Claims

1. An apparatus comprising a microfluidic cartridge comprising a wet cartridge, a dry cartridge, and a protein microarray, wherein the wet cartridge comprises:

i) at least one reagent reservoir for storing a reagent fluid;

ii) at least one buffer reservoir for storing a buffer fluid; and

iii) a plurality of waste reservoirs for receiving the reagent fluid or the buffer fluid; and the dry cartridge comprises an aperture for detecting the protein microarray, the aperture defining an array chamber in conjunction with the protein microarray, and a plurality of microfluidic channels, the microfluidic channels comprising:

- i) a main channel coupled to the array chamber;
- ii) at least one reagent channel configured to transfer the reagent fluid from each of the at least one reagent reservoir to the main channel;
- iii) at least one buffer channel configured to transfer the buffer fluid from each of the at least one buffer reservoir to the main channel to flush the reagent fluid from the main channel; and
- iv) a plurality of channels configured to transfer the reagent fluid or the buffer fluid to the waste reservoirs;

wherein the channels are configured to allow for smooth flow of fluids and minimization of cross-contamination;

wherein the dry cartridge is in alignment with and positioned above the wet cartridge and reagent fluid and buffer fluid in the reservoirs of the wet cartridge are pushed up against gravity into the channels of the dry cartridge and the protein microarray.

2. The apparatus of claim 1, wherein the wet cartridge includes,

i) a plurality of reagent reservoirs;

ii) a plurality of buffer reservoirs, wherein the number of buffer reservoirs is the same as the number of reagent reservoirs;

iii) first and second waste reservoirs;

iv) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs;

v) a sample well for receiving a fluid sample; and

vi) a plurality of ports corresponding to each of the buffer reservoirs, reagent reservoirs, waste reservoirs and sample well;

the dry cartridge includes an aperture for detecting the protein microarray, the aperture defining an array chamber in conjunction with the protein microarray, the main channel

includes a main junction and a plurality of microfluidic channels are disposed around the main junction, the microfluidic channels comprising:

i) a plurality of reagent channels, wherein each reagent channel corresponds to one of the reagent reservoirs of the wet cartridge;

ii) a plurality of buffer channels, wherein each buffer channel corresponds to one of the buffer reservoirs of the wet cartridge and wherein each buffer channel connects to each corresponding reagent channel, to form buffer channel/reagent channel pairs;

iii) a channel leading from the main junction to each buffer channel;

iv) a channel connecting the array chamber to the first waste reservoir;

v) a channel connecting the array chamber to the main junction;

vi) a channel connecting the main junction to the second waste reservoir; wherein the channels are configured to allow for smooth flow of fluids and minimization of cross-contamination;

vii) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs of the wet cartridge; and

viii) a plurality of liquid-impermeable, gas-permeable barriers corresponding to each of the vents;

and the dry cartridge is in alignment with and positioned above the wet cartridge and reagent fluid and buffer fluid in the reservoirs of the wet cartridge are pushed up against gravity into the channels of the dry cartridge, and the vents of the dry cartridge are capable of interfacing with a manifold of an instrument.

3. The apparatus of claim 1, wherein the wet cartridge includes,

i) a plurality of reagent reservoirs;

ii) a plurality of buffer reservoirs, wherein the number of buffer reservoirs is the same as the number of reagent reservoirs;

iii) first and second waste reservoirs;

iv) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs;

v) a sample well for receiving a fluid sample; and

vi) a plurality of ports corresponding to each of the buffer reservoirs, reagent reservoirs, waste reservoirs and sample well;

the dry cartridge comprises an aperture for detecting the protein microarray, the aperture defining an array chamber in conjunction with the protein microarray, and a plurality of microfluidic channels, the microfluidic channels comprising:

i) a plurality of reagent channels, wherein each reagent channel corresponds to one of the reagent reservoirs of the wet cartridge;
ii) a plurality of buffer channels, wherein each buffer channel corresponds to one of the buffer reservoirs of the wet cartridge, and wherein each buffer channel connects to each corresponding reagent channel, to form buffer channel/reagent channel pairs, and wherein each buffer channel connects to the main channel;
iii) a channel connecting the array chamber to the first waste reservoir;
iv) a channel connecting the array chamber to the main channel;
v) a channel connecting the main channel to the second waste reservoir; wherein the channels are configured to allow for smooth flow of fluids and minimization of cross-contamination;
vi) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs of the wet cartridge; and
vii) a plurality of liquid-impermeable, gas-permeable barriers corresponding to each of the vents;
and wherein the dry cartridge is in alignment with and positioned above the wet cartridge and reagent fluid and buffer fluid in the reservoirs of the wet cartridge are pushed up against gravity into the channels of the dry cartridge, and the vents of the dry cartridge are capable of interfacing with a manifold of an instrument.

