**Table S1 Gene mutation sites detected in the present study**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Gene | Base mutation | Amino acid variation  | Gene | Base mutation | Amino acid variation  |
| FGFR3 | [c.1280C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6966404) | [p.S427C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6966404) | TP53 | [c.743G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10662) | [p.R248Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10662) |
|  | [c.732C>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6912506) | [p.D244E](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6912506) |  | [c.529C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10650) | [p.P177S](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10650) |
|  | [c.1244C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6908704) | [p.S415F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6908704) |  | [c.536A>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10889) | [p.H179R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10889) |
|  | [c.1271C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6946809) | [p.S424F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6946809) |  | [c.659A>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10758) | [p.Y220C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10758) |
|  | [c.499C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6942256) | [p.P167S](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6942256) |  | [c.754delC](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=44541) | [p.L252fs93](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=44541) |
|  | [c.2407G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6948128) | [p.G803S](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6948128) |  | [c.518T>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=44327) | [p.V173A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=44327) |
|  | [c.1687C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6933299) | [p.L563V](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6933299) |  | [c.844C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10704) | [p.R282W](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10704) |
|  | [c.560C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6943530) | [p.S187C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6943530) |  | [c.839G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10724) | [p.R280T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=10724) |
|  | [c.749C>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6936172) | [p.P250Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6936172) |  | [c.692C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=44820) | [p.T231I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=44820) |
|  | [c.1045C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3775710) | [p.H349Y](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3775710) |  | [c.882G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=44412) | [p.E294E](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=44412) |
|  | [c.1728C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3775713) | [p.D576D](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3775713) |  | [c.419C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=43742) | [p.T140I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=43742) |
|  | [c.1420C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1757110) | [p.L474L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1757110) |  | [c.496T>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=45336) | [p.S166T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=45336) |
| PIK3CA | [c.3140A>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=775) | [p.H1047R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=775) | ERBB3 | [c.1064C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1476732) | [p.T355I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1476732) |
|  | [c.1775C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6916108) | [p.S592C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6916108) |  | [c.310G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=20710) | [p.V104M](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=20710) |
|  | [c.1898C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6916107) | [p.S633C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6916107) |  | [c.2981G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6918156) | [p.G994D](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6918156) |
|  | [c.1633G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=763) | [p.E545K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=763) |  | [c.310G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1299642) | [p.V104L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1299642) |
|  | [c.1624G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=760) | [p.E542K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=760) |  | [c.310G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1299642) | [p.V104L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1299642) |
|  | [c.263G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=746) | [p.R88Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=746) |  | [c.3104T>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767528) | [p.V1035D](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767528) |
|  | [c.3140A>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=776) | [p.H1047L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=776) |  | [c.1276C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767526) | [p.R426W](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767526) |
|  | [c.3140A>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=775) | [p.H1047R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=775) |  | [c.310G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=20710) | [p.V104M](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=20710) |
|  | [c.1633G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=763) | [p.E545K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=763) |  | [c.3104T>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767528) | [p.V1035D](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767528) |
|  | [c.1624G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=125369) | [p.E542K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=125369) |  | [c.310G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1299642) | [p.V104L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1299642) |
|  | [c.263G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=271684) | [p.R88Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=271684) |  | [c.2981G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6918155) | [p.G994D](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6918155) |
|  | [c.2702G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1041510) | [p.C901F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1041510) |  | [c.310G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=191840) | [p.V104L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=191840) |
| TSC1 | [c.845C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4761746) | p.S282 |  | [c.1064C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=431477) | [p.T355I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=431477) |
