Light-Tissue (Skin) Interaction Model Using COMSOL

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Content

INTRODUCTION

- Study of Skin Tissue and Light Interaction using COMSOL Multiphysics.
- In order to improve the dermatological tests that take place, this model will provide some ideas that can help in improving the analysis that is made.

Purpose of the Project

The purpose of this project is to understand the light and tissue interaction through a computational model designed in COMSOL Multiphysics. It helps in stimulation of the designed sample on the software itself providing us with results of the analysis being made. This will help to pinpoint on the possible issue being under the dermatology spectrum and provide solutions for the same.

Our Motivation

We are trying to understand the interaction of the skin surface layer by layer with the optical wavelength range targetted on the surface. It will help in understanding the factors responsible for skin surface defects observed in dermatological testing.

Model a structure similar to Skin Tissue.

Psuedo Skin Tissue model is prepared for stimulating its surface.

Study its interaction with light.

The interaction of light with the designed model is evaluated for desired purposes.

Analyze the suitability of designed model.

Analysis of the designed model is necessary to proceed forward with its valid and reasonable analysis for real time implementations.
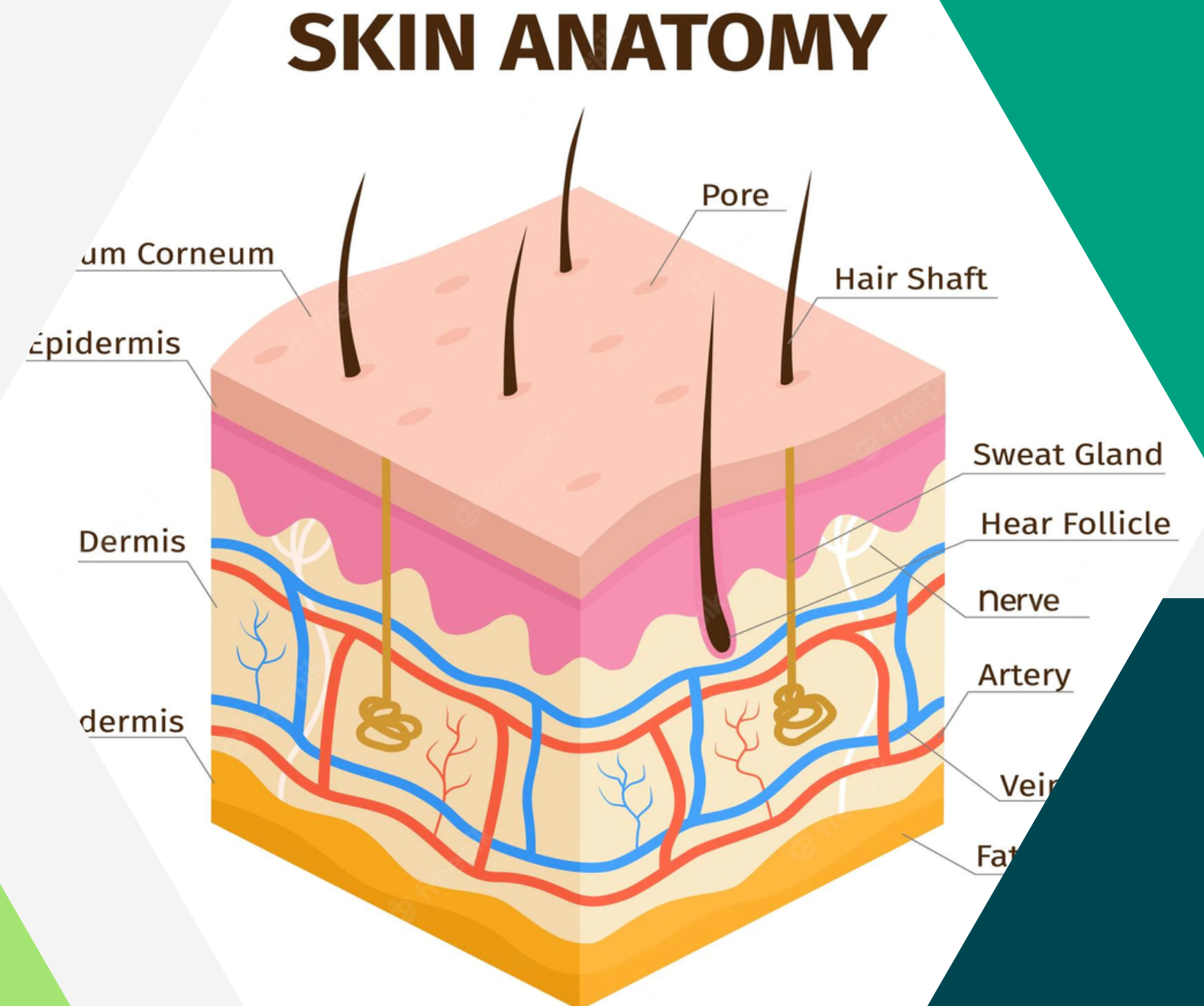
Dermatology

