THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An in vitro method for selectively controlling growth and development of a stem cell in a tissue, the method comprising:

a) genetically modifying a selected type of stem cell to express a microbial opsin;

b) stimulating the genetically modified stem cell with a light-based activation signal, wherein the light-based activation signal is generated by a system comprising:

i) a light source;

ii) a pulse generator that is configured to send signals to and control the light source;

iii) a signal receiver that is configured to receive response signals from the genetically modified stem cell; and

iv) a computer that is configured to modulate signals sent by the pulse generator based on the response signals;

c) receiving one or more response signals from the genetically modified stem cell; and

d) modulating the light-based activation signal based on the response signals, thereby selectively controlling growth and development of the genetically modified stem cell.

2. The method of claim 1, wherein the tissue is brain tissue.

3. The method of claim 1, wherein the tissue is an artificial tissue.

4. The method of claim 3, wherein the artificial tissue comprises cells within an artificial matrix.

5. The method of claim 3 or claim 4, wherein the artificial tissue is for use as an implant.

6. The method of any one of claims 1 to 5, wherein the microbial opsin is encoded by a nucleotide sequence operably linked to a cell type-specific promoter.

7. The method of any one of claims 1 to 6, wherein the stem cell is an induced pluripotent stem cell.

8. The method of any one of claims 1 to 6, wherein the stem cell is a neural stem cell.

9. The method of claim 8, wherein the method further comprises:

genetically modifying a glial cell to express a second microbial opsin; and

inducing the glial cell to release nerve growth factor to the neural stem cell in vitro by activating the second microbial opsin using direct pulses of illumination.

10. The method of claim 9, wherein the second microbial opsin is encoded by a nucleotide sequence operably linked to a glial cell-specific promoter.

11. The method of any one of claims 1 to 6, wherein the stem cell is a neuronal stem cell.

12. The method of claim 11, wherein the microbial opsin is encoded by a nucleotide sequence operably linked to a neuron-specific promoter.

13. The method of any one of claims 1 to 12, further including facilitating cellular growth of the stem cell within a predetermined spatial configuration.

14. The method of any one of claims 1 to 13, wherein the microbial opsin is channelrhodopsin-2.

15. The method of any one of claims 1 to 14, wherein the genetically modified stem cell is illuminated by said direct pulses for a period of time of 5 days.

16. A structure comprising:

a tissue culture matrix that contains a genetically modified progenitor cell that expresses a microbial opsin, wherein the progenitor cell is a neuronal progenitor cell, a glial progenitor cell, or a vascular progenitor cell; and a system comprising:

i) a light source configured to provide light pulses to the genetically modified progenitor cell in the tissue culture matrix;

ii) a pulse generator that is configured to send signals to and control the light source;

iii) a signal receiver that is configured to receive response signals from the genetically modified progenitor cell; and

iv) a computer that is configured to modulate signals sent by the pulse generator based on the response signals.

17. The structure of claim 16, wherein the microbial opsin is an ion channel or an ion pump.

18. The structure of claim 16, wherein the microbial opsin is channelrhodopsin-2.

19. The structure of any one of claims 16 to 18, wherein the tissue culture matrix comprises a porous barrier membrane that is configured to prevent cell migration out of the tissue culture matrix and to prevent clumping in other portions of the engineered matrix.

20. The structure of any one of claims 16 to 18, wherein the tissue culture matrix includes a porous barrier membrane comprising polyethylene terephthalate and having pores of a diameter between approximately 3 μm and 7 μm.

21. The structure of any one of claims 16 to 20, further comprising a photo detector for sensing light provided by an indicator of an action potential.