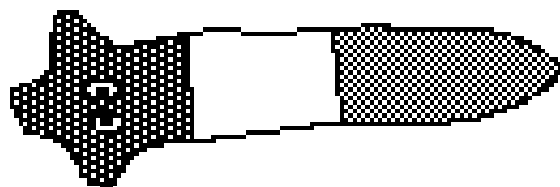
The background of the book cover is a deep blue gradient. It features several 3D ball-and-stick molecular models. One prominent model in the lower-left corner shows a complex, interconnected network of spheres and rods, resembling a protein structure or a complex crystal lattice. Other smaller, less detailed molecular structures are visible in the upper-left and lower-right areas. The overall aesthetic is scientific and academic.

Sketching Theoretical Biology

*Toward a
Theoretical Biology*

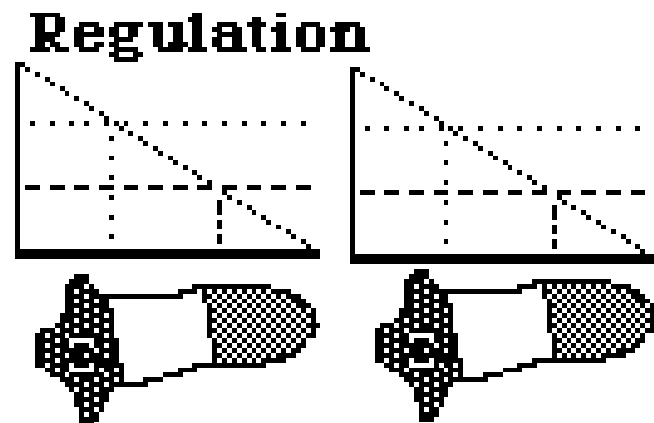
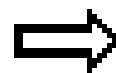
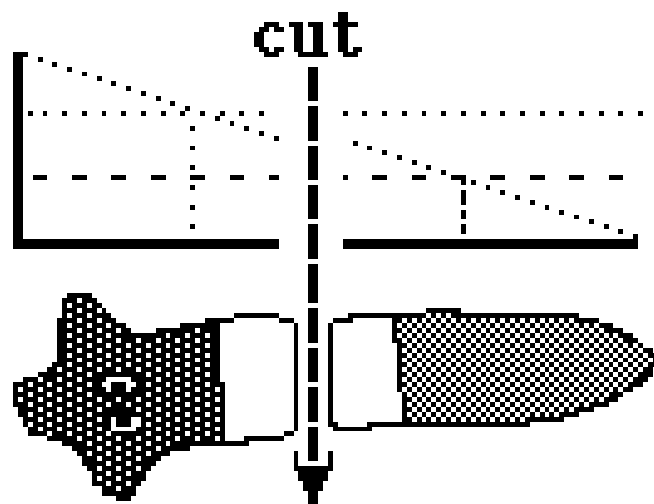
C.H. Waddington
editor