- The study, research, diagnosis, and management of any health conditions that may affect the skin, fat hair, nails, and membranes.
- Dermatologist, health professional who specializes in this domain of healthcare.
- This umbrella of medical sciences, encompasses all the factors that affect the superficial coverings of the skin even in their internal surfaces, this includes, hair, skin, nails, etc.
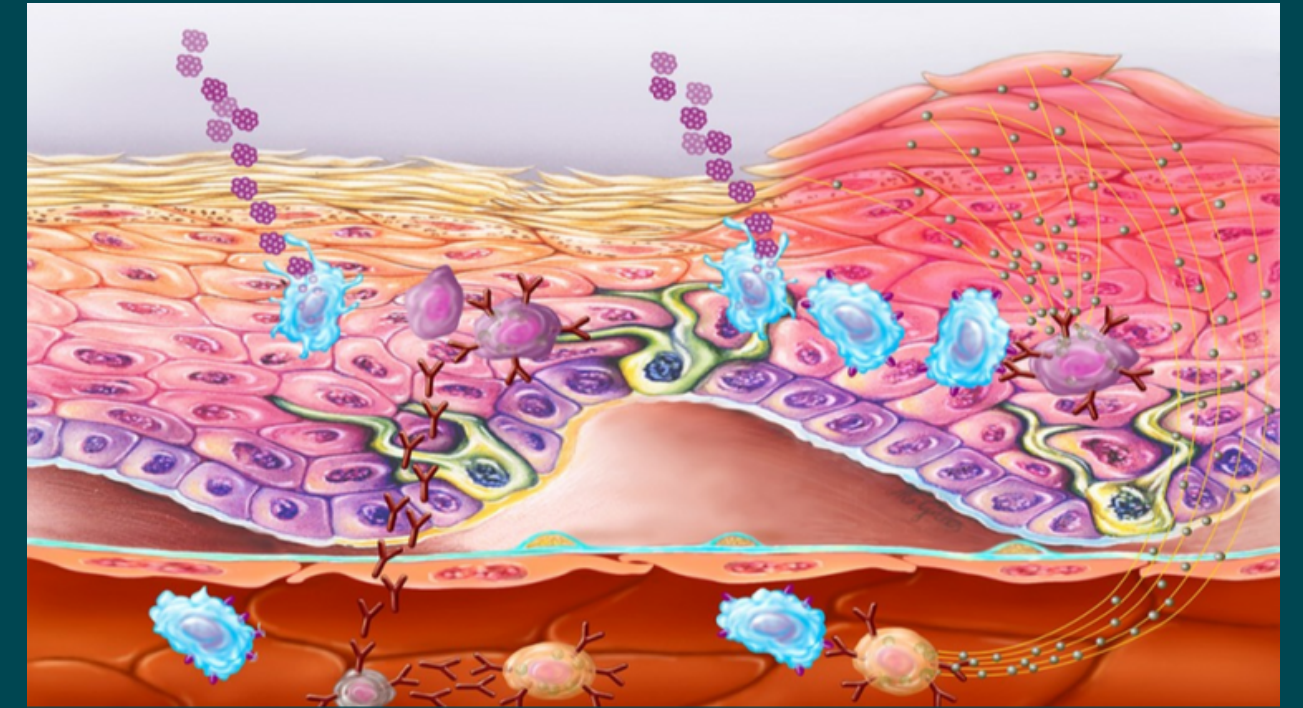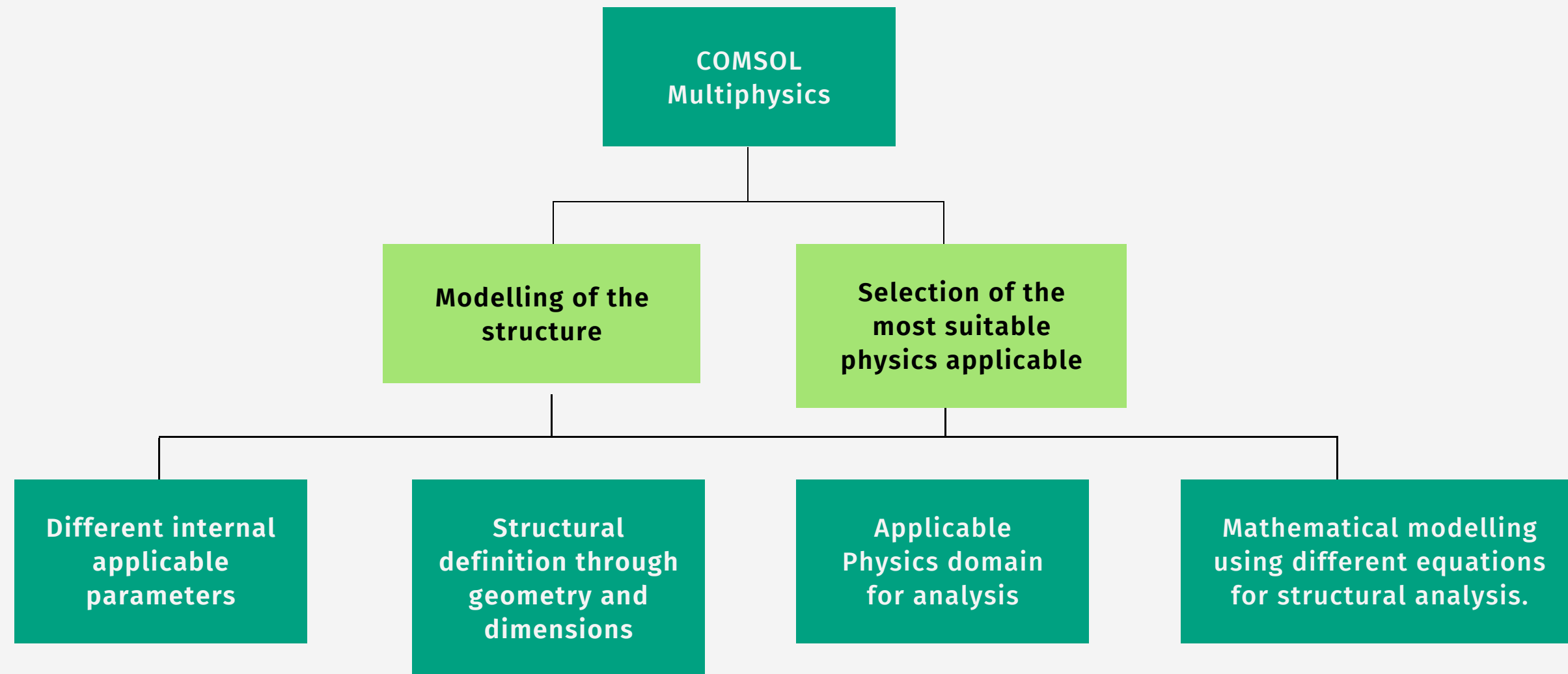
Skin

