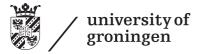
Activation and regulation of *E. coli* DNA Polymerase V studied at the single-molecule level

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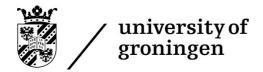
The work described in this thesis was performed in the research group Single Molecule Biophysics of the Zernike Institute for Advanced Materials at the University of Groningen, the Netherlands.

Cover design: Victor E. A. Caldas

 $Cover image: Super-resolution image reconstruction o {\it E. coli} cells. Membrane marker (red) is LacY-eYFP and the contraction of {\it E. coli} cells. Membrane marker (red) is LacY-eYFP and$

and blue is UmuC-mKate2.

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Activation and regulation of *E. coli* DNA Polymerase V studied at the single-molecule level

PhD thesis

to obtain the degree of PhD at the University of Groningen on the authority of the Rector Magnificus Prof. E. Sterken and in accordance with the decision by the College of Deans.

This thesis will be defended in public on

Friday 6 May 2016 at 16:15 hours

by

Victor Emanoel Armini Caldas

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Dr. A. Robinson

Assessment Committee

Prof. B. Poolman Prof. E.J.G. Peterman Prof. P.L. Foster

Science is a wonderful thing if one does not have to earn one's living at it. Albert Einstein



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SUMMARY

Write your summary here.



SAMENVATTING

Write the Dutch Summary here.



RESUMO



PREFACE

Preface goes here. This chapter is optional.

Albert Einstein Groningen, January 2016



1

INTRODUCTION

Albert EINSTEIN

Nature and nature's laws lay hid in the night; God said 'Let Newton be!' and all was light.

Alexander Pope

It did not last: the devil shouting 'Ho. Let Einstein be!' restore the status quo.

Sir John Collings Squire

2 1. Introduction

1

ABSTRACT

Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

This document is intended to be both an example of the TU Delft dissertation template for \LaTeX , as well as a short introduction to its use. It is not intended to be a general introduction to \LaTeX itself, and we will assume the reader to be familiar with the basics of creating and compiling documents.

Instructions on how to use this template under Windows and Linux, and which LATEX packages are required, can be found in README.txt.

1.1. DOCUMENT STRUCTURE

S INCE a dissertation is a substantial document, it is convenient to break it up into smaller pieces. In this template we therefore give every chapter its own file. The chapters (and appendices) are gathered together in dissertation.tex, which is the master file describing the overall structure of the document, dissertation.tex starts with the line

\documentclass{dissertation}

which loads the dissertation template. The template is based on the LaTeX book document class and stored in dissertation.cls. The document class accepts several comma-separated options. By default, hyperlinks are shown in cyan, which is convenient when reading the dissertation on a computer, but can be expensive when printing. They can be turned black with the print option. This will also turn the headers dark gray instead of cyan. Moreover, it will add a 3 mm bleed around the page including crop marks. This will help the printer with the thumb indices, since they run right up to the page borders. Finally, the nativefonts option can be used to override the automatic font selection (see below).

A dissertation is a big document, which makes it easy to miss warnings about the layout in the Lag output. In order to locate problem areas, add the draft option to the \documentclass line. This will display a vertical bar in the margins next to the paragraphs that require attention.

The contents of the dissertation are included between the \begin{document} and \end{document} commands, and split into three parts by

- 1. \frontmatter, which uses Roman numerals for the page numbers and is used for the title page and the table of contents;
- 2. \mainmatter, which uses Arabic numerals for the page numbers and is the style for the chapters;
- 3. \appendix, which uses letters for the chapter numbers, starting with 'A'.

The title page is defined in title.tex in the title folder and included verbatim with \include{title/title},² (see below). Additionally, it is possible to include a preface, containing, for example, the acknowledgements. An example can be found in preface.tex. The table of contents is generated automatically with the \tableofcontents command.

¹We recommend http://en.wikibooks.org/wiki/LaTeX as a reference and a starting point for new users.

²Note that it is not necessary to specify the file extension.

4 1. Introduction

1

Chapters are included after \mainmatter and appendices after \appendix. For example, \include{chapter-1/chapter-1} includes chapter-1.tex, which contains this introduction.

1.2. TITLE PAGE

The title pages are defined in title/title.tex, which you will have to modify according to your needs. Note that these pages are subject to the requirements of the *promotieregelement* and cannot be changed at will. Apart from the names and dates, most of the Dutch text is dictated literally.

Since the thesis title and name of the author appear several times throughout the document (on the title page, but also in, *e.g.*, the preface and cv), special commands are provided so they only have to be specified once. The title (and optional subtitle) can be specified with

```
\title[Optional subtitle]{Title}
```

The name of the author is specified with

```
\author{First name}{Last name}
```

Note that the first and last name are separate arguments, since they may be printed in different font shapes. The \title and \author commands also ensure that the title and author appear in the metadata of the final PDF.

See title/title.tex for detailed documentation on the comment and layout of the title pages. Logos of institutes that have contributed financially to the dissertation may be included on reverse side of the title page. A few example logos can be found in the title/logos folder.