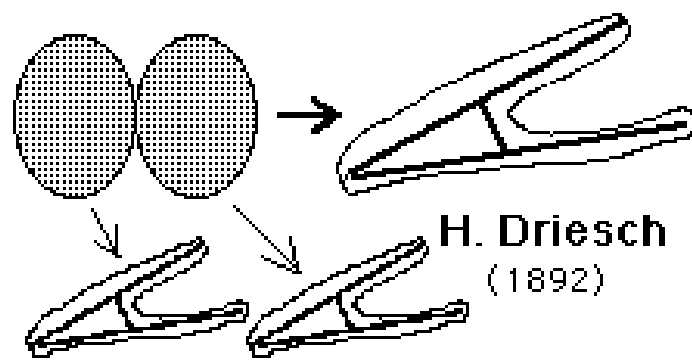
Volume 2



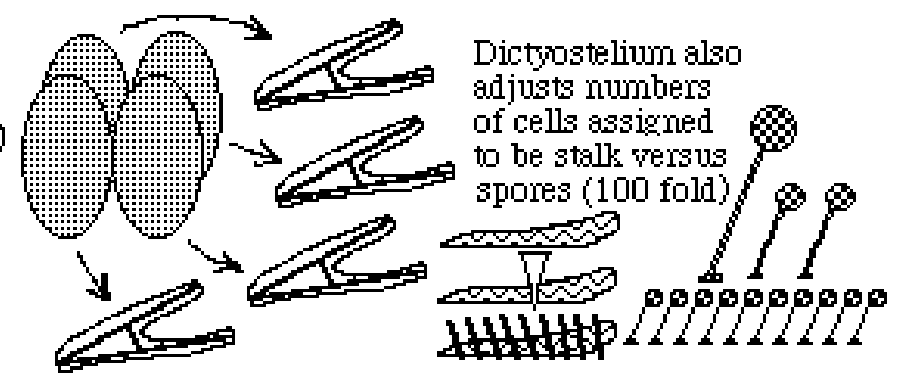
Morphogen
concentration



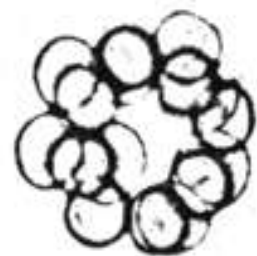




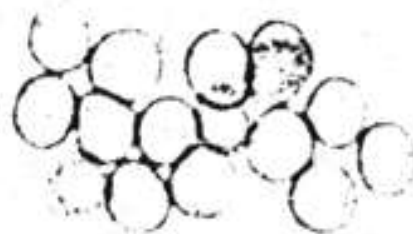
H. Driesch
(1892)



Dictyostelium also
adjusts numbers
of cells assigned
to be stalk versus
spores (100 fold)



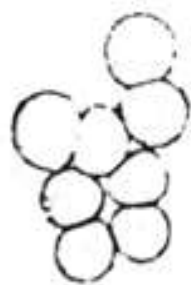
(a)



(b)



200 μm



(c)

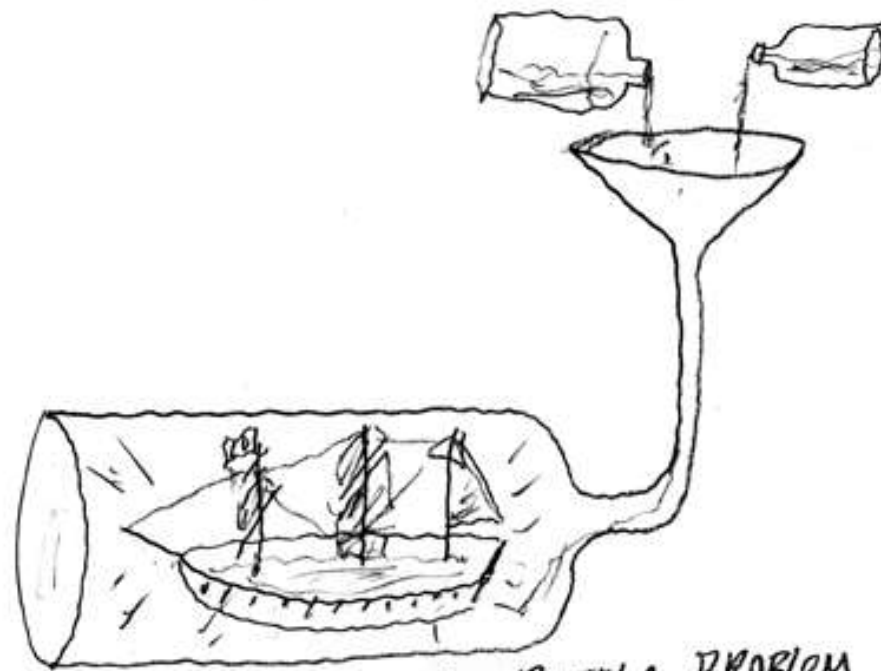


(d)



(e)



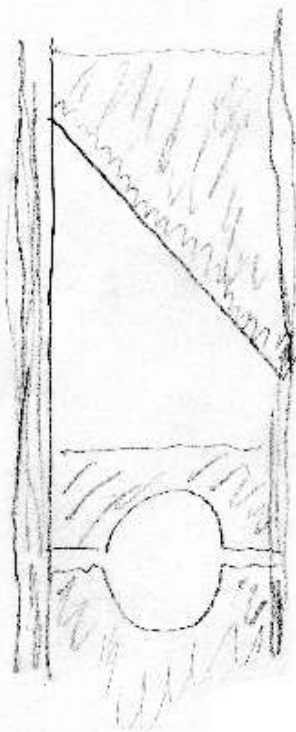


SHIP IN THE BOTTLE PROBLEM



DRIESCH VERSION

(SMALLER BOTTLES, LESS CHEMICALS,
SMALLER SHIPS FORM)



