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# بسم الله الرحمن الرحيم

مركز الشبكات وتكنولوجيا المعلومات

قسم التوثيق الإلكتروني



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# جامعة عين شمس

التوثيق الإلكتروني والميكرو فيلم

## قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها  
على هذه الأقراص المدمجة قد أعدت دون أية تغييرات





**Mechanics of Human Red Blood Cell at the Onset and Progression  
Stages of Plasmodium Falciparum Malaria Parasite**

By

**Mohamed Tawfik Ahmed Eraky**

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
in Partial Fulfillment of the  
Requirements for the Degree of  
**MASTER OF SCIENCE**  
in  
**Aerospace Engineering**

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
GIZA, EGYPT  
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**Title of Thesis:**

**MECHANICS OF HUMAN RED BLOOD CELL AT THE ONSET AND PROGRESSION STAGES OF PLASMODIUM FALCIPARUM MALARIA PARASITE**

**Key Words:**

Human Red Blood Cells, Malaria, Plasmodium Falciparum, Shear modulus, Skalak model

**Summary:**

This thesis aims to get insight into the mechanics of human red blood cell in healthy case and during the progression of Plasmodium Falciparum malaria parasite. As the computed results in previous studies using previous models in both cases did not agree with the in-vitro stretching tests, Skalak's hyperelastic constitutive model is used. This model achieved a remarkable agreement with stretching tests in the healthy case. During infection the cell membrane is patched with one infected patch with high shear modulus whereas the remaining membrane segment is represented with a lower shear modulus. The infection progression is represented by increasing the patch diameter. In the all infection simulation, the geometry mutation of the infected cell from the biconcave shape to the spherical-like shape in the last infection stage is considered. Present simulation results using ABAQUS explicit it showed an accurate agreement with in-vitro stretching optical tweezers tests.

# Disclaimer

I hereby confirm that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute. I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name:

Date:

Signature:

# Dedication

I would like to dedicate this work to help humanity. Malaria is one of the intransigent diseases which claims the life of around 500,000 humans per year. This work could help to tackle Malaria infection by engineering human organs, early detection of infection and diagnosing infection during different progression stages.



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