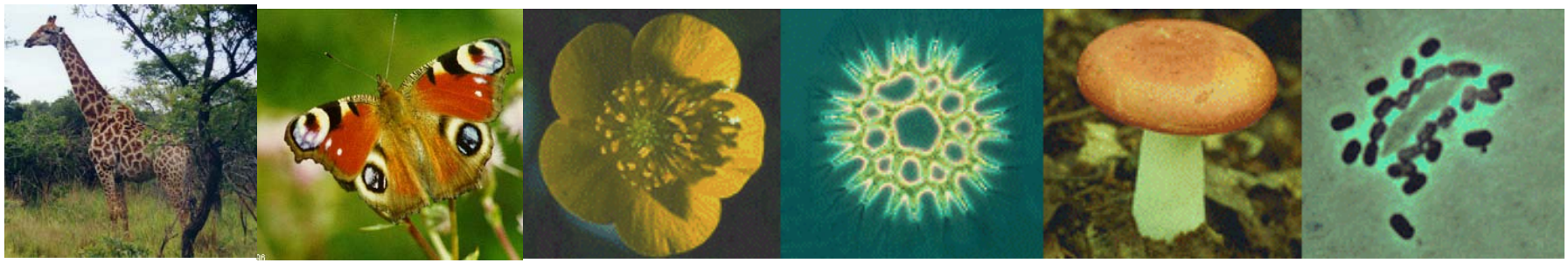
Pattern



formation…

in

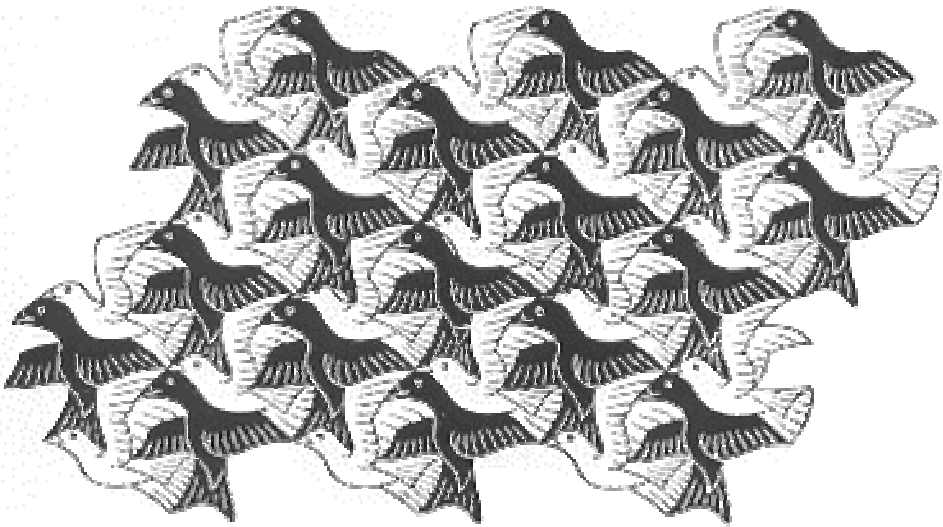
living

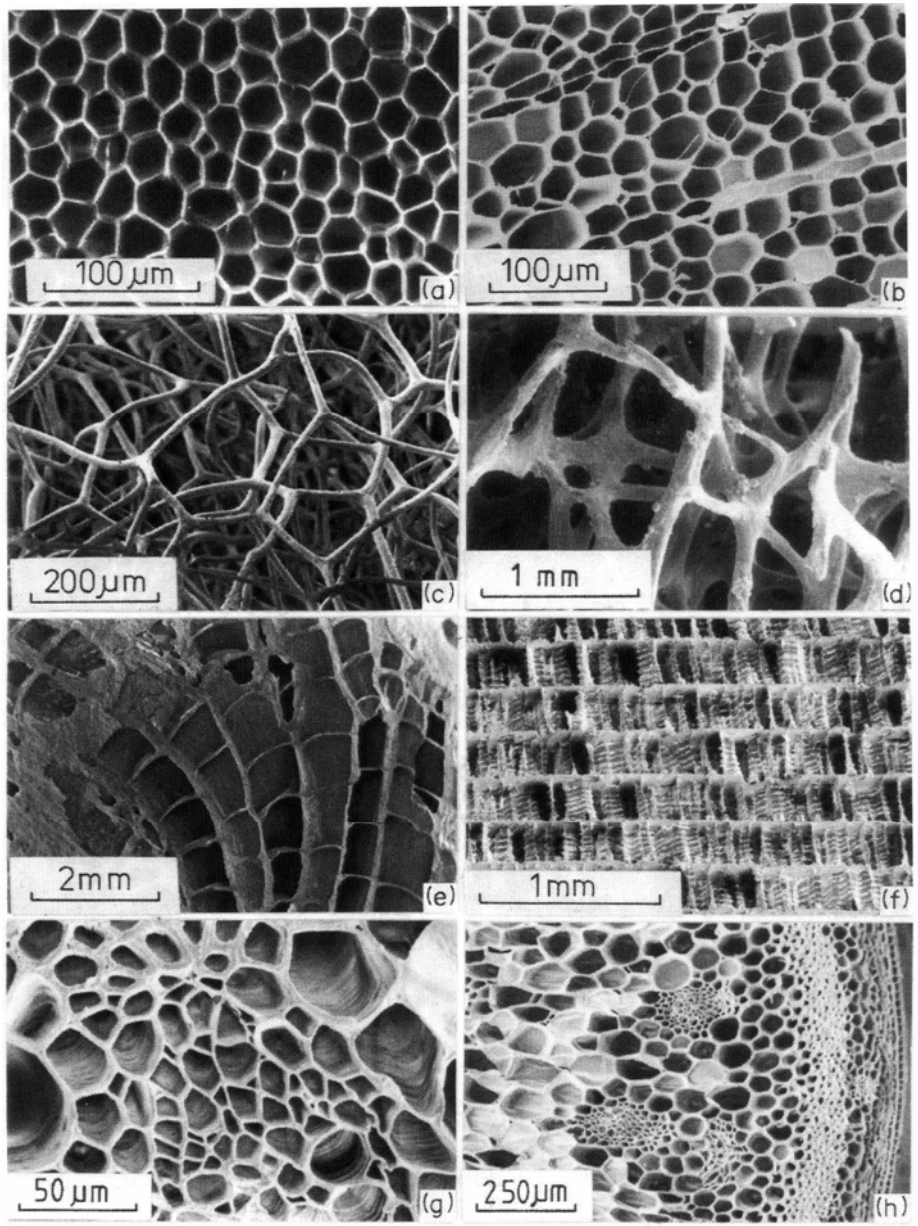


systems

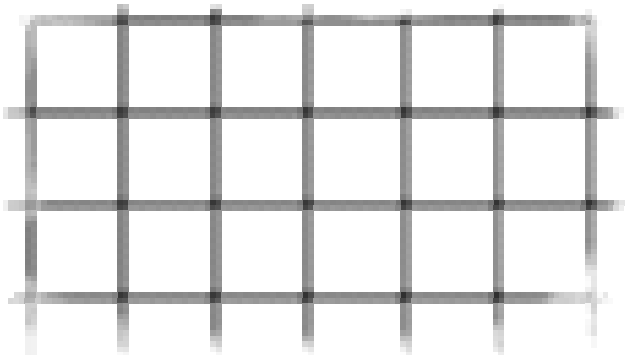
Courtesy: Vidya Athreya

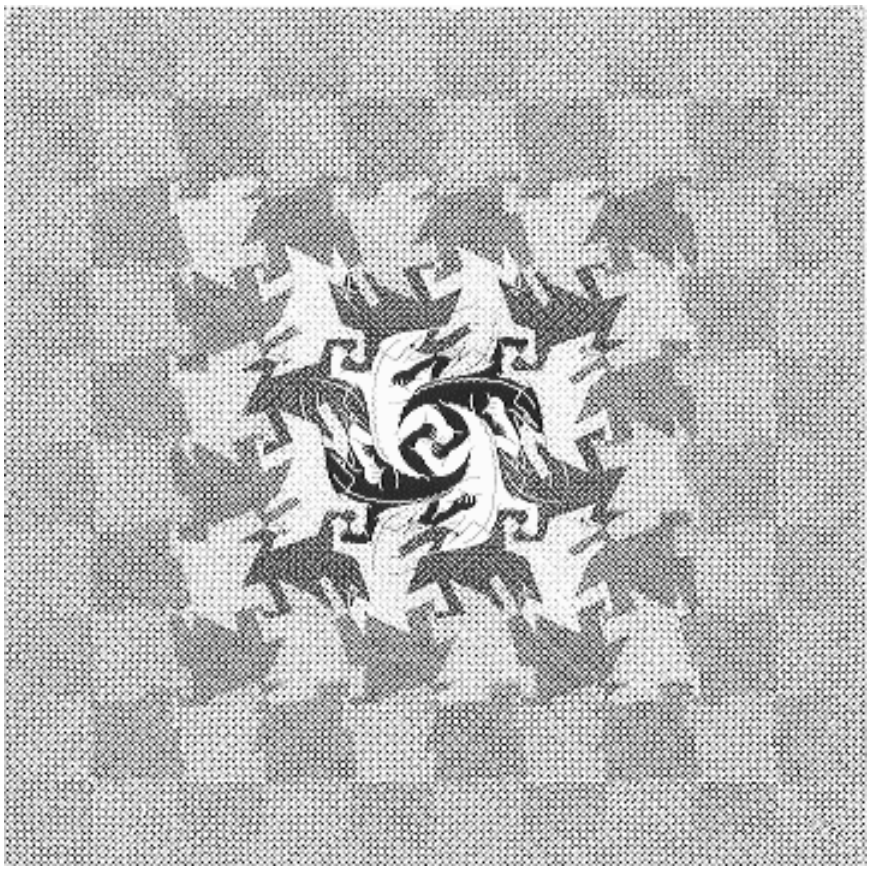
How to generate patterns that are

