LABORPRAKTIKUM

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Some Active Motion and First-passage Time

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CONTENTS

Part I

PREPARATION

Not sure if an introduction is needed for the Laborpraktikum.

1 INTRODUCTION

Write some kind of intro here.

2 ACTIVE MOTION

`Active motion` describes the process of converting energy resources into directed motion. Living beings using active motion are e. g. humans, animals and microorganisms such as cells or bacteria.

The motion of a human floating in a sea is only subject to the current, however, by using energy and muscle power the human can swim and therefore move directed.

2.1 SOME EXAMPLES

The motivation for actively moving around the environment varies for different living beings and different environmental conditions. Also the types of motion are diverse. Accordingly, the variety of movement patterns and their purposes is immense. In this section, therefore, a small selection is presented.

REZA: Maybe one could highlight the paragraphs for animals humans etc more by indenting the text? See next section for alternative style.

HUMANS Nowadays there is an unlimited pool of trivial reasons for actively moving, whereby some are necessary, like e. g. getting food, and some are more or less by choice, like e. g. doing sports. Also (ancient) human migration and colonization is an example of macroscopic human active motion. In this sense the colonization of America and the Neanderthal replacement in Europe has been studied [7].

ANIMALS Animals is a very overall term for terrestrial animals, birds, fishes and here, is supposed to include insects as well. Some reasons for motion are:

- *Foraging / finding prey.*
- *Evading predators / hazards.*
- *Finding mates.*
- *Finding shelter / new habitats.*

Whereas the type of movement pattern not only depends on the motivation but also on the species. There is a lot of literature considering these topics such as the *Encyclopedia of Animal Behavior* [3] and the book *Animal Behavior* [4] which cover many interesting aspects such as *search, navigation, migration, dispersal, foraging, self-defense, mating*, and many more in great generality.

TODO: "in great generality" that doesn't sound good

More specific research concentrates on e. g. the movement of fish and crustaceans [22], the foraging behavior of squirrels [25], planktivorous fish [19], and foraging/moving animals in general [13, 23]. The search for prey has been studied for e. g. toads [15], different

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ant-eating jumping spiders (*Saliticidae*) [12], buried bivalves [9], and predator search in general [1].

Certain tasks within the human body require cells to move directed, like e. g. morphogenesis, wound healing, immune response, etc.

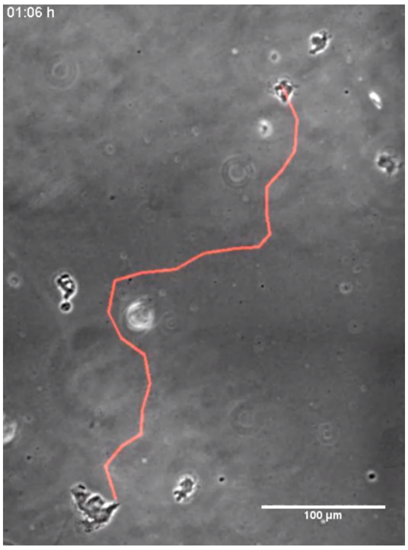
MICROORGANISMS The reasons for microorganisms to actively move are as diverse as their variety. For some bacteria it could be *finding food* in order to grow and multiply, whereas cells in the human body might be involved in *morphogenetic* processes.

Many microscopic organisms are surrounded by fluids and therefore experience thermal diffusion. This diffusion leads to so called *Brownian motion*, a random motion named after its famous discoverer Brown and his studies on the motion of pollen particles [5].

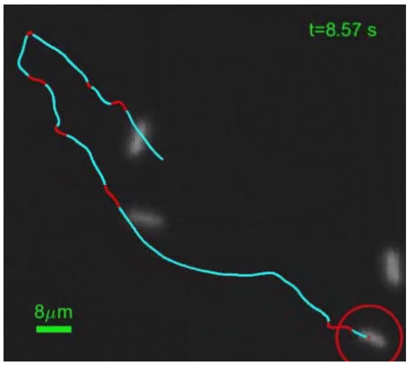
A random motion alone, though, would be highly inefficient considering the task of reaching to a certain location. Also some microorganisms do not experience diffusion in their environment and therefore they need to be able to move by themselves. Thus, it is not surprising that *directed, persistent migration* has been observed for many different microorganisms.

In the past 30 years there has been a focus on understanding migrational processes of cells and bacteria, the underlying mechanics and their properties [6, 8, 10, 11, 14, 16–18, 20, 21, 24, 26]. These include basic as well as specific studies of *in vitro* experiments, the comparison of random and directed motion, migration in complex environments, theoretical and mathematical models, and many properties of microscopic migration in general.

Figure 2.1 shows two exemplary migration trajectories for a cell (immature bone marrow-derived mice dendritic cell) and *Bacillus subtilis*, which are directed and sectionally persistent.



(a) Cell (immature bone marrow-derived mice dendritic cell) [16]



(b) Bacillus subtilis[1]

Figure 2.1: Directed migration paths.

ARTIFICIAL PARTICLES Nowadays researchers have even developed artificial active particles on the micro- and nanometer scale [2], which could turn out to be very useful in many different fields.

1 J. Najafi *et al.*, under review (2018)

2.2 SOME EXAMPLES *alternative version*

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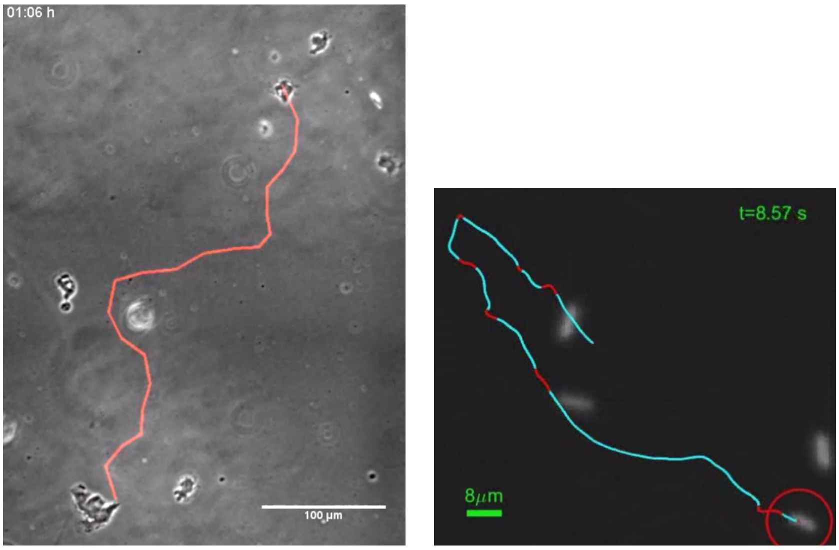
Figure 2.2 shows two exemplary migration trajectories for a cell (immature bone marrow-derived mice dendritic cell) and *Bacillus subtilis*, which are directed and sectionally straight.

REZA: the graphics are not indented correctly, I haven't found an adequate solution for this problem yet



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Part II

PART 2

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