- Composed mainly of 3 layers: Epidermis, Dermis, and Hypodermis.
- Epidermis: Keratinocytes, Melanocytes, and Dendritic cells along with sweat glands and sebaceous glands.
- Dermis: Fibroblasts, Endothelial cells, and cells of the hematopoietic region.
- Hypodermis: Subcutaneous-fat region with blood vessels for supporting blood transportation.

SKIN ANATOMY

Pore

um Corneum

Hair Shaft

Epidermis

Sweat Gland

Hear Follicle

Dermis

Nerve

Artery

dermis

Vei

Fat

COMSOL Multiphysics

REVIEW

Light tissue interaction using COMSOL Multiphysics for multi-layered skin tissues	Development of temperature distribution and light propagation model in biological tissue irradiated by 980 nm laser diode and using COMSOL Simulation	A biphasic multilayer computational model of human skin
Light tissue interaction using COMSOL Multiphysics for multi-layered skin tissues.	Development of temperature distribution and light propagation model in biological tissue irradiated by 980 nm laser diode and using COMSOL Simulation.	A biphasic multilayer computational model of human skin.
Key Points	**Key Points**	**Key Points**
Diffuse Optical Spectroscopy, Radiative Transport Equation through Helmholtz equation in the software. Diffusion equation; primarily used for studying the propagation of light in biological tissues.	The depth that laser light penetrates tissue depends upon the optical properties of the tissue, which vary with wavelength. As the collimated beam passes through tissue, it is exponentially attenuated by absorption and scattering.	Multilayer model of skin, Layer specific mechanical behavior, Layer specific properties at physiological deformation levels.
Conclusion	**Conclusion**	**Conclusion**
