CLAIMS

1. A process of capturing nucleic acid material from individual biological cells within a micro-fluidic device, said process comprising:

placing an individual biological cell into one of a plurality of isolation pens disposed within the micro-fluidic device; the micro-fluidic device comprising:

an electrode activation substrate comprising dielectrophoresis (DEP) electrodes at a surface thereof, wherein each electrode is configured to be selectively activated and deactivated;

a micro-fluidic structure that, along with the surface of the substrate, defines a micro-fluidic channel configured to contain a flow of a first liquid medium flowing in a direction from an inlet to an outlet of the micro-fluidic structure;

wherein the plurality of isolation pens is disposed in the micro-fluidic channel, wherein each isolation pen comprises:

a single opening configured to open to the micro-fluidic channel so as to permit exchange of a second liquid medium in the isolation pen with the first liquid medium flowing through the micro-fluidic channel by diffusion, the single opening not configured to open to the direction of the first liquid medium and thereby prevent flow directly into the isolation pen; and

wherein an interior space of the isolation pen is sufficiently enclosed to prevent biological material or objects in that interior space from mixing with biological material or objects in an interior space of another isolation pen of said plurality of isolation pens;

introducing a capture object into one of the plurality of isolation pens;

lysing said individual biological cell in said one of said plurality of isolation pens;

capturing with said capture object in said one of said plurality of isolation pens nucleic acid material from said lysed cell; and

after said capturing, removing said capture object from said isolation pen.

2. The process of claim 1, wherein said placing comprises:

selecting said individual biological cell from a group of biological cells in a common space in said micro-fluidic device, and

moving said individual biological cell from said common space into said one isolation pen in said micro-fluidic device.

3. The process of claim 2, wherein said selecting comprises testing said group of biological cells in said micro-fluidic device for a particular characteristic.

4. The process of claim 3, wherein said individual biological cell is one of said biological cells in said group that tests positive for said particular characteristic.

5. The process of claim 3, wherein said individual biological cell is one of said biological cells in said group that tests negative for said particular characteristic.

6. The process of any one of claims 2 to 5, wherein said selecting further comprises creating an individual light trap trapping said individual cell by projecting a light pattern into said common space inside said micro-fluidic device.

7. The process of claim 6, wherein said moving comprises moving said individual light trap from said common space into said one isolation pen.

8. The process of claim 3, wherein said particular characteristic comprises a size of one or more individual biological cells of said group of biological cells or a morphology of one or more individual biological cells of said group of biological cells.

9. The process of claim 3, wherein said particular characteristic comprises whether one or more individual biological cells of said group of biological cells comprise a particular material or whether one or more individual biological cells of said group of biological cells produce a particular material.

10. The process of any one of claims 1 to 9, wherein a plurality of individual biological cells are placed into a corresponding plurality of isolation pens such that each isolation pen includes a single individual biological cell.

11. The process of claim 10, wherein said lysing comprises lysing said plurality of said individual biological cells in said plurality of isolation pens simultaneously.

12. The process of any one of claims 1 to 9, wherein said lysing comprises:

flowing a lysing reagent through the micro-fluidic channel in said micro-fluidic device in which said one isolation pen is located,

directing a beam of electromagnetic energy at said individual biological cell,

electroporating said individual biological cell,

changing a temperature of said individual biological cell sufficiently to lyse said individual biological cell, or

applying sufficient acoustic energy to said individual biological cell to lyse said individual biological cell.

13. The process of claim 10, wherein said lysing comprises:

selecting a specific individual one of said individual biological cells in said plurality of isolation pens, and

lysing said specific individual one of said individual biological cells without also simultaneously lysing any others of said individual biological cells in said plurality of isolation pens.

14. The process of claim 13, wherein said lysing further comprises sequentially lysing a plurality of said individual biological cells in said plurality of isolation pens by sequentially repeating a plurality of times said selecting a specific individual one of said individual biological cells in said one isolation pens followed by said lysing said specific individual one of said individual biological cells.

15. The process of any one of claims 1 to 9, wherein:

said lysing comprises compromising an outer membrane of said individual biological cell without compromising a membrane of a first internal element of said individual biological cell,

said compromising said outer membrane releases a first type of nucleic acid from said individual biological cell, and

said capture object is a first capture object configured to capture said first type of nucleic acid.

16. The process of claim 15 further comprising repeating said lysing and said capturing as follows:

lysing in said isolation pen said first internal element of said individual biological cell by compromising said membrane of said first internal element, and

capturing with a second capture object in said one isolation pen a second type of nucleic acid material released by said lysing said first internal element.