|  | [c.866C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6949991) | p.S289 | NF1 | [c.910C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=24486) | [p.R304](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=24486) |
|  | [c.721G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6927420) | [p.E241Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6927420) |  | [c.8087C>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767668) | [p.P2696Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767668) |
|  | [c.649G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6928439) | [p.E217K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6928439) |  | [c.1466C>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767669) | [p.P489Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767669) |
|  | [c.2059G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6912512) | p.E687 |  | [c.1088G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1744275) | [p.R363Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1744275) |
|  | [c.1546C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=307636) | p.Q516 |  | [c.276C>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4769428) | [p.F92L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4769428) |
|  | [c.2198C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=14059) | [p.T733I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=14059) |  | [c.680C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4768181) | [p.T227I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4768181) |
|  | [c.2264T>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=14060) | [p.L755S](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=14060) |  | [c.1394G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4768413) | [p.R465L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4768413) |
|  | [c.2305G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13170) | [p.D769H](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13170) |  | [c.70A>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1435649) | [p.K24E](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1435649) |
|  | [c.929C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=48358) | [p.S310F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=48358) |  | [c.8G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1435651) | [p.R3K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1435651) |
|  | [c.235T>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1600406) | [p.Y79H](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1600406) |  | [c.541G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4768279) | [p.E181Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4768279) |
|  | [c.569\_569delG](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1600407) | [p.R190fs20](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1600407) |  | [c.58A>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1744279) | [p.R20R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1744279) |
|  | [c.1257delC](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1460747) | [p.R420fs20](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1460747) |  | [c.541G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4768278) | [p.E181Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4768278) |
| ERBB2 | [c.929C>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=94225) | [p.S310Y](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=94225) | FGFR1 | [c.1454G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1314032) | [p.G485A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1314032) |
|  | [c.793G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767523) | [p.E265K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767523) |  | [c.2139G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=422133) | [p.L713L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=422133) |
|  | [c.874G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767524) | [p.G292R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767524) |  | [c.995C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3779208) | [p.S332F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3779208) |
|  | [c.929C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=48358) | [p.S310F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=48358) |  | [c.933G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3779213) | [p.L311F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3779213) |
|  | [c.2524G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=14065) | [p.V842I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=14065) |  | [c.304G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6925708) | [p.V102I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6925708) |
|  | [c.874G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767524) | [p.G292R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767524) |  | [c.1966A>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1755713) | p.K656 |
|  | [c.793G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767523) | [p.E265K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4767523) |  | [c.748C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3900049) | [p.R250W](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=3900049) |
|  | [c.2524G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=14065) | [p.V842I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=14065) |  | [c.1605G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6945236) | [p.M535I](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6945236) |
|  | [c.929C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=48358) | [p.S310F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=48358) |  | [c.1966A>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1755713) | p.K656 |
|  | [c.2033G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=436498) | [p.R678Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=436498) |  | [c.160C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=2960585) | [p.R54C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=2960585) |
|  | [c.884C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=5174142) | [p.S295F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=5174142) |  | [c.311G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6953168) | [p.S104N](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6953168) |
| CDKN2A | [c.250G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13299) | [p.D84Y](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13299) | ARID1A | [c.1897C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=254551) | [p.Q633\*](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=254551) |
|  | [c.238C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=12475) | p.R80 |  | [c.5975C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=254538) | [p.S1992\*](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=254538) |
|  | [c.204G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=12749) | [p.A68A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=12749) |  | [c.6381C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=254539) | [p.I2127M](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=254539) |
|  | [c.329G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=12481) | p.W110 |  | [c.2632C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=251399) | p.Q878 |
|  | [c.250G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13488) | [p.D84N](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13488) |  | [c.2993delC](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=255048) | [p.S999fs40](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=255048) |
