

What is claimed:

1. A method of identifying a cancer patient that is responsive to treatment with a fibroblast growth factor receptor (FGFR) inhibitor comprising:
 - evaluating a biological sample from the patient for a FGFR mutant from a FGFR mutant gene panel, wherein the FGFR mutant is a FGFR fusion gene or a FGFR single nucleotide polymorphism, and wherein said evaluating comprises
 - amplifying cDNA with a pair of primers that bind to and amplify one or more FGFR mutants from the FGFR mutant gene panel; and
 - determining whether the one or more FGFR mutants from the FGFR mutant gene panel are present in the sample, wherein the presence of the one or more FGFR mutants indicates that the patient is responsive to treatment with the FGFR inhibitor.
2. A method of identifying a cancer patient that is responsive to treatment with a fibroblast growth factor receptor (FGFR) inhibitor comprising:
 - evaluating a biological sample from the patient for the presence of one or more FGFR mutants from a FGFR mutant gene panel, wherein the FGFR mutant is a FGFR fusion gene or a FGFR single nucleotide polymorphism, wherein the presence of the one or more FGFR mutants indicates that the patient is responsive to treatment with the FGFR inhibitor.
3. The method of claim 1 or 2, wherein the FGFR fusion gene comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:TACC3 Intron, FGFR3:BAIAP2L1, FGFR2:BICC1, FGFR2:AFF3, FGFR2:CASP7, FGFR2:CCDC6, or FGFR2:OFD1, or any combination thereof.
4. The method of claim 1 or 2, wherein the FGFR single nucleotide polymorphism comprises R248C, S249C, G370C, or Y373C, or any combination thereof.
5. The method of claim 1 or 2, wherein the cancer is bladder cancer and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:BAIAP2L1, FGFR2:BICC1, FGFR2:AFF3, FGFR2:CASP7, FGFR3 R248C, FGFR3 S249C, FGFR3 G370C, or FGFR3 Y373C, or any combination thereof.

6. The method of claim 1 or 2, wherein the cancer is metastatic bladder cancer and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:BAIAP2L1, FGFR2:BICC1, FGFR2:AFF3, FGFR2:CASP7, FGFR3 R248C, FGFR3 S249C, FGFR3 G370C, or FGFR3 Y373C, or any combination thereof.
7. The method of claim 1 or 2, wherein the cancer is ovarian cancer and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:BAIAP2L1, FGFR2:BICC1, FGFR2:AFF3, FGFR2:CASP7, FGFR3 R248C, FGFR3 S249C, FGFR3 G370C, or FGFR3 Y373C, or any combination thereof.
8. The method of claim 1 or 2, wherein the cancer is head and neck cancer and the FGFR mutant gene panel comprises FGFR3:BAIAP2L1, FGFR2:CASP7, FGFR3 R248C, FGFR3 S249C, FGFR3 G370C, or FGFR3 Y373C, or any combination thereof.
9. The method of claim 1 or 2, wherein the cancer is metastatic head and neck cancer and the FGFR mutant gene panel comprises FGFR3:BAIAP2L1, FGFR2:CASP7, or FGFR2:OFD1, or any combination thereof.
10. The method of claim 1 or 2, wherein the cancer is esophageal cancer and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR2:BICC1, FGFR2:CASP7, FGFR3 R248C, FGFR3 S249C, FGFR3 G370C, or FGFR3 Y373C, or any combination thereof.
11. The method of claim 1 or 2, wherein the cancer is metastatic esophageal cancer and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:TACC3 Intron, FGFR3:BAIAP2L1, FGFR2:BICC1, FGFR2:AFF3, FGFR2:CASP7, FGFR2:CCD6, or FGFR2:OFD1, or any combination thereof.
12. The method of claim 1 or 2, wherein the cancer is non-small-cell lung carcinoma adenocarcinoma and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:TACC3 Intron, FGFR3:BAIAP2L1, FGFR2:AFF3, FGFR2:CASP7, FGFR3 R248C, FGFR3 S249C, FGFR3 G370C, or FGFR3 Y373C, or any combination thereof.