HANS
ADOLF
EDUARD
DRIESCH



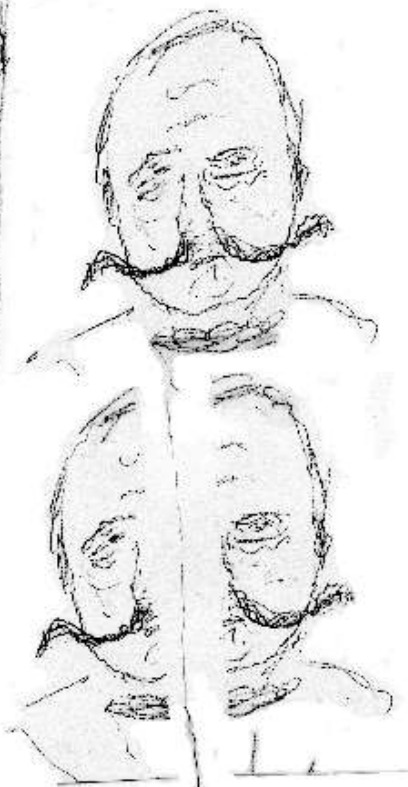
Was



für



ein

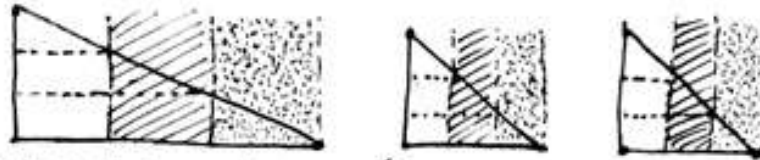


KOPFSCHMERZ!

EMBRYONIC
REGULATION

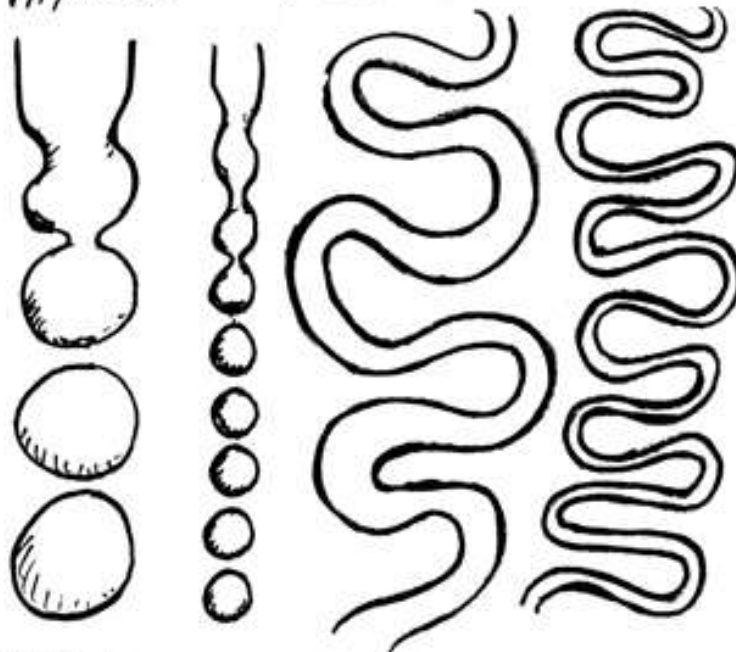
"Size Invariance" (L. Wolpert)