Different factors present in the skin surface affected the observation of intensity and light relation plots mentioned. Helmholtz module was used to replace the diffusion equation which is applied for analysis of the light distribution at a fixed target distance.	The study is expected to have a positive impact and a better simulation on laser treatment planning of biological tissues. Moreover, it may enable us to replace animal tests with the results of a COMSOL predictive model.	Reticular dermis, stiffest layer in tension bearing. Softer papillary dermis and epidermis ensures more compliant response in suction experiments. Difference in mechanical properties of layer is responsible for out-of-plane curvature. Low permeability in epidermis and papillary dermis results in stronger hinderance for fluid flow.
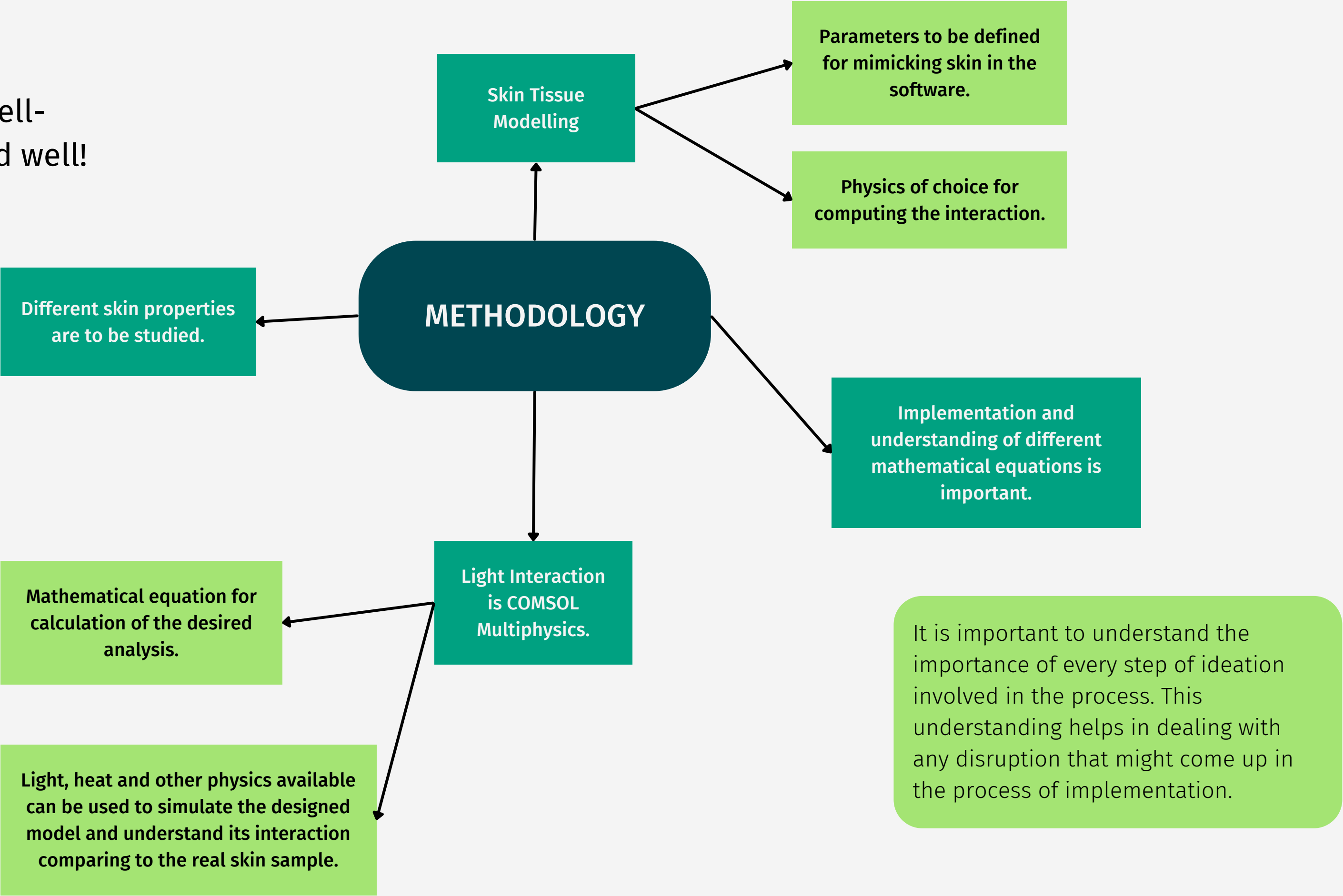
Expectations

A skin model is similar to a real skin structure in order to assess and analyze its properties.

Optical properties of the skin along with its thermal property changes in the skin are to be observed under the COMSOL Multiphysics software.

Understanding of the different variations in the skin is to be observed and through the observed changes, a well-defined pathway for dermatological benefits will be identified.

References

1. Light tissue interaction using COMSOL Multiphysics for multi-layered skin tissues; Vysakh Vasudevan, N. Sujatha.

2. Development of temperature distribution and light propagation model in biological tissue irradiated by 980 nm laser diode and using COMSOL Simulation; Kawthar Shurrab, Nabil Kochaji, Wesam Bachir.

3. A biphasic multilayer computational model of human skin; David Sachs, Adam Whalsten, Sebastian Kozerke, Gaetana Restivo, Edoardo Mazza.

THANK YOU