17. The process of claim 16, wherein said first internal element is one of a nucleus or an organelle of said one of said individual biological cells.

18. The process of claim 17, wherein said lysing said one of said individual biological cells further comprises compromising said outer membrane of said one of said individual biological cells without compromising a membrane of a second internal element of said one of said individual biological cells,

19. The process of claim 18 further comprising repeating again said lysing and said capturing as follows:

lysing in said one isolation pen said second internal element of said individual biological cell by compromising said membrane of said second internal element, and

capturing with a third capture object in said one isolation pen a third type of nucleic acid material released by said lysing said second internal element.

20. The process of claim 19, wherein:

one of said first internal element or said second internal element is a nucleus of said one of said individual biological cells, and

another of said first internal element or said second internal element is an organelle of said one of said individual biological cells.

21. The process of claim 20, wherein:

said first type of nucleic acid material is a different type of nucleic acid material than said second type of nucleic acid material,

said second type of nucleic acid material is a different type of nucleic acid material than said third type of nucleic acid material, and

said first type of nucleic acid material is a different type of nucleic acid material than said third type of nucleic acid material.

22. The process of claim 10 or 11 wherein:

said lysing comprises lysing said plurality of individual biological cells in said plurality of isolation pen,

said capturing comprises capturing with a plurality of capture objects in said plurality of isolation pens nucleic acid material from said lysed individual biological cells, and

said removing comprises removing said plurality of capture objects from said plurality of isolation pens.

23. The process of claim 22, wherein:

each of said capture objects comprises an identifier that uniquely identifies each said capture object from every other capture object of said plurality, and

said process further comprises storing in a memory device a correlation between each said capture object and data regarding nucleic acid material captured by said capture object.

24. The process of claim 23, wherein said data comprises a type of said nucleic acid material captured by said capture object.

25. The process of claim 23, wherein said correlation comprises a characteristic of one of said lysed individual biological cells from which said nucleic acid material captured by said capture object originated.

26. The process of any one of claims 1 to 9 further comprising placing a blocking object substantially in an opening of said one isolation pen, wherein said blocking object is configured to capture nucleic acid material from said lysed cell.

27. The process of any one of claims 1 to 9, wherein said individual biological cell is a cell from a clonal cell colony.

28. The process of claim 27, wherein said placing comprises moving said individual biological cell from a clonal cell colony in a culturing pen in said micro-fluidic device into said one isolation pen.

29. The process of claim 28 wherein:

said lysing comprises lysing said individual biological cell in said one isolation pen,

said capturing comprises capturing with one or more capture objects in said one isolation pen nucleic acid material from said lysed individual biological cell, and

said removing comprises removing said one or more capture objects from said one isolation pen.

30. The process of claim 29, wherein:

each of said capture objects comprises an identifier that uniquely identifies each said capture object from every other one of said capture objects, and

said process further comprises storing in a memory device a correlation between said identifier of each said capture object and an identification of said clonal cell colony from which said one of said individual biological cells whose nucleic acid material is captured by said capture object originated.

31. The process of claim 10 or 11, wherein:

said lysing comprises lysing said one of said individual biological cells in said one of said isolation pens at a first time,

said process further comprises lysing a second one of said individual biological cells in a second one of said isolation pens at a second time, and

said second time is after said first time.

32. The process of claim 31 further comprising monitoring said micro-fluidic device for an event inside said micro-fluidic device, wherein:

said first time is a first time period from detection of said event, and

said second time is a second time period from said detection of said event.

33. The process of claim 31 further comprises testing a group of individual biological cells in said micro-fluidic device for particular characteristics, wherein:

said one of said individual biological cells tested positive for a first one of said characteristics, and

said second one of said individual biological cells tested positive for a second one of said characteristics.

34. A process of capturing nucleic acid material from individual biological cells within a micro-fluidic device, comprising:

placing a first biological cell into a first isolation pen disposed within the micro-fluidic device by projecting a light pattern to create a light trap trapping the first biological cell and then moving the light trap containing the first biological cell into the first isolation pen, the micro-fluidic device comprising:

an electrode activation substrate comprising dielectrophoresis (DEP) electrodes configured to be selectively activated and deactivated;

a micro-fluidic channel configured to contain flow of a first liquid medium flowing in a direction from an inlet to an outlet of a micro-fluidic structure;

wherein the first isolation pen is disposed in the micro-fluidic channel with the first isolation pen containing a single opening to the micro-fluidic channel that permits

exchange of a second liquid medium in the first isolation pen with the first liquid medium flowing through the micro-fluidic channel by diffusion, the single opening not configured to open to the flow direction of the first liquid medium; and

introducing a first capture object into the first isolation pen;

lysing the first biological cell in the first isolation pen;

capturing nucleic acid material from the lysed cell with the first capture object in the first isolation pen; and

then removing the first capture object from the first isolation pen.

