Unraveling the effect of steroid hormones on biophysical properties of biomimetic cell membranes

Popular science summary

There are dozens of different steroid hormones in the human body. The basic and most important are: female sex hormones – progesterone and estrogens, male sex hormones – androgens, especially testosterone, and stress hormones – mainly cortisol. They perform a variety of functions, including regulation of various metabolic processes, water-electrolyte balance maintenance, body development support, secondary sexual characteristics maintenance, and sexual function and behavior control. In addition, steroids have found wide pharmacological applications in autoimmune diseases, inflammation and cancer treatment, contraception, and anesthesia. To perform their functions, steroid hormones must interact with the cell membrane, which separates the inside of the cell from the outside environment. The structure of the cell membrane is based primarily on a double layer of fats (lipids). In order to exert an appropriate cellular response, the steroid molecules either bind to a signal receptor located in the cell membrane or freely cross the cell membrane (they do so easily because they are fat-soluble) and bind to the appropriate signal receptor located in the cell nucleus. However, there is evidence that **steroid hormones can also induce cellular responses by directly interacting with the lipid membrane and altering its biophysical properties, such as fluidity and spatial organization of membrane components**. Therefore, it is clear that in order to explain the diverse biological functions that steroid hormones perform, it is crucial to understand the interactions between steroid molecules and the cell membrane.

The goal of this project is to understand the effects of principal human steroid hormones (progesterone, estrogen, testosterone, and cortisol) on the biophysical properties of model cell membranes using a suite of fluorescence techniques with spatially resolved information.

The proposed research will answer the following questions:

1. How do steroid hormones affect the lipid order (fluidify the membrane or rigidify it)?
2. How do steroid hormones affect the rate of lateral lipid mobility in the membrane?
3. How does the membrane microstructure change in the presence of steroid hormones?

The proposed experiments are designed to **answer the above questions with respect to the composition of model cell membranes, the chemical structure of steroid hormones, and their concentration**.

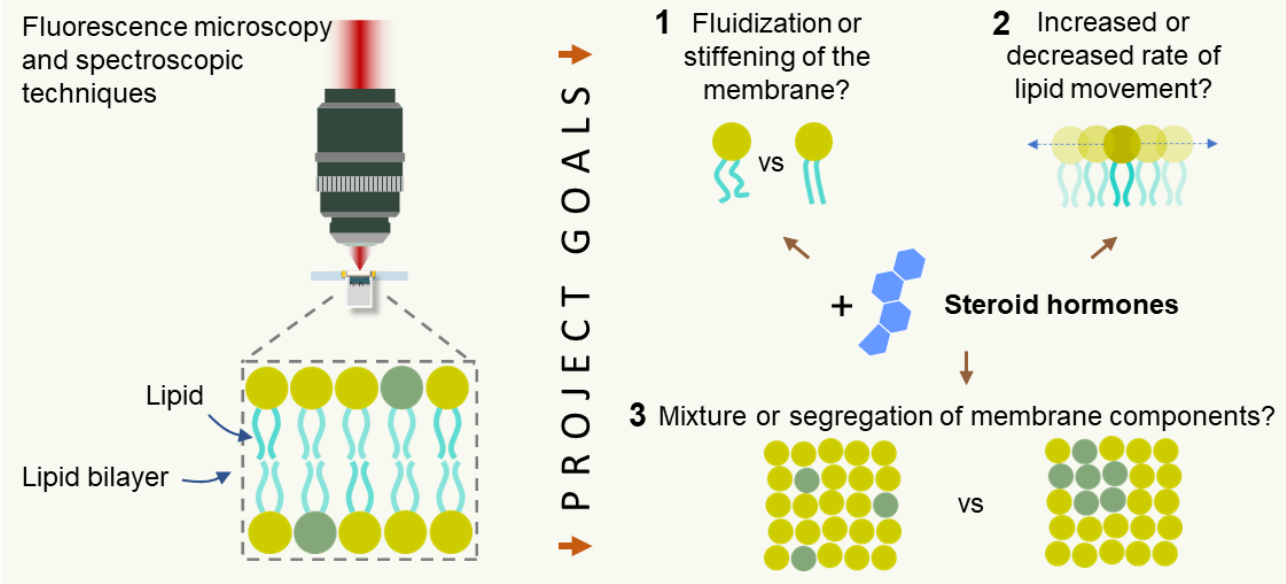

Fig. 1 Project concept - key objectives of the proposed research.

Understanding the interaction of steroid hormones with lipid membranes is important not only in terms of gaining new knowledge about the mechanisms of steroid action but also in terms of practical application in medicine. It should be mentioned that some steroids (e.g. progesterone and its derivatives) have the potential to inhibit tumor cell invasiveness by decreasing cell membrane fluidity. Therefore, the results of this project are anticipated to be of broad interest - they will provide fundamental knowledge at the borderline between biophysics and biochemistry.