PROPORTIONAL ADJUSTMENT OF DIMENSIONS



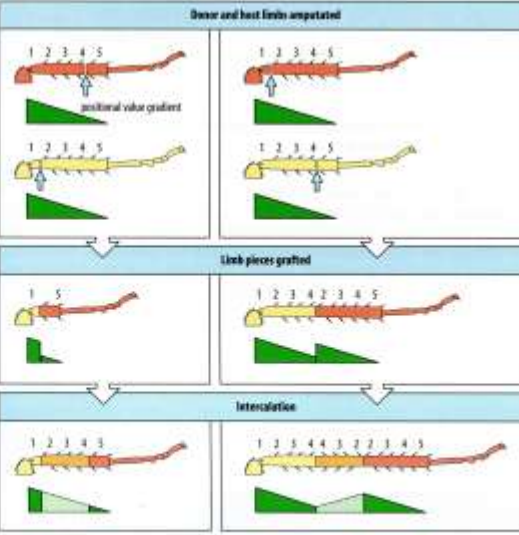
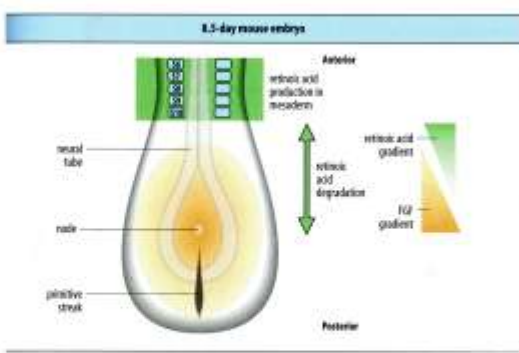
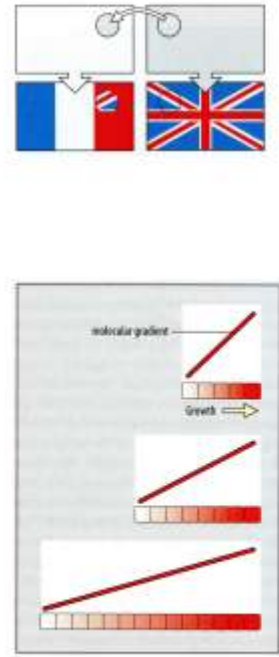
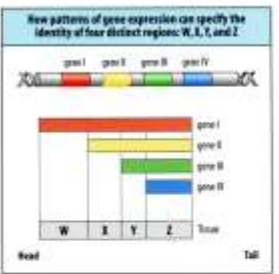
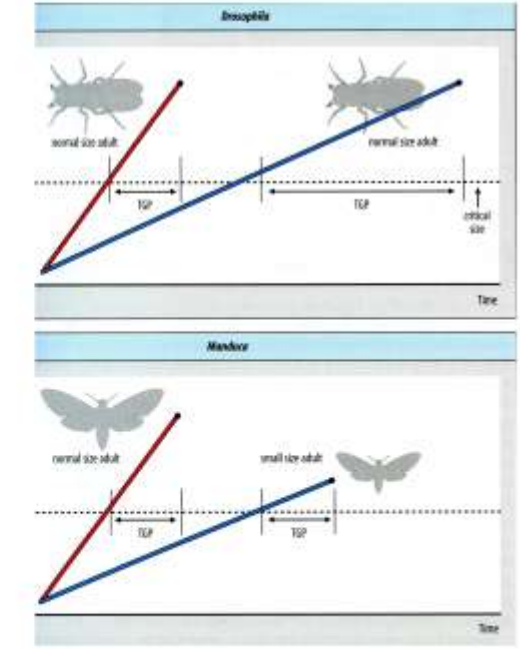
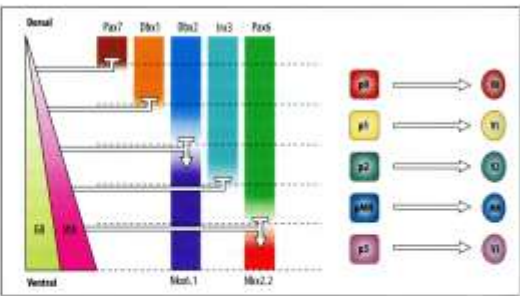
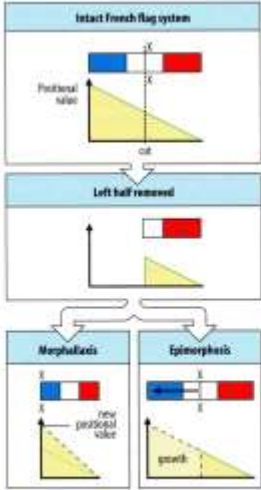
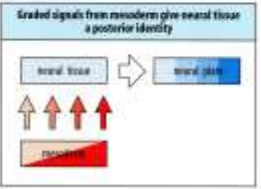
AS EXPLAINED IN TERMS OF "POSITIONAL INFORMATION"

