Chapter 6

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The development of electronic circuit model of neuron using biologically sensitive field effect transistor (BioFET) to reproduce the behavior of nerve axon was presented for the first time. The BioFET which is an acetylcholine sensitive ENFET (AchFET) was fabricated on the ITO coated glass using ECD technique. The sensing membrane of this ENFET is a chitosan doped NiO nanocomposite. The enzyme, AchE was immobilized on the sensing membrane by using physical absorption technique. The response of the device has shown sensitivity ~57 mV/decade with good linearity for acetylcholine concentration from 0.01 mM to 0.2 mM. Its characteristics was compared with its MOSFET counterpart and found to be similar. This fabricated AchFETs was used as an analog of variable conductances of H-H circuit model to develop a physiologic based circuit model of neuron, the NEUROAchFET. The experimental results have indicated that this circuit can reproduce potassium and sodium conductances satisfactorily and the electronic action potential is very similar to the recorded action potential. Inclusion of AchFET in the circuit model of neuron open the possibility of measurement of concentration of acetylcholine responsible for synaptic actions. Moreover, AchFET has potential for on chip integration leading to the development of lab-on-chip system used in advanced biomedical applications.

The developed electronic model of neuron was validated using biologically inspired optimization method namely Firefly algorithm (FA). FA was used by establishing that it is superior to existing metaheuristic algorithms. The estimated parameters from the signals obtained from NEUROAchFET was compared with simulated and other model parameters and found to be in good agreement with already established data.

Scopes for future work

Following points was identified for future work:

1. Presently the circuit is capable of reproducing sodium conductances satisfactorily for applied voltages above 10 mV. But for lower voltages it fails to give established experimental data. As a result, the circuit could not produce the action

potential. In future, therefore, there is scope for more accurate reproduction of conductances.

2. Developing a nerve networks with BioFET as a basic analog of variable conductance.

3. Development of other neurotransmitter sensitive FETs to use as an analog of other conductances of neuron.

4. Experiments may be conducted using different transmitter concentrations to study the synaptic potentials: excitatory and inhibitory post synaptic potentials.