4. The apparatus of claim 3, wherein the fluid sample is a biological sample.

5. The apparatus of claim 1, wherein the protein microarray is an antibody microarray.

6. The apparatus of claim 2, wherein the instrument comprises an integrated microcontroller, pump, valves and optical sensor.

7. The apparatus of claim 6, wherein the optical sensor is configured to capture an image of the protein microarray from the aperture of the dry cartridge, the image being a readout from the optical sensor which can be interpreted using quantification software.

8. The apparatus of claim 1, wherein the at least one buffer reservoir, reagent reservoir and the waste reservoirs are configured to allow for pre- determined volumes.

9. The apparatus of claim 1, wherein the wet cartridge comprises a laminate bottom.

10. The apparatus of claim 9, wherein the laminate bottom comprises precut holes in alignment with each of the buffer reservoirs, reagent reservoirs and waste reservoirs for loading the reservoirs.

11. The apparatus of claim 1, wherein the wet cartridge is reusable.

12. The apparatus of claim 1, wherein the dry cartridge is disposable.

13. The apparatus of claim 1, wherein the microfluidic cartridge is disposable.

14. An instrument comprising the microfluidic apparatus of claim 1, the instrument further comprising a pump, a plurality of valves, a microcontroller and an optical system.

15. A microfluidic cartridge comprising a wet cartridge, a dry cartridge, and a protein microarray, wherein the wet cartridge comprises:
i) at least one reagent reservoir for storing a reagent fluid;
ii) at least one buffer reservoir for storing a buffer fluid; and
iii) a plurality of waste reservoirs for receiving the reagent fluid or the buffer fluid; and the dry cartridge comprises an aperture for detecting the protein microarray, the aperture defining an array chamber in conjunction with the protein microarray, and a plurality of microfluidic channels, the microfluidic channels comprising:

- i) a main channel coupled to the array chamber;
- ii) at least one reagent channel configured to transfer the reagent fluid from each of the at least one reagent reservoir to the main channel;
- iii) at least one buffer channel configured to transfer the buffer fluid from each of the at least one buffer reservoir to the main channel to flush the reagent fluid from the main channel; and
- iv) a plurality of channels configured to transfer the reagent fluid or the buffer fluid to the waste reservoirs;

wherein the channels are configured to allow for smooth flow of fluids and minimization of cross-contamination;
wherein the dry cartridge is in alignment with and positioned above the wet cartridge and reagent fluid and buffer fluid in the reservoirs of the wet cartridge are pushed up against gravity into the channels of the dry cartridge and the protein microarray.

16. The microfluidic cartridge of claim 15, wherein the wet cartridge includes,
i) a plurality of reagent reservoirs;

ii) a plurality of buffer reservoirs, wherein the number of buffer reservoirs is the same as the number of reagent reservoirs;
iii) first and second waste reservoirs;
iv) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs;
v) a sample well for receiving a fluid sample; and
vi) a plurality of ports corresponding to each of the buffer reservoirs, reagent reservoirs, waste reservoirs and sample well
the dry cartridge comprises an aperture for detecting the protein microarray, the aperture defining an array chamber in conjunction with the protein microarray, the main channel includes a main junction and a plurality of microfluidic channels are disposed around a main junction, the microfluidic channels comprising:

i) a plurality of reagent channels, wherein each reagent channel corresponds to one of the reagent reservoirs of the wet cartridge;
ii) a plurality of buffer channels, wherein each buffer channel corresponds to one of the buffer reservoirs of the wet cartridge and wherein each buffer channel connects to each corresponding reagent channel, to form buffer channel/reagent channel pairs;
iii) a channel leading from the main junction to each buffer channel;
iv) a channel connecting the array chamber to the first waste reservoir;
v) a channel connecting the array chamber to the main junction;
vi) a channel connecting the main junction to the second waste reservoir; wherein the channels are configured to allow for smooth flow of fluids and minimization of cross-contamination;
vii) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs of the wet cartridge; and
viii) a plurality of liquid-impermeable, gas-permeable barriers corresponding to each of the vents;

and wherein the dry cartridge is in alignment with and positioned above the wet cartridge and reagent fluid and buffer fluid in the reservoirs of the wet cartridge are pushed up against gravity into the channels of the dry cartridge, and the vents are capable of interfacing with a manifold of an instrument.