13. The method of claim 1 or 2, wherein the cancer is non-small cell lung carcinoma squamous cell carcinoma and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:BAIAP2L1, FGFR2:BICC1, FGFR2:AFF3, FGFR2:CASP7, FGFR2:CCDC6, FGFR3 R248C, FGFR3 S249C, FGFR3 G370C, or FGFR3 Y373C, or any combination thereof.
14. The method of claim 1 or 2, wherein the cancer is metastatic endometrial cancer and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:TACC3 Intron, FGFR3:BAIAP2L1, FGFR2:CASP7, FGFR2:CCDC6, or FGFR2:OFD1, or any combination thereof.
15. The method of claim 1 or 2, wherein the cancer is breast cancer and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:TACC3 Intron, FGFR3:BAIAP2L1, FGFR2:BICC1, FGFR2:AFF3, FGFR2:CASP7, FGFR2:CCDC6, or FGFR2:OFD1, or any combination thereof.
16. The method of claim 1 or 2, wherein the cancer is hepatocellular carcinoma and the FGFR mutant gene panel comprises FGFR3:TACC3 v1, FGFR3:TACC3 v3, FGFR3:TACC3 Intron, FGFR3:BAIAP2L1, FGFR2:BICC1, FGFR2:AFF3, FGFR2:CASP7, FGFR2:CCDC6, FGFR2:OFD1, FGFR3 R248C, FGFR3 S249C, FGFR3 G370C, or FGFR3 Y373C, or any combination thereof.
17. The method of any one of claims 2-16, wherein the evaluating comprises amplifying cDNA with a pair of primers that bind to and amplify one or more FGFR mutants from the FGFR mutant gene panel.
18. The method of claim 17, wherein the cDNA is pre-amplified cDNA.
19. The method of any one of the previous claims, wherein the FGFR mutant and pair of primers are:
- FGFR3:TACC3 v1 and primers having the amino acid sequences of SEQ ID NO:5 and SEQ ID NO:6;
- FGFR3:TACC3 v3 and primers having the amino acid sequences of SEQ ID NO:7 and SEQ ID NO:8;

FGFR3:TACC3 Intron and primers having the amino acid sequences of SEQ ID NO:9 and SEQ ID NO:10;

FGFR3:BAIAP2L1 and primers having the amino acid sequences of SEQ ID NO:11 and SEQ ID NO:12;

FGFR2:BICC1 and primers having the amino acid sequences of SEQ ID NO:13 and SEQ ID NO:14;

FGFR2:AFF3 and primers having the amino acid sequences of SEQ ID NO:15 and SEQ ID NO:16;

FGFR2:CASP7 and primers having the amino acid sequences of SEQ ID NO:17 and SEQ ID NO:18;

FGFR2:CCDC6 and primers having the amino acid sequences of SEQ ID NO:19 and SEQ ID NO:20;

FGFR2:OFD1 and primers having the amino acid sequences of SEQ ID NO:21 and SEQ ID NO:22;

R248C and primers having the amino acid sequences of SEQ ID NO:23 and SEQ ID NO:24 or SEQ ID NO:31 and SEQ ID NO:32;

S249C and primers having the amino acid sequences of SEQ ID NO:25 and SEQ ID NO:26 or SEQ ID NO:33 and SEQ ID NO:34;

G370C and primers having the amino acid sequences of SEQ ID NO:27 and SEQ ID NO:28 or SEQ ID NO:35 and SEQ ID NO:36;

Y373C and primers having the amino acid sequences of SEQ ID NO:29 and SEQ ID NO:30 or SEQ ID NO:37 and SEQ ID NO:38;

or any combination thereof.

20. The method of any one of the previous claims, wherein the evaluating comprises:
isolating RNA from the biological sample and synthesizing cDNA from the isolated RNA.
21. The method of claim 20, further comprising pre-amplifying the cDNA prior to the amplifying step.
22. The method of any one of claims 1 or 3-21, wherein the cDNA is preamplified.

23. The method of any one of claims 1 or 3-22, wherein the amplifying step comprises performing real-time PCR.
24. The method of claim 23, wherein the real-time PCR is performed with one or more probes comprising SEQ ID NO:43, SEQ ID NO:44, SEQ ID NO:45, SEQ ID NO:46, SEQ ID NO:47, SEQ ID NO:48, SEQ ID NO:49, SEQ ID NO:50, SEQ ID NO:51, SEQ ID NO:52, SEQ ID NO:53, SEQ ID NO:54, and/or SEQ ID NO:55.
25. The method of claim 23 or 24, wherein the real-time PCR is performed with one or more 3' blocking oligonucleotides comprising SEQ ID NO:39, SEQ ID NO:40, SEQ ID NO:41, and/or SEQ ID NO:42.
26. The method of any one of claims 1 or 3-25, wherein said determining step comprises sequencing the amplified cDNA.
27. A kit for identifying the presence of one or more FGFR mutant genes in a biological sample comprising:
pairs of primers having the sequences of SEQ ID NO:5 and SEQ ID NO:6, SEQ ID NO:7 and SEQ ID NO:8, SEQ ID NO:9 and SEQ ID NO:10, SEQ ID NO:11 and SEQ ID NO:12, SEQ ID NO:13 and SEQ ID NO:14, SEQ ID NO:15 and SEQ ID NO:16, SEQ ID NO:17 and SEQ ID NO:18, SEQ ID NO:19 and SEQ ID NO:20, SEQ ID NO:21 and SEQ ID NO:22, SEQ ID NO:23 and SEQ ID NO:24, SEQ ID NO:25 and SEQ ID NO:26, SEQ ID NO:27 and SEQ ID NO:28, SEQ ID NO:29 and SEQ ID NO:30, SEQ ID NO:31 and SEQ ID NO:32, SEQ ID NO:33 and SEQ ID NO:34, SEQ ID NO:35 and SEQ ID NO:36, SEQ ID NO:37 and SEQ ID NO:38, or any combination thereof; and
instructions for performing an assay to detect one or more FGFR mutant genes.
28. The kit of claim 27, further comprising one or more probes, one or more 3' blocking oligonucleotides, or both.
29. The kit of claim 28, wherein
- the pair of primers have the sequences SEQ ID NO:5 and SEQ ID NO:6 and the probe has the sequence of SEQ ID NO:43;