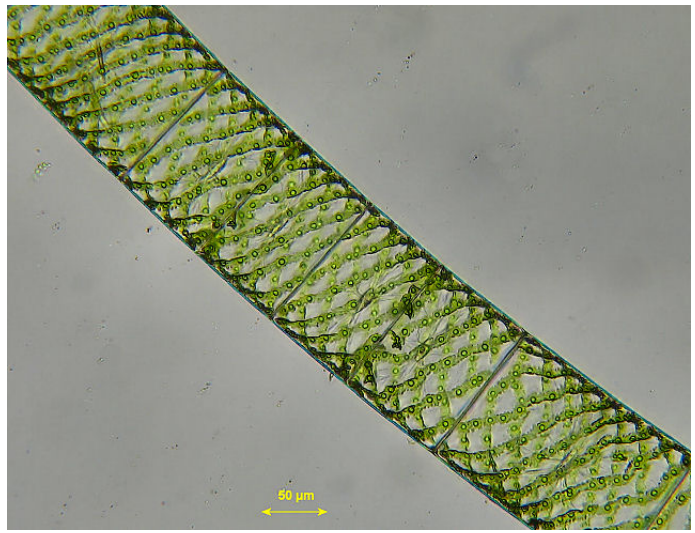




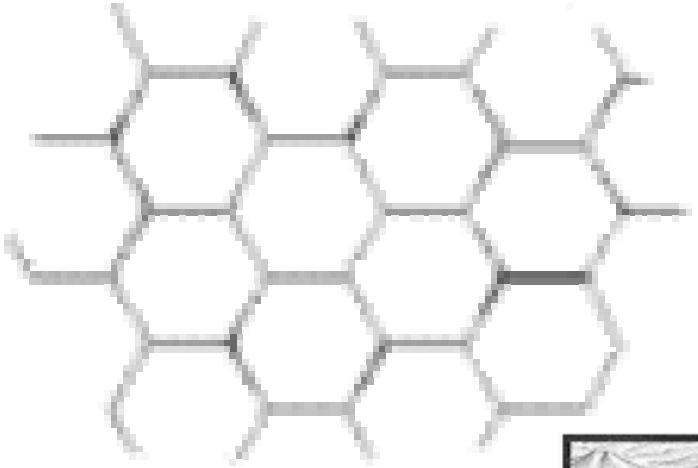
very simple

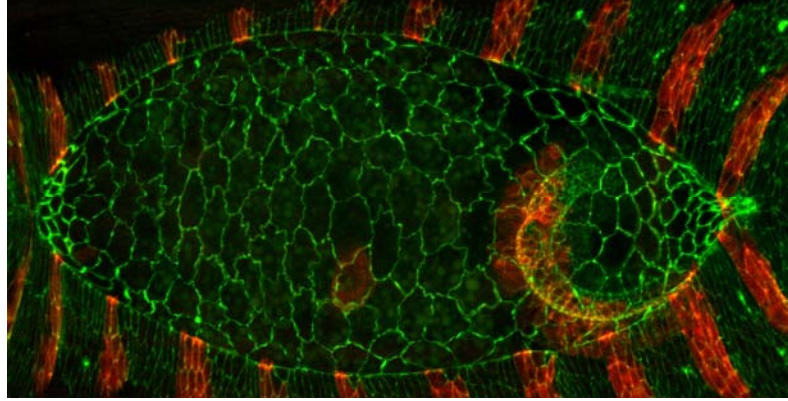


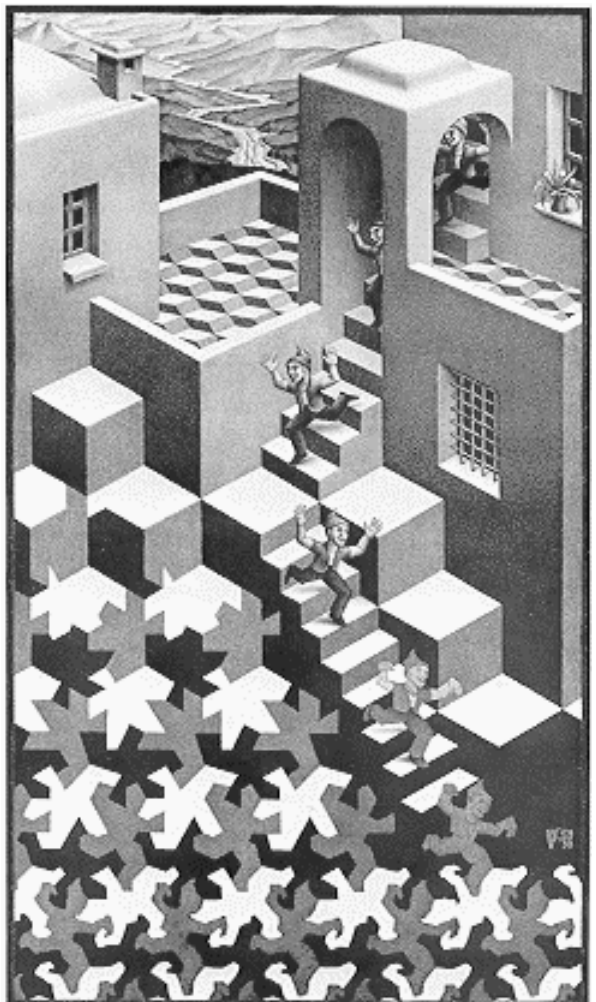


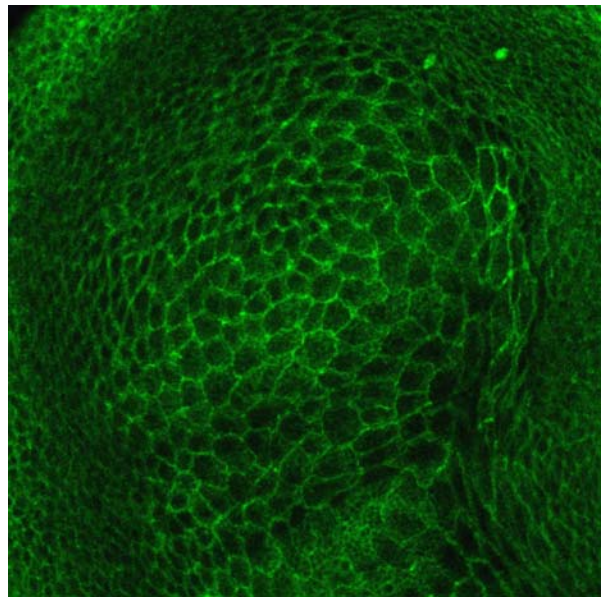


very simple

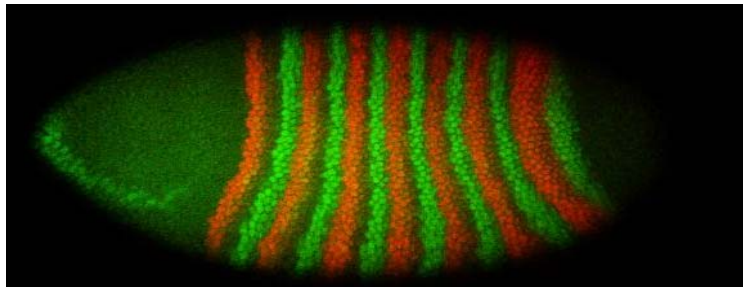








Simple