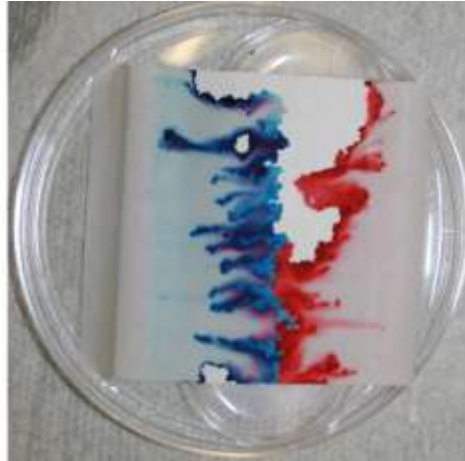
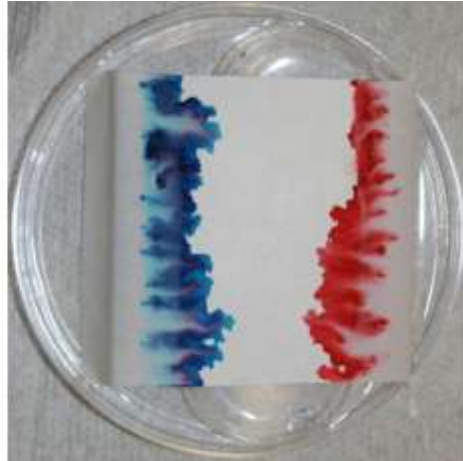
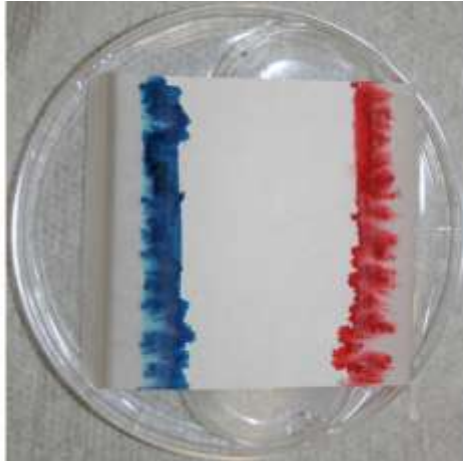
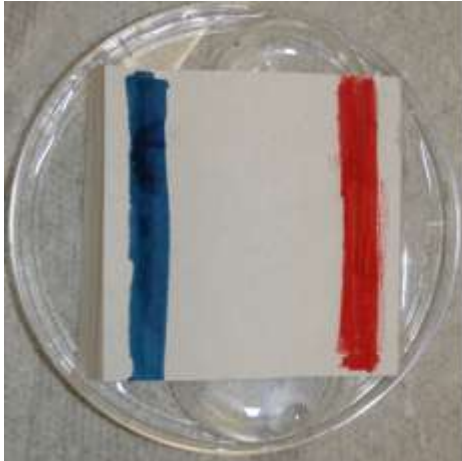
PHYSICAL or MECHANICAL ANALOGIES