35. The process of claim 34, wherein the moving comprises moving the individual light trap from a common space in the microfluidic device into the first isolation pen.

36. The process of claim 34, wherein a plurality of biological cells are placed into a corresponding plurality of isolation pens such that each isolation pen contains a single biological cell.

37. The process of claim 36, wherein the lysing comprises simultaneously lysing the plurality of biological cells in the plurality of isolation pens.

38. The process of claim 36, wherein the lysing comprises lysing the first biological cell without also simultaneously lysing any other biological cell.

39. The process of claim 34, wherein the lysing comprises:

flowing a lysing reagent through the micro-fluidic channel in the micro-fluidic device,

directing a beam of electromagnetic energy at the first biological cell,

electroporating the first biological cell,

changing a temperature of the first biological cell sufficiently to lyse the individual biological cell, or

applying sufficient acoustic energy to the first biological cell to lyse the first biological cell.

40. The process of claim 34, wherein:

the lysing includes compromising an outer membrane of the first biological cell to release a first type of nucleic acid without compromising a membrane of a first internal element of the first biological cell, and

capturing the first type of nucleic acid using the first capture object.

41. The process of claim 40, further comprising:

lysing the first internal element of the first biological cell in the first isolation pen by compromising the membrane of the first internal element; and

capturing a second type of nucleic acid material released by the first internal element using a second capture object in the first isolation pen.

42. The process of claim 41, wherein the first internal element is a nucleus or an organelle.

43. The process of claim 42, wherein the lysing further comprises compromising the outer membrane of the first biological cell without compromising a membrane of a second internal element of the first biological cell.

44. The process of claim 43, further comprising:

lysing the second internal element of the first biological cell in the first isolation pen by compromising the membrane of the second internal element; and

capturing a third type of nucleic acid material released by the second internal element using a third capture object in the first isolation pen.

45. The process of claim 44, wherein:

one of the first or second internal elements is a nucleus of the first biological cell, and

the other internal element is an organelle of the first biological cell.

46. The process of claim 45, wherein:

the first type of nucleic acid material is different than the second type of nucleic acid material,

the second type of nucleic acid material is different than the third type of nucleic acid material, and

the first type of nucleic acid material is different than the third type of nucleic acid material.

47. The process of claim 36, further comprising:

lysing the plurality of biological cells in the plurality of isolation pens,

capturing nucleic acid material from the lysed biological cells with a plurality of capture objects while in the plurality of isolation pens, and

removing the plurality of capture objects from the plurality of isolation pens.

48. The process of claim 47, wherein:

each capture object comprises an identifier that uniquely identifies that capture object from other capture objects of the plurality of capture objects, and

the process further comprises storing in a memory device a correlation between each capture object and data regarding the nucleic acid material captured by that capture object.

49. The process of claim 48, wherein the correlation comprises a characteristic of the lysed first biological cell from which the nucleic acid material captured by the first capture object originated.

50. The process of claim 34, further comprising placing a blocking object substantially in an opening of the first isolation pen, wherein the blocking object is configured to capture nucleic acid material from the lysed first biological cell.

51. The process of claim 34, wherein the first biological cell is a cell from a clonal cell colony.

52. The process of claim 51, wherein the placing comprises moving the first biological cell from the clonal cell colony located in a culturing pen of the micro-fluidic device into the first isolation pen.

53. The process of claim 34, further comprising:

lysing the first biological cell in the first isolation pen at a first time,

lysing a second biological cell in a second isolation pen at a second time after the first time.

54. The process of claim 53, further comprising monitoring the micro-fluidic device for an event inside the micro-fluidic device, wherein:

the first time is a first time period from detection of the event, and

the second time is a second time period from detection of the event.

55. The process of claim 34, further comprising testing a group of biological cells in the micro-fluidic device for particular characteristics, wherein:

the first biological cell tests positive for a first characteristic, and

a second biological cells tests positive for a second characteristic different than the first characteristic.