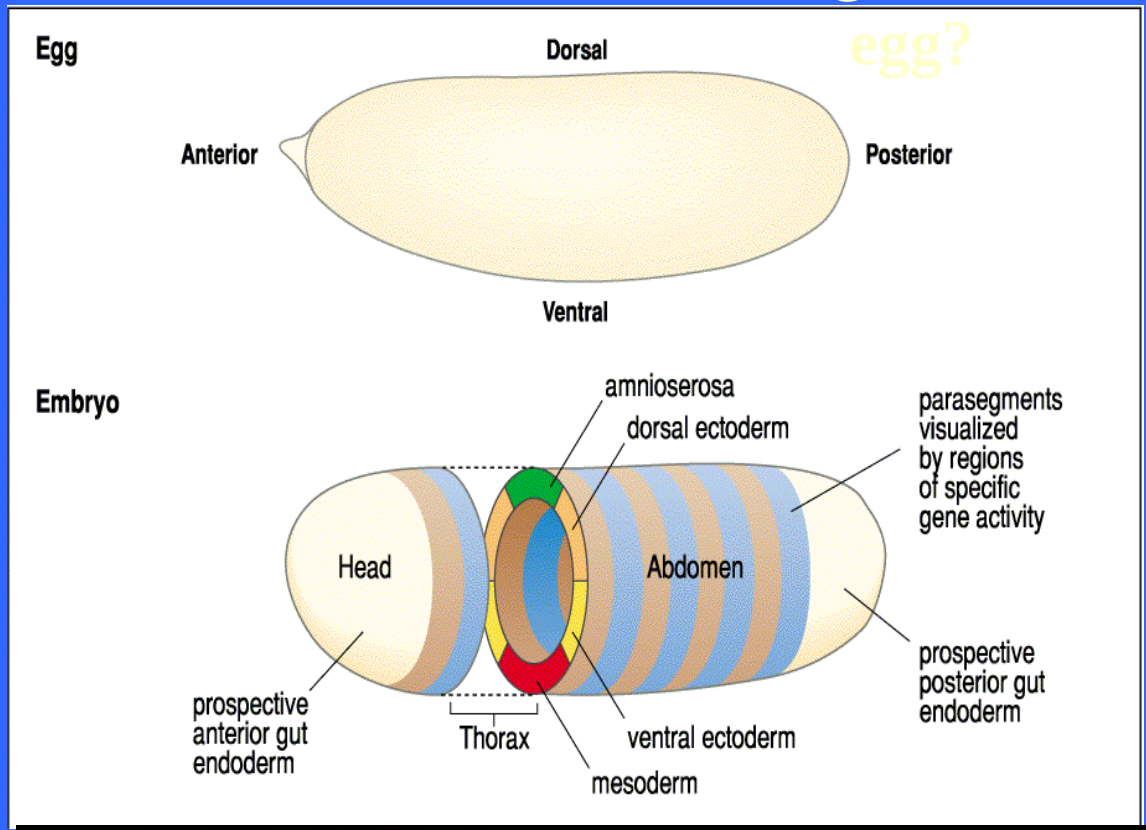


complicated

Very complicated

Very very complicated

How does a multicellular organism develop from a unicellular egg?



"nothing in biology makes sense except in the light of evolution."

Theodosius Dobzhansky

"nothing in life makes sense except in the light of evolution."