|  | [c.296G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13618) | [p.R99Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13618) |  | [c.5606delG](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=255050) | [p.P1870fs13](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=255050) |
|  | [c.35C>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13522) | p.S12 |  | [c.1991C>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=79135) | p.S664 |
|  | [c.322G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=12484) | [p.D108N](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=12484) |  | [c.802C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=126559) | p.Q268 |
|  | [c.355G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1314727) | [p.E119K](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1314727) |  | [c.2830C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=130413) | p.Q944 |
|  | [c.238C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=12475) | p.R80 |  | [c.4270C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=144171) | p.Q1424 |
|  | [c.339G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13695) | [p.L113L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=13695) |  | [c.1177C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=51446) | p.Q393 |
| STAG2 | [c.293T>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6907461) | [p.V98G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6907461) | KTM2D | [c.6562C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4507077) | p.Q2188 |
|  | [c.1052T>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6909886) | [p.L351Q](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6909886) |  | [c.3943G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6942266) | p.E1315 |
|  | [c.2857C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1114446) | p.R953 |  | [c.3593G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6962167) | [p.C1198Y](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6962167) |
|  | [c.1821G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6909619) | [p.K607N](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6909619) |  | [c.1495G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6963907) | p.E499 |
|  | [c.638G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6909615) | [p.R213T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6909615) |  | [c.4897C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=144608) | p.R1633 |
|  | [c.1286G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6909617) | [p.G429A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6909617) | CREBBP | [c.656G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6981460) | [p.G219V](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6981460) |
|  | [c.3524T>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6975385) | [p.M1175T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6975385) |  | [c.1069C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6208053) | p.Q357 |
|  | [c.1108C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=238562) | [p.R370W](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=238562) |  | [c.1156C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6948858) | [p.R386\*](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6948858) |
|  | [c.2314T>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1735712) | [p.C772R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1735712) |  | [c.3089C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6955565) | [p.S1030F](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6955565) |
|  | [c.1708delG](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=5946041) | [p.A570fs\*6](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=5946041) |  | [c.4445A>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1315875) | [p.Y1482C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=1315875) |
|  | [c.775C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=216178) | p.R259 |  | [c.3689A>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=254632) | [p.Y1230C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=254632) |
|  | [c.2979A>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6907460) | [p.P993P](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=6907460) |  | [c.286C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=88756) | p.Q96\* |
|  | [c.367C>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=4167146) | p.Q123 |  | [c.4307G>A](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=220496) | [p.S1436N](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=220496) |
| HRAS | [c.182A>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=498) | [p.Q61L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=498) |  | [c.4506G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=88753) | [p.W1502C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=88753) |
|  | [c.35G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=483) | [p.G12V](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=483) |  |  |  |
|  | [c.34G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=481) | [p.G12C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=481) |  |  |  |
|  | [c.38G>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=489) | [p.G13V](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=489) |  |  |  |
|  | [c.182A>G](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=499) | [p.Q61R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=499) |  |  |  |
|  | [c.182A>T](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=498) | [p.Q61L](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=498) |  |  |  |
|  | [c.37G>C](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=486) | [p.G13R](https://cancer.sanger.ac.uk/cosmic/mutation/overview?id=486) |  |  |  |

**Table S2 Consistency of 14 genes mutation between tissue and urinary sediment cells**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Gene | group | Wild consistency | Mutation consistency | Consistency |
| FGFR3 | NMIBC | 0.23（5/22） | 0.55（12/22） | 0.78 |
| Control | 0.50（5/10） | 0.3（3/10） | 0.80 |
| TP53 | NMIBC | 0.18（4/22） | 0.45（10/22） | 0.63 |
| Control | 0.50（5/10） | 0.20（2/10） | 0.70 |
| PIK3CA | NMIBC | 0.36（8/22） | 0.27（6/22） | 0.60 |
| Control | 0.50（5/10） | 0.10（1/10） | 0.60 |
| ERBB3 | NMIBC | 0.55（12/22） | 0.27（6/22） | 0.72 |
| Control | 0.50（5/10） | 0.10（1/10） | 0.60 |
| TSC1 | NMIBC | 0.55（12/22） | 0.09（2/22） | 0.64 |
| Control | 0.60（6/10） | 0.00（0/10） | 0.60 |
| NF1 | NMIBC | 0.64（14/22） | 0.09（2/22） | 0.73 |
| Control | 0.60（6/10） | 0.10（1/10） | 0.70 |
| ERBB2 | NMIBC | 0.55（12/22） | 0.18（4/22） | 0.73 |
| Control | 0.70（7/10） | 0.00（0/10） | 0.70 |
| FGFR1 | NMIBC | 0.68（15/22） | 0.09（2/22） | 0.77 |
| Control | 0.70（7/10） | 0.10（1/10） | 0.80 |
| CDKN2A | NMIBC | 0.64（14/22） | 0.18（4/22） | 0.82 |
| Control | 0.70（7/10） | 0.00（0/10） | 0.70 |
| ARID1A | NMIBC | 0.64（14/22） | 0.18（4/22） | 0.82 |
| Control | 0.60（6/10） | 0.20（2/10） | 0.80 |
| STAG2 | NMIBC | 0.45（10/22） | 0.27（6/22） | 0.72 |
| Control | 0.70（7/10） | 0.10（1/10） | 0.80 |
| KTM2D | NMIBC | 0.55（11/22） | 0.27（6/22） | 0.82 |
| Control | 0.70（7/10） | 0.10（1/10） | 0.80 |
| CREBBP | NMIBC | 0.59（13/22） | 0.23（5/22） | 0.82 |
| Control | 0.70（7/10） | 0.10（1/10） | 0.80 |
| HRAS | NMIBC | 0.59（13/22） | 0.09（2/22） | 0.68 |
| Control | 0.80（8/10） | 0.00（0/10） | 0.80 |