

MICROFLUIDIC SYSTEM FOR AMPLIFYING AND DETECTING POLYNUCLEOTIDES IN PARALLEL

CLAIM OF PRIORITY

[0001] The instant application claims the benefit of priority to U.S. provisional applications having Ser. Nos. 60/859,284, filed Nov. 14, 2006, and 60/959,437, filed Jul. 13, 2007, the specifications of both of which are incorporated herein by reference in their entireties. The instant application is also a continuation-in-part of U.S. patent application Ser. No. 11/728,964, filed Mar. 26, 2007, the specification of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The technology described herein generally relates to systems for detecting polynucleotides in samples, particularly from biological samples. The technology more particularly relates to microfluidic systems that carry out PCR on nucleotides of interest within microfluidic channels, and detect those nucleotides.

BACKGROUND

[0003] The medical diagnostics industry is a critical element of today's healthcare infrastructure. At present, however, diagnostic analyses no matter how routine have become a bottleneck in patient care. There are several reasons for this. First, many diagnostic analyses can only be done with highly specialist equipment that is both expensive and only operable by trained clinicians. Such equipment is found in only a few locations—often just one in any given urban area. This means that most hospitals are required to send out samples for analyses to these locations, thereby incurring shipping costs and transportation delays, and possibly even sample loss. Second, the equipment in question is typically not available 'on-demand' but instead runs in batches, thereby delaying the processing time for many samples because they must wait for a machine to fill up before they can be run.

[0004] Understanding that sample flow breaks down into several key steps, it would be desirable to consider ways to automate as many of these as possible. For example, a biological sample, once extracted from a patient, must be put in a form suitable for a processing regime that typically involves using PCR to amplify a vector of interest. Once amplified, the presence of a nucleotide of interest from the sample needs to be determined unambiguously. Sample preparation is a process that is susceptible to automation but is also relatively routinely carried out in almost any location. By contrast, steps such as PCR and nucleotide detection have customarily only been within the compass of specially trained individuals having access to specialist equipment.

[0005] There is a need for a method and apparatus of carrying out PCR and detection on prepared biological samples, and preferably with high throughput. In particular there is a need for an easy-to-use device that can deliver a diagnostic result on several samples in a short time.

[0006] The discussion of the background to the technology herein is included to explain the context of the technology. This is not to be taken as an admission that any of the material referred to was published, known, or part of the common general knowledge as at the priority date of any of the claims.

[0007] Throughout the description and claims of the specification the word "comprise" and variations thereof, such as

"comprising" and "comprises", is not intended to exclude other additives, components, integers or steps.

SUMMARY

[0008] The present technology addresses systems for detecting polynucleotides in samples, particularly from biological samples. In particular, the technology relates to microfluidic systems that carry out PCR on nucleotides of interest within microfluidic channels, and detect those nucleotides.

[0009] An apparatus, comprising: a receiving bay configured to receive a microfluidic cartridge; at least one heat source thermally coupled to the cartridge and configured to carry out PCR on a microdroplet of polynucleotide-containing sample, in the cartridge; a detector configured to detect presence of one or more polynucleotides in the sample; and a processor coupled to the detector and the heat source, configured to control heating of one or more regions of the microfluidic cartridge.

[0010] A method of carrying out PCR on a plurality of polynucleotide-containing samples, the method comprising: introducing the plurality of samples in to a microfluidic cartridge, wherein the cartridge has a plurality of PCR reaction chambers configured to permit thermal cycling of the plurality of samples independently of one another; moving the plurality of samples into the respective plurality of PCR reaction chambers; and amplifying polynucleotides contained with the plurality of samples, by application of successive heating and cooling cycles to the PCR reaction chambers.

[0011] The details of one or more embodiments of the technology are set forth in the accompanying drawings and further description herein. Other features, objects, and advantages of the technology will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 shows an exemplary apparatus, a microfluidic cartridge, and a read head, as further described herein;

[0013] FIG. 2 shows an exemplary sample-preparation kit;

[0014] FIG. 3 shows a schematic diagram of an apparatus;

[0015] FIG. 4 shows a cross-section of a pipetting head and a cartridge in position in a microfluidic apparatus.

[0016] FIG. 5 shows introduction of a PCR-ready sample into a cartridge, situated in an instrument;

[0017] FIGS. 6A-6E show exemplary embodiments of an apparatus;

[0018] FIG. 7 shows an exploded view of an apparatus;

[0019] FIG. 8 shows a block diagram of control circuitry;

[0020] FIG. 9 shows a plan view of an exemplary multi-lane microfluidic cartridge;

[0021] FIG. 10A shows an exemplary multi-lane cartridge;

[0022] FIG. 10B shows a portion of an exemplary multi-lane cartridge;

[0023] FIGS. 11A-C show exploded view of an exemplary microfluidic cartridge;

[0024] FIG. 12 shows an exemplary highly-multiplexed microfluidic cartridge;

[0025] FIGS. 13-16 show various aspects of exemplary highly multiplexed microfluidic cartridges; and

[0026] FIGS. 17A-C show various aspects of a radially configured highly multiplexed microfluidic cartridge.

[0027] FIG. 18 shows an exemplary microfluidic network in a lane of a multi-lane cartridge;