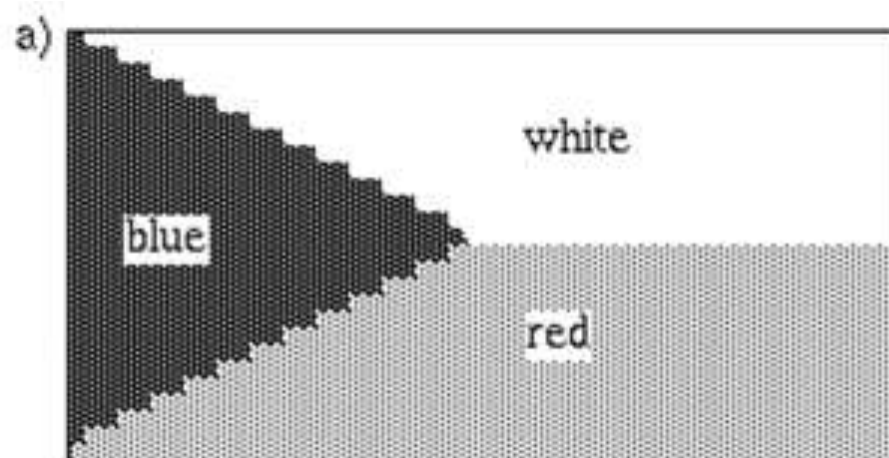


WATER DROPS

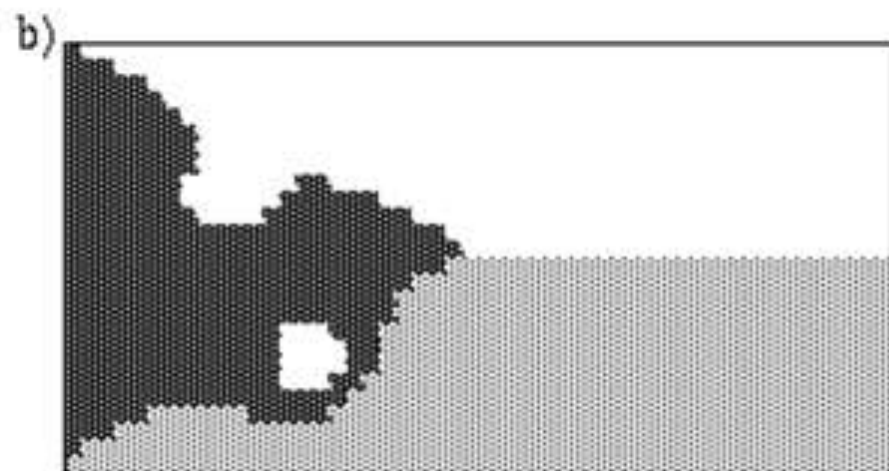
River Meanders







This is an approximation of the flag of Czechoslovakia. Basing your answer on Wolpert's concept of the "French Flag Model", imagine that there is a species of flatworm found along the coast of Bohemia that has this anatomical pattern. Explain what rules the cells would have to obey in order to generate this pattern, if they had a gradient of one morphogen with a source at the left and a sink at the right, and a second morphogen with a source at the top and a sink at the bottom.



Next, suppose that someone had introduced an artificial source of one morphogen and an artificial sink for the other morphogen (maybe an enzyme that digests it). The result was the generation of the abnormal pattern shown here on the left. Explain clearly which abnormality must have been caused by the abnormal source, and which must have been caused by the abnormal sink. Also state which of the two morphogens must have been affected in each case. Make your reasoning clear; when in doubt, make it clear that you understand the ideas.

WHY MOUNTAINS FORM WHERE THEY DO
(With apologies to Lewis Wolpert)