Complexity of the system

Complexity of the system

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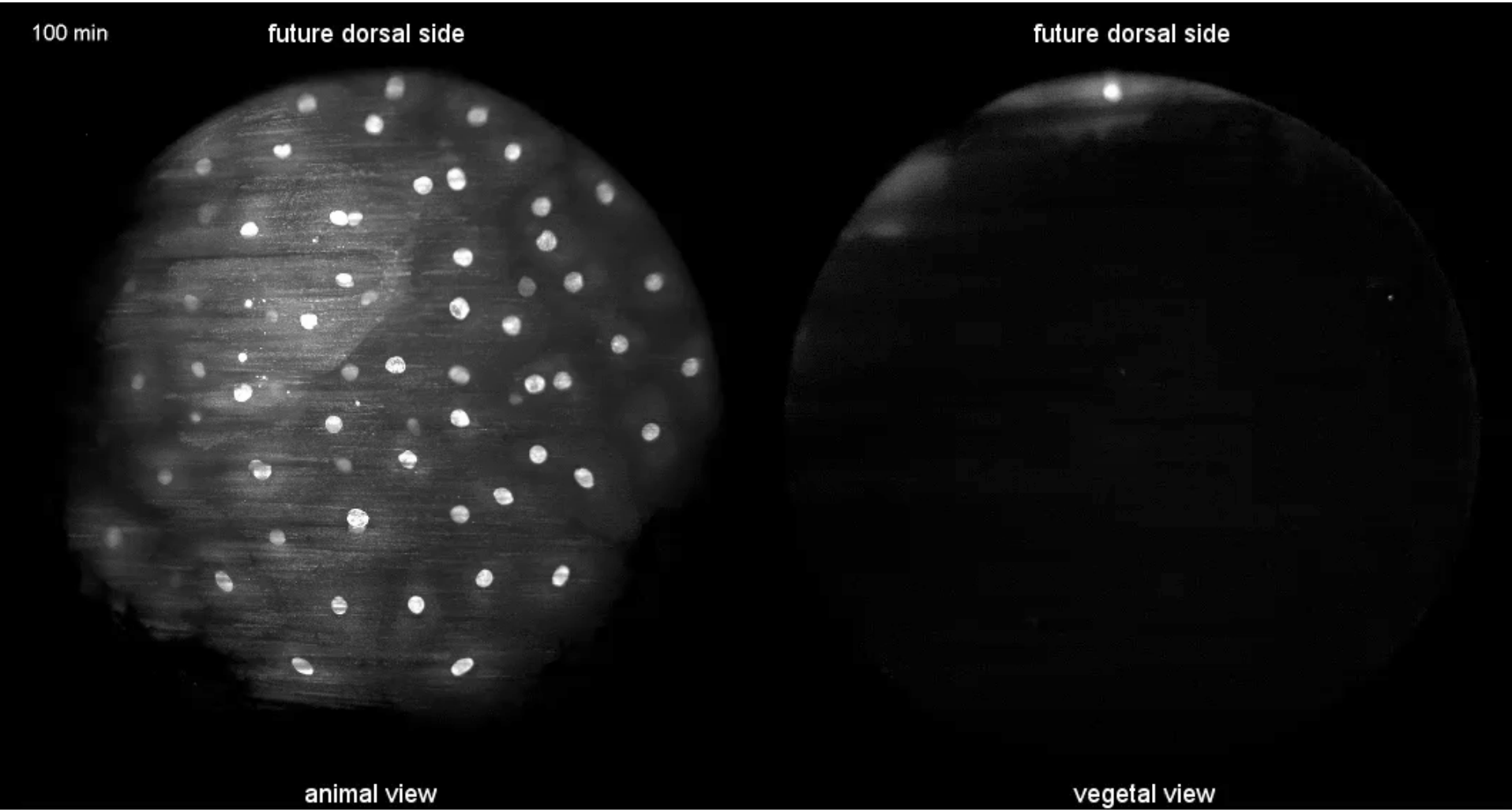
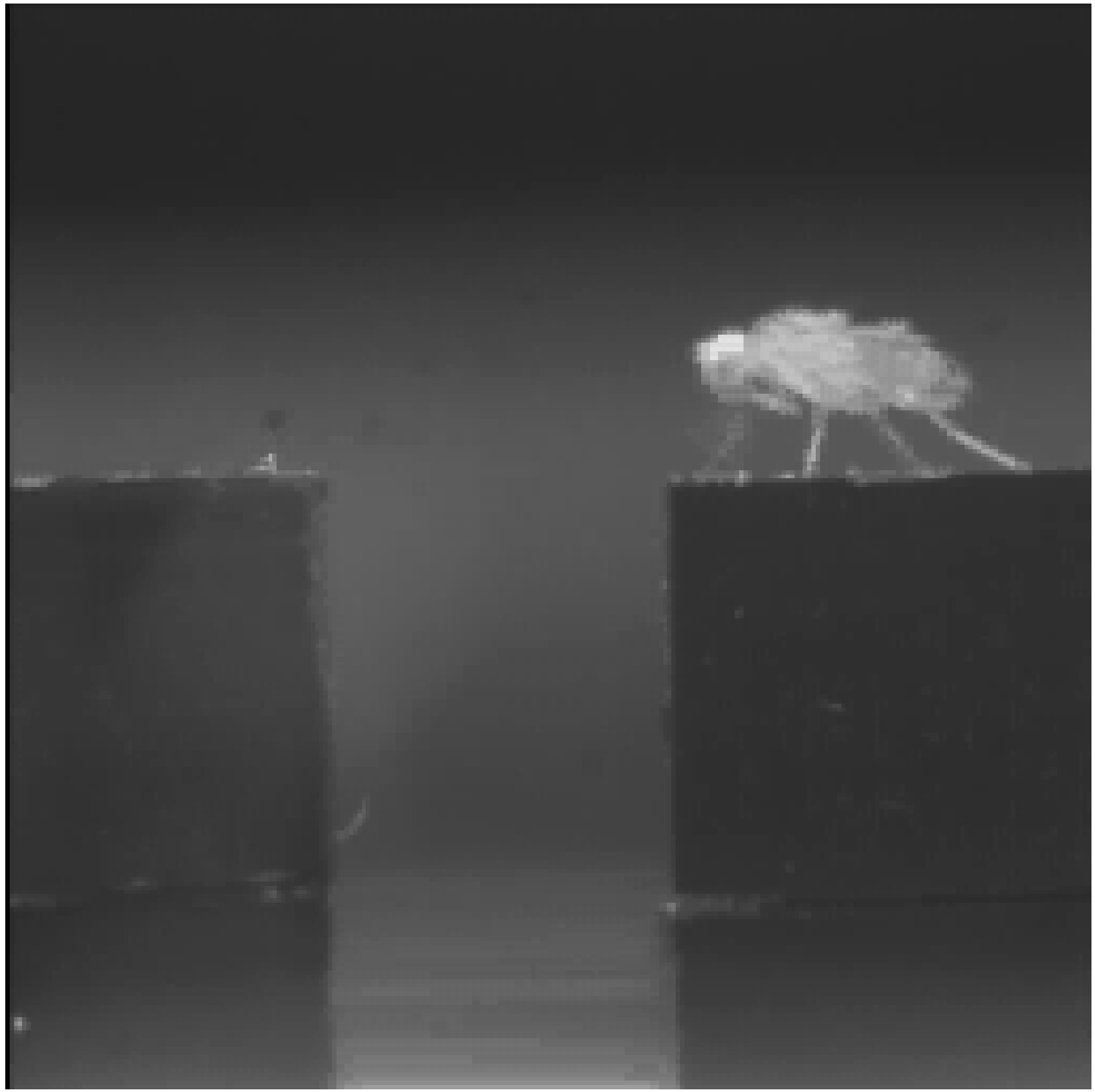