17. The microfluidic cartridge of claim 15, wherein the wet cartridge includes,

i) a plurality of reagent reservoirs;

ii) a plurality of buffer reservoirs, wherein the number of buffer reservoirs is the same as the number of reagent reservoirs;
iii) first and second waste reservoirs;
iv) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs;
v) a sample well for receiving a fluid sample; and
vi) a plurality of ports corresponding to each of the buffer reservoirs, reagent reservoirs, waste reservoirs and sample well;
the dry cartridge comprises an aperture for detecting the protein microarray, the aperture defining an array chamber in conjunction with the protein microarray, and a plurality of microfluidic channels, the microfluidic channels comprising:

i) a plurality of reagent channels, wherein each reagent channel corresponds to one of the reagent reservoirs of the wet cartridge;
ii) a plurality of buffer channels, wherein each buffer channel corresponds to one of the buffer reservoirs of the wet cartridge, and wherein each buffer channel connects to each corresponding reagent channel, to form buffer channel/reagent channel pairs, and wherein each buffer channel connects to the main channel;
iii) a channel connecting the array chamber to the first waste reservoir;
iv) a channel connecting the array chamber to the main channel;
v) a channel connecting the main channel to the second waste reservoir; wherein the channels are configured to allow for smooth flow of fluids and minimization of cross-contamination;
vi) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs of the wet cartridge; and
vii) a plurality of liquid-impermeable, gas-permeable barriers corresponding to each of the vents;

and wherein the dry cartridge is in alignment with and positioned above the wet cartridge and reagent fluid and buffer fluid in the reservoirs of the wet cartridge are pushed up against gravity into the channels of the dry cartridge, and the vents are capable of interfacing with a manifold of an instrument.

18. A wet cartridge comprising:
i) at least one reagent reservoir for storing a reagent fluid;
ii) at least one buffer reservoir for storing a buffer fluid;
iii) first and second waste reservoirs;

iv) a plurality of vents corresponding to each of the at least one buffer reservoir, at least one reagent reservoir and waste reservoirs;
v) a sample well for receiving a fluid sample; and
vi) a plurality of ports corresponding to each of the at least one buffer reservoir, at least one reagent reservoir, waste reservoirs and sample well;
wherein the wet cartridge is configured for alignment with and below a dry cartridge and a protein microarray, and configured to push reagent fluid and buffer fluid up against gravity through the corresponding ports.

19. A dry cartridge comprising an aperture for detecting a protein microarray, the aperture defining an array chamber in conjunction with the protein microarray, and a plurality of microfluidic channels disposed around a main junction, wherein:

A) the microfluidic channels are disposed around a main junction and comprise:

i) at least one reagent channel, wherein each reagent channel corresponds to one reagent reservoir of a wet cartridge;

ii) at least one buffer channel, wherein each buffer channel corresponds to one buffer reservoir of the wet cartridge and wherein each buffer channel connects to each corresponding reagent channel, to form a buffer channel/reagent channel pair;

iii) a channel leading from the main junction to each buffer channel;

iv) a channel connecting the array chamber to a first waste reservoir;

v) a channel connecting the array chamber to the main junction;

vi) a channel connecting the main junction to a second waste reservoir; wherein the channels are configured to allow for smooth flow of fluids and minimization of cross-contamination;

vii) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs of the wet cartridge; and

viii) a plurality of liquid-impermeable, gas-permeable barriers corresponding to each of the vents; or

B) the microfluidic channels comprise:

i) at least one reagent channel, wherein each reagent channel corresponds to one reagent reservoir of the wet cartridge;
ii) at least one buffer channel, wherein each buffer channel corresponds to one buffer reservoir of the wet cartridge, and wherein each buffer channel connects to each corresponding reagent channel, to form a buffer channel/reagent channel pair, and wherein each buffer channel connects to a main channel;
iii) a channel connecting the array chamber to the first waste reservoir;
iv) a channel connecting the array chamber to the main channel;

v) a channel connecting the main channel to the second waste reservoir; wherein the channels are configured to allow for smooth flow of fluids and minimization of cross-contamination;

vi) a plurality of vents corresponding to each of the buffer reservoirs, reagent reservoirs and waste reservoirs of the wet cartridge;

wherein the dry cartridge is configured for alignment with and above the wet cartridge, and the vents of the dry cartridge are configured for interfacing with a manifold of an instrument that pushes fluid from the reagent and buffer reservoirs of the wet cartridge up against gravity into corresponding channels of the dry cartridge.