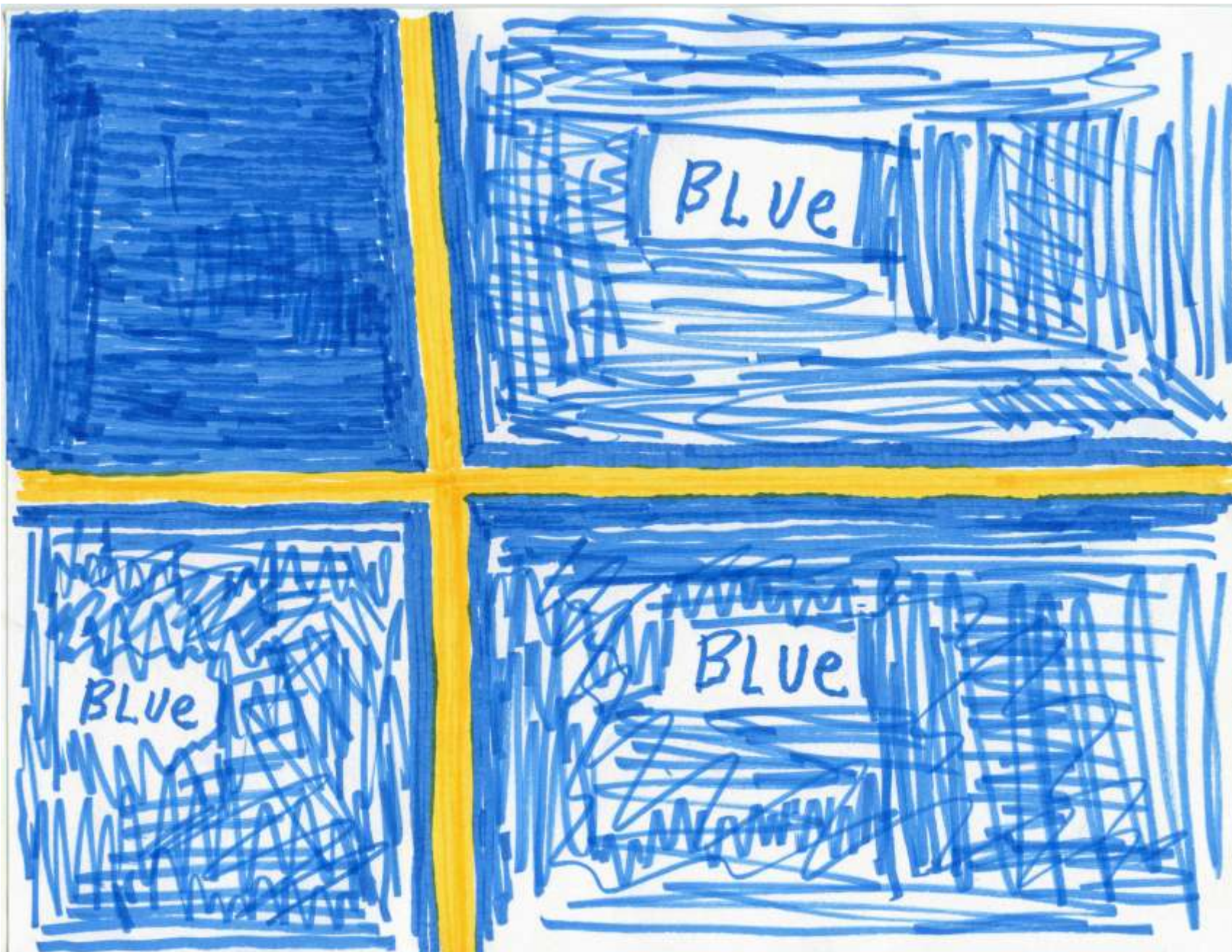


- 1) First, individual rocks determine their latitude and longitude.
- 2) Then those rocks having certain positions interpret this positional information by folding upward to form mountains.

(We know this because moving rocks from one location to another will determine whether or not they will become parts of mountains. However, it is also found that the precise contours of the mountains can be influenced by the chemical nature of the rocks.)

Although it is uncertain how rocks determine their position, GRADIENTS OF TEMPERATURE have been detected in the NORTH-SOUTH direction, and GRADIENTS OF SUNRISE-TIME in the EAST-WEST direction. It is hard to imagine what other purpose these gradients might have.







Analytic Geometry

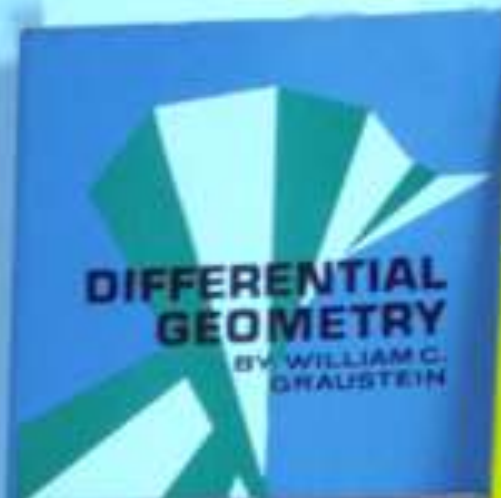
**defines shapes in terms of distances
(and sometimes directions)
from sets of planes, lines or points.**



**whether the coordinate system is Cartesian (distances from 3 perpendicular planes
or whether the coordinates are polar, spherical, cylindrical, or something else.**

Differential Geometry

**defines shapes in terms of curvatures
and other local properties of adjacent parts
of the shape or surface itself.**



DIFFERENTIAL GEOMETRY

BY WILLIAM C.
GRAUSTEIN

Lecture Notes in Mathematics

Edited by A. Dold and B. Eckmann

1000

Heinz Hopf

Differential Geometry in the Large

Seminar Lectures, New York University 1960
and Stanford University 1961



Springer-Verlag
Berlin Heidelberg New York Tokyo

ELEMENTARY DIFFERENTIAL GEOMETRY

Applied differential geometry

WILLIAM L. BURKE

DIFFERENTIAL GEOMETRY

Heinrich W. Guggenheimer



WALTER F. MCCARTHY

Differential Geometry of Curves and Surfaces