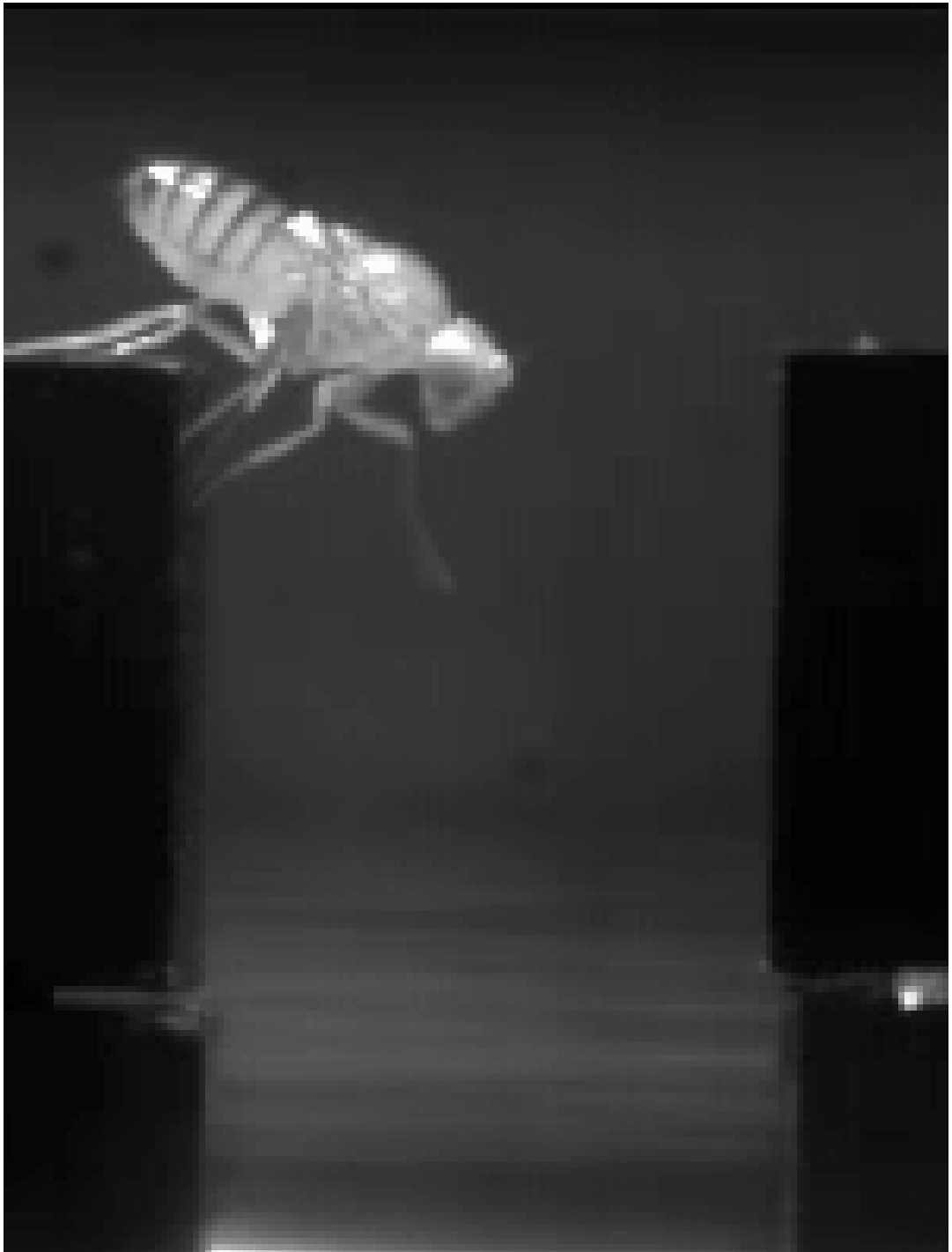
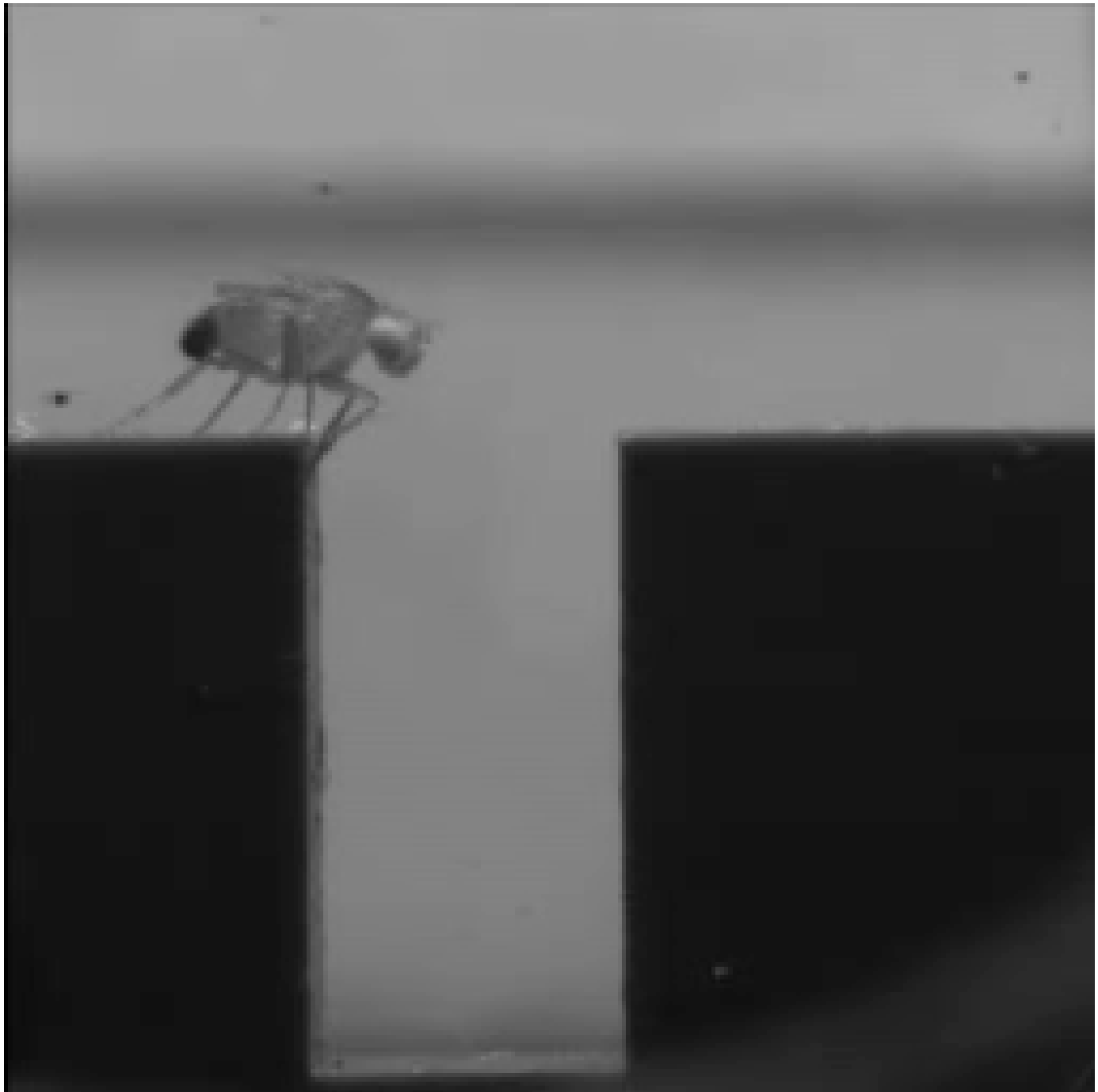


