M. Ben Amar

ICFP COURSE: Morphogenesis

A continuous viewpoint of morphogenesis.
Preliminaries: : This plan takes into account the advancement in the Stephan Fauve's course in the technics of nonlinear physics

1 Chemical dynamical systems and patterns formation.

1a) Chemical reactions, law of mass action, singular perturbation analysis.
1b) Mass-flux equation and reaction-diffusion equations: The Turing Instabil- ity.
1c) Mass-flux equation for biological systems: chemotaxis, haptotaxis...
Nonlinear physics tools: Boundary layer, linear stability analysis.

2 Biochemical signaling and mechanics.

2a) From cells to tissues. Introduction to elasticity and visco-elasticity.
2b) Activity or how to modify the mechanical laws.
2c) The mixture model and tumor growth.
2d) The theory of active gels.
Nonlinear physics tools : Variational techniques, self-similar solutions

3 Morphogenesis of Physical systems.

3**a)** Viscous fingering and dendritic growth: model systems for growth in physics and free-boundary problems.
3b) Volume equation and boundary conditions of Dirichlet and Neumann types.
3c) Elementary solutions: the planar and radial front solutions analysis. From viscous fingering to fractal growth.
3d) Exact soltions. Capillarity as a selection parameter. WKB methods. *Nonlinear physics tools* : Neumann boundary conditions with sources, com- plex analysis, selection

4 Free-boundary problems and living colonies.

4a) Fluid colonies of bacteria (active or passive)
4b) Moving epithelia on solid substrate: chemotaxis, durotaxis and homeosta- sis.
Nonlinear physics tools: Galilean invariance, Normal Form