GÖTEBORG UNIVERSITY
Faculty of Sciences
Mathematical Sciences **SYLLABUS**

MAN 560, Morphomatics, 5 credits (ECTS 7.5), advanced level

1. **Decision** The decision of this syllabus was taken by the vice-dean of the department of Mathematical Sciences 2006-06-01 and is valid from that date. Responsible and owner of the course: Mathematical Sciences. Educational area: Sciences 100%.

2. **Aim** The main objective of the course is to study certain fundamental biological questions where geometry and dynamics is put into focus. We will present central, and in some cases relatively new, mathematical concepts and tools from a biological viewpoint. The underlying question which will follow us throughout the course is: How can a complex organism be created from a, more or less, uniform egg? We will also discuss different approaches on dynamical modeling. The word morphomatics was coined by Ian Stewart in Warwick in an attempt to describe a not-yet-developed mathematical theory on biological pattern-formation.

3. **Contents** The course starts with an introduction to developmental biology, and some of the central problems there, which in many cases have a geometrical flavor. We will introduce biological pattern formation problems such as: the morphogenesis problem, the French-flag-problem, BZ-patterning, protein folding, scaling laws, anatomical invariances, wound healing, etc. We will also present some of the current morphogenesis models, such as the gradient method, chemotaxis, reaction-diffusion. Interfoliated with this, we will discuss mathematical concepts which can, or might, be useful for creating new models studying morphogenesis. These mathematical concepts are for example, fractals, Lindenmeyer-systems, and free-boundaries. We will also spend time studying developmental biology inspired computation, and applications of biologically inspired development.

   A central part in the course will be the work on your relatively open home assignments, which partly is about programming and simulating, and partly more theoretical.

4. **Learning outcomes** After finishing the course, the student is expected to:

   • Have insights in general morphological problems and questions,

   • Have knowledge about different classes of mathematical models of morphological processes,

   • Have improved her skills to set up mathematical models, analyze, and numerically simulate them,

   • Have improved her information seeking and presentation (written and orally) skills,

   • Be able to critically examine different types of bio-mathematical models.

5. **Prerequisites** Some previous exposition of PDE:s, complex analysis, and programming.

6. **Examination** There will be three short home-assignment, and one a little more elaborate, plus a project. The project is to be hand in and distributed to all participants in the course one week before the presentation. On the presentation day you will shortly (10 min) present your work, and discuss all the other projects as well. On top of that, there will be a very short individual oral examination at the end of that day. The examination will be based on the home assignments, the project, and the oral examination.

7. **Grades** The level of grades are: Fail (U), Pass (G), and Pass with distinction (VG). Students who wants ECTS-grades should report this to the examiner at latest one week after the course-start.

8. **Course evaluation** Oral and/or written course evaluations will be performed.

9. **Literature** See separate list.