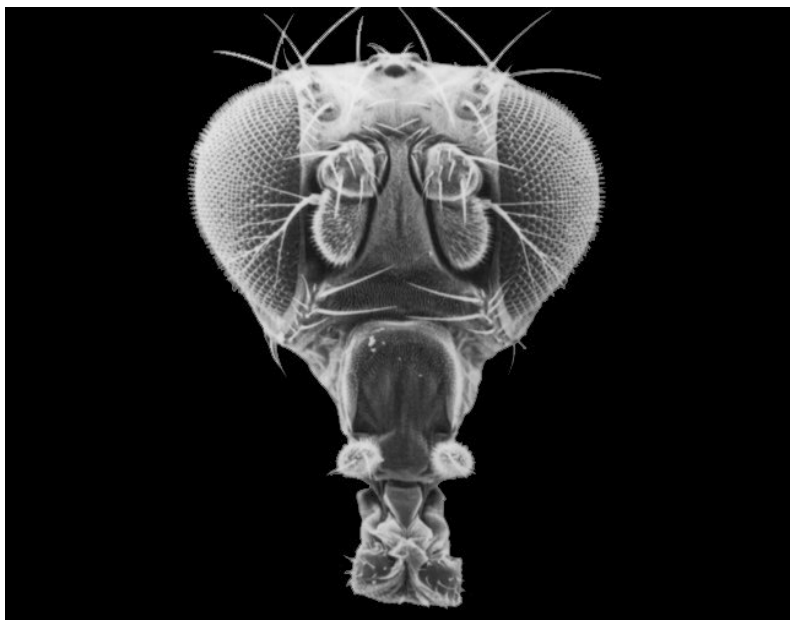


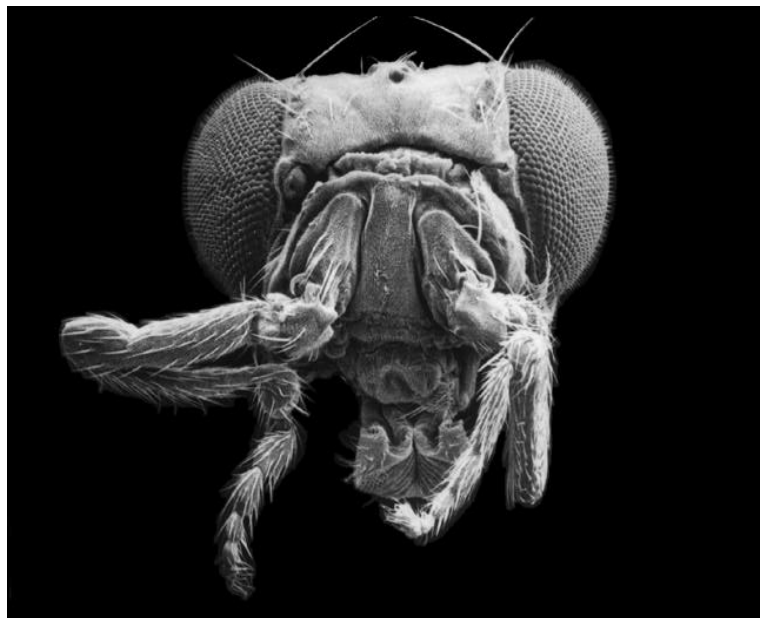


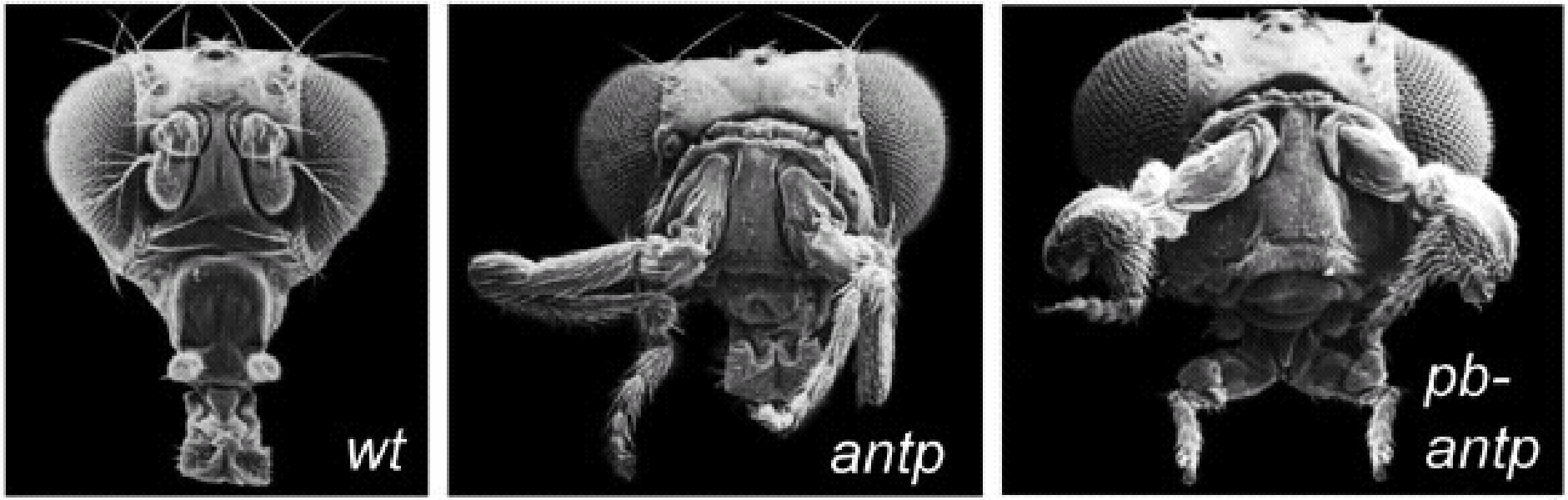


can one induce eye development on legs…

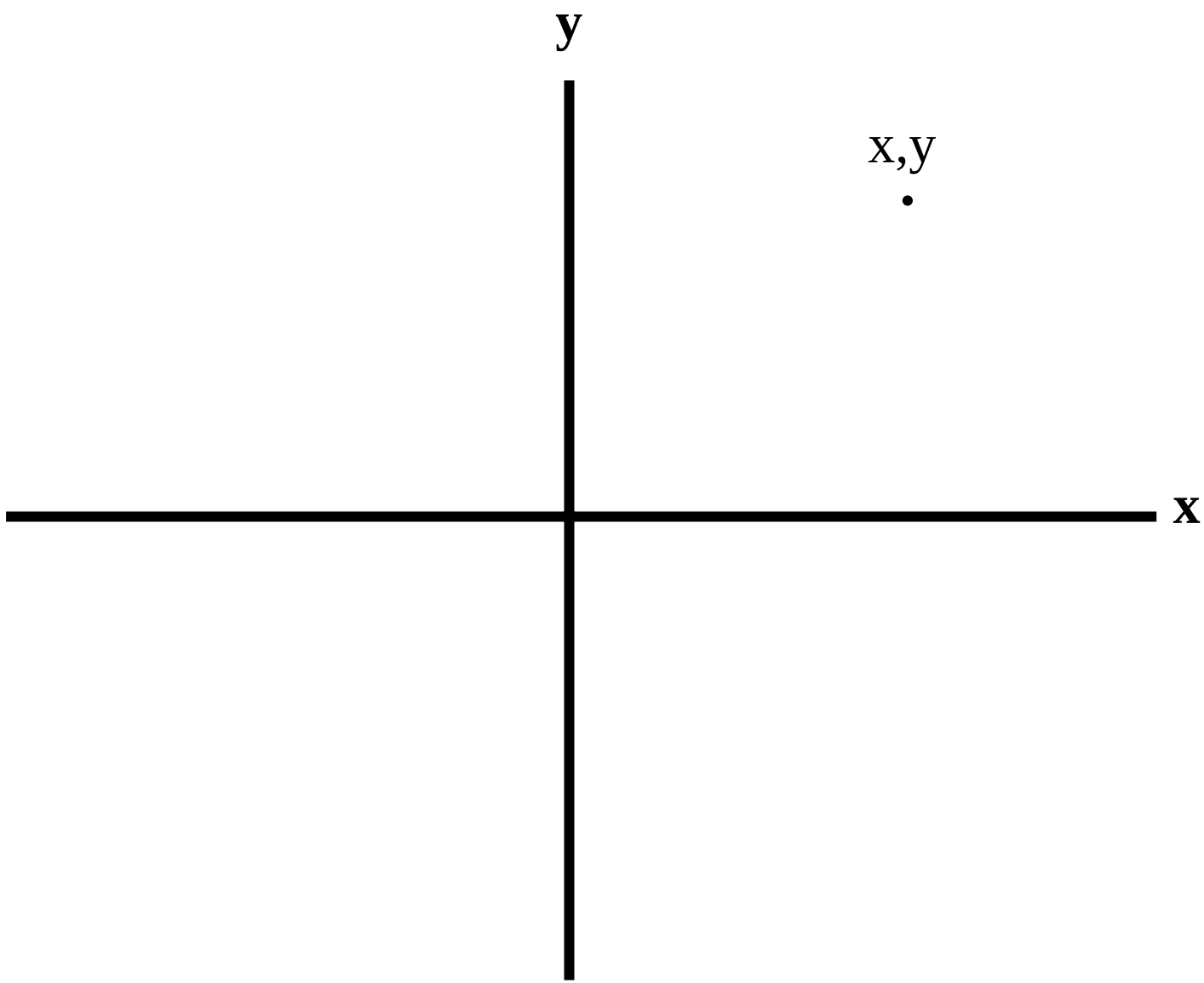