1.3. CHAPTERS

E ach chapter has its own file. For example, the LaTeX source of this chapter can be found in chapter-1.tex. A chapter starts with the command

```
\chapter{Chapter title}
```

This starts a new page, prints the chapter number and title and adds a link in the table of contents. If the title is very long, it may be desirable to use a shorter version in the page headers and the table of contents. This can be achieved by specifying the short title in brackets:

\chapter[Short title]{Very long title with many words which could not possibly fit on one line}

Unnumbered chapters, such as the preface, can be created with \chapter*{Chapter title}. Such a chapter will not show up in the table of contents or in the page header. To create a table of contents entry anyway, add

1.4. \SECTION{...}

5

\addcontentsline{toc}{chapter}{Chapter title}

after the \chapter command. To print the chapter title in the page header, add

```
\setheader{Chapter title}
```

If (parts of) the chapter have already been published elsewhere, it is customary to add a reference. This can be done with the special unnumbered footnote command \blfootnote. For example,

```
\blfootnote{Parts of this chapter have been published in Annalen der Physik \textbf{324}, 289 (1906) \cite {Einstein1906}.}
```

generates the footnote at the beginning of this chapter. Because this footnote is unnumbered, the hyperref package may throw a warning, which safely be ignored.

If multiple people have contributed significantly to this chapter, they can be lister with the \authors command. This can be followed by a quotation using \epigraph as shown above. Finally, it is customary for a dissertation to include an abstract for every chapter (except perhaps the introduction). This can be accomplished with the abstract environment. The abstract should be followed by \newpage to start the chapter text on a new page.

In a dissertation, each chapter has its own list of references. These can be generated with the special command \references{dissertation} from dissertation.bib at the end of the chapter. Note that this means that you need to run a command like bibtex chapter-1/chapter-1 for each chapter. The bibliography style is specified in dissertation.bst, which is a modified version of apsrev4-1.bst (from REVTeX) designed to also display the titles of referenced articles. The template will automatically generate clickable hyperlinks if a URL or DOI (digital object identifier) is present for the reference. Although it is possible to manage the bibliography by hand, we recommend using EndNote (available from Blackboard) or JabRef (available from http://jabref.sourceforge.net/).

Chapters are subdivided into sections, subsections, subsubsections, and, optionally, paragraphs and subparagraphs. All can have a title, but only sections and subsections are numbered. As with chapters, the numbering can be turned off by using \section*{...} instead of \section{...}, and similarly for the subsection.

1.4. \SECTION{...}

1.4.1. \SUBSECTION{...}

\SUBSUBSECTION{...}

\paragraph{...} Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1

6 1. Introduction

1

1.5. FONTS AND COLORS

The fonts used by this template depend on which version of Latex, you use. Regular Latex, i.e., if you compile your document with with latex, pslatex or pdflatex, will use Utopia for text, Fourier for math and Latin Modern for sans-serif and monospaced text. However, if you want to adhere to the TU Delft house style, you will need to use Xallatex, as it supports TrueType and OpenType fonts. Compiling with xelatex will use Bookman Old Style for titles, Tahoma for text, Courier New for monospace and Cambria for math. If you want to use Xallatex, but do not want to use the TU Delft house style fonts, you can add the nativefonts option to the document class.

This template supports the use of drop caps, a large colored initial at the beginning of a chapter or section, via the \dropcap command:

```
\dropcap{L}{orem} ipsum...
```

The first argument is the capital that will be printed on two lines (in the title color), and the second argument is the rest of the word. Depending on the font, the latter may be printed in small caps.

The corporate colors of the TU Delft are cyan, black and white, available, respectively, via \color{tudelft-cyan}, \color{tudelft-black} (which differs slightly from the default black) and \color{tudelft-white}. Apart from these three, the house style defines the basic colors

- tudelft-sea-green,
- tudelft-green,
- tudelft-dark-blue,
- tudelft-purple,
- tudelft-turquoise and
- tudelft-sky-blue,

as well as the accent colors

- tudelft-lavendel,
- tudelft-orange,
- tudelft-warm-purple,
- tudelft-fuchsia,
- tudelft-bright-green and
- tudelft-yellow.

Colors were deactivated in my version of this tex file. Refer to the original package if interested.

REGULATION OF MUTAGENIC DNA POLYMERASE V IN SPACE AND TIME

Andrew Robinson, John P. McDonald, Victor E. A. Caldas, Meghna Patel, Elizabeth A. Wood, Christiaan M. Punter, Harshad Ghodke, Michael M. Cox, Roger Woodgate, Myron F. Goodman, Antoine M. van Oijen.

ABSTRACT

Write here the Abstract

Here starts your content.



3

CONCLUSION

This is a concluding chapter explaining the scientific and technical implications for society of the research findings in considerable detail.



EPILOGUE

This is an optional epilogue.



ACKNOWLEDGEMENTS

This is an optional chapter containing acknowledgements.



CURRICULUM VITÆ

Albert EINSTEIN

14-03-1879 Born in Ulm, Germany.

EDUCATION

1892–1896 Grammar School

Luitpold Gymnasium, Münich (1892–1895)

Aurau, Switzerland (1895-1896)

1896–1900 Undergraduate in Mathematics & Physics

Eidgenössische Polytechnische Schule Zürich

1905 PhD. Physics

Eidgenössische Polytechnische Schule Zürich

Thesis: Eine neue Bestimmung der Moleküldimensionen

Promotor: Prof. dr. A. Kleiner

AWARDS

1922 Nobel Prize in Physics

1925 Copley Medal

1929 Max Planck Medal

1999 Time magazine's person of the century



LIST OF PUBLICATIONS

- 4. **A. Einstein**, *Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig?*, Annalen der Physik **18**, 639 (1906).
- 3. **A. Einstein**, *Zur Elektrodynamik bewegter Körper*, Annalen der Physik **17**, 891 (1905).
- 2. **A. Einstein**, Über die von der molekularkinetischen Theorie der Wärme geforderte Bewegung von in ruhenden Flüssigkeiten suspendierten Teilchen, Annalen der Physik **17**, 549 (1905).
- 1. **A. Einstein**, Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt, Annalen der Physik **17**, 132 (1905).