- b. the pair of primers have the sequences SEQ ID NO:7 and SEQ ID NO:8 and the probe has the sequence of SEQ ID NO:44;
- c. the pair of primers have the sequences SEQ ID NO:9 and SEQ ID NO:10 and the probe has the sequence of SEQ ID NO:46;
- d. the pair of primers have the sequences SEQ ID NO:11 and SEQ ID NO:12 and the probe has the sequence of SEQ ID NO:47;
- e. the pair of primers have the sequences SEQ ID NO:13 and SEQ ID NO:14 and the probe has the sequence of SEQ ID NO:45;
- f. the pair of primers have the sequences SEQ ID NO:15 and SEQ ID NO:16 and the probe has the sequence of SEQ ID NO:48;
- g. the pair of primers have the sequences SEQ ID NO:17 and SEQ ID NO:18 and the probe has the sequence of SEQ ID NO:49;
- h. the pair of primers have the sequences SEQ ID NO:19 and SEQ ID NO:20 and the probe has the sequence of SEQ ID NO:50;
- i. the pair of primers have the sequences SEQ ID NO:21 and SEQ ID NO:22 and the probe has the sequence of SEQ ID NO:51;
- j. the pair of primers have the sequences SEQ ID NO:23 and SEQ ID NO:24 and the probe has the sequence of SEQ ID NO:52;
- k. the pair of primers have the sequences SEQ ID NO:25 and SEQ ID NO:26 and the probe has the sequence of SEQ ID NO:53;
- l. the pair of primers have the sequences SEQ ID NO:27 and SEQ ID NO:28 and the probe has the sequence of SEQ ID NO:54;
- m. the pair of primers have the sequences SEQ ID NO:29 and SEQ ID NO:30 and the probe has the sequence of SEQ ID NO:55;
- n. the pair of primers have the sequences SEQ ID NO:31 and SEQ ID NO:32, the probe has the sequence of SEQ ID NO:52, and the 3' blocking oligonucleotide has the sequence of SEQ ID NO:39;
- o. the pair of primers have the sequences SEQ ID NO:33 and SEQ ID NO:34, the probe has the sequence of SEQ ID NO:53, and the 3' blocking oligonucleotide has the sequence of SEQ ID NO:40;
- p. the pair of primers have the sequences SEQ ID NO:35 and SEQ ID NO:36, the probe has the sequence of SEQ ID NO:54, and the 3' blocking oligonucleotide has the sequence of SEQ ID NO:41;

- q. the pair of primers have the sequences SEQ ID NO:37 and SEQ ID NO:38, the probe has the sequence of SEQ ID NO:55, and the 3' blocking oligonucleotide has the sequence of SEQ ID NO:42; or
 - r. any combination thereof.
30. A primer having the amino acid sequence of SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:10, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:18, SEQ ID NO:19, SEQ ID NO:20, SEQ ID NO:21, SEQ ID NO:22, SEQ ID NO:23, SEQ ID NO:24, SEQ ID NO:25, SEQ ID NO:26, SEQ ID NO:27, SEQ ID NO:28, SEQ ID NO:29, SEQ ID NO:30, SEQ ID NO:31, SEQ ID NO:32, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:35, SEQ ID NO:36, SEQ ID NO:37, SEQ ID NO:38 or any combination thereof.
31. A set of primers having the sequences of SEQ ID NO:5 and SEQ ID NO:6, SEQ ID NO:7 and SEQ ID NO:8, SEQ ID NO:9 and SEQ ID NO:10, SEQ ID NO:11 and SEQ ID NO:12, SEQ ID NO:13 and SEQ ID NO:14, SEQ ID NO:15 and SEQ ID NO:16, SEQ ID NO:17 and SEQ ID NO:18, SEQ ID NO:19 and SEQ ID NO:20, SEQ ID NO:21 and SEQ ID NO:22, SEQ ID NO:23 and SEQ ID NO:24, SEQ ID NO:25 and SEQ ID NO:26, SEQ ID NO:27 and SEQ ID NO:28, SEQ ID NO:29 and SEQ ID NO:30, SEQ ID NO:31 and SEQ ID NO:32, SEQ ID NO:33 and SEQ ID NO:34, SEQ ID NO:35 and SEQ ID NO:36, SEQ ID NO:37 and SEQ ID NO:38, or any combination thereof.
32. An oligonucleotide probe having the sequence of any one of SEQ ID NOs:43-55, or any combination thereof.
33. An oligonucleotide having the sequence of any one of SEQ ID NOs:39-42, or any combination thereof.