…or virtually anywhere?!



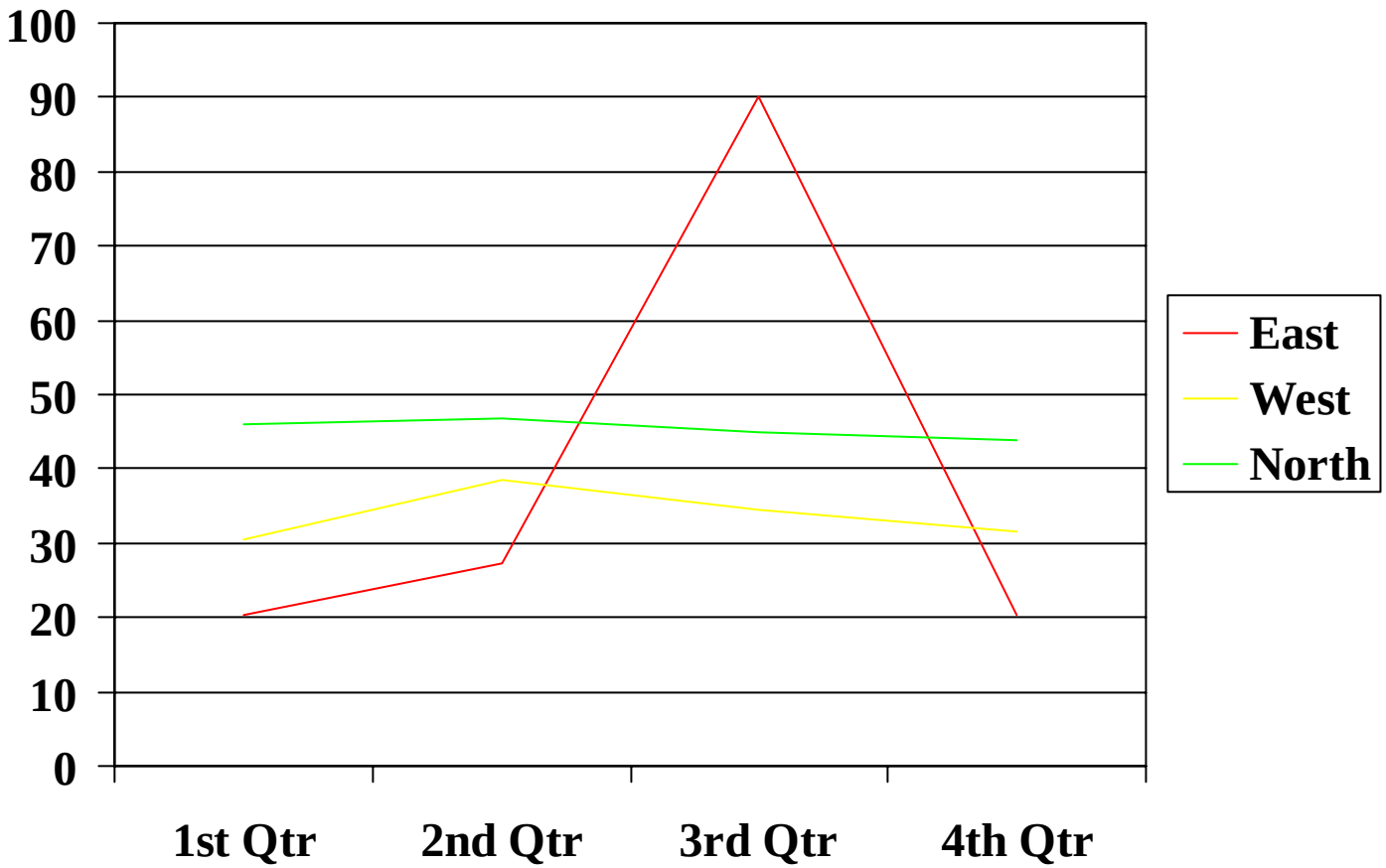




Leg-headed fly


y
x,y
x


A
B



Axes are reference lines from which distances or angles are measured in a coordinate system