

Table 1: Selected Personalized Medicine Drugs, Treatments, and Diagnostics as of March 2009*

Therapeutic product label contains pharmacogenomic information as:

- Information only
- Recommended
- Required

THERAPY	BIOMARKER/TEST	INDICATION
Herceptin® (trastuzumab) Tykerb® (lapatinib)	HER-2/neu receptor	Breast cancer: "...for the treatment of patients with metastatic breast cancer whose tumors over-express the HER2 protein and who have received one or more chemotherapy regimens for their metastatic disease."
Pharmaceutical and surgical prevention options and surveillance	<i>BRCA 1,2</i>	Breast cancer: Guides surveillance and preventive treatment based on susceptibility risk for breast and ovarian cancer.
Tamoxifen	Aviara Breast Cancer Index SM (<i>HOXB13, IL17BR</i>)	Breast cancer: Calculates a combined risk analysis for recurrence after tamoxifen treatment for ER-positive, node-negative breast cancer.
Chemotherapy	Mammostrat®	Breast cancer: Prognostic immunohistochemistry (IHC) test used for postmenopausal, node negative, estrogen receptor expressing breast cancer patients who will receive hormonal therapy and are considering adjuvant chemotherapy.
Chemotherapy	MammaPrint®	Breast cancer: Assesses risk of distant metastasis in a 70 gene expression profile.
Coumadin® (warfarin)	<i>CYP2C9</i>	Cardiovascular disease: "an increased bleeding risk for patients carrying either the <i>CYP2C9</i> *2 or <i>CYP2C9</i> *3 alleles."
Coumadin® (warfarin)	<i>VKORC1</i>	Cardiovascular disease: "Certain single nucleotide polymorphisms in the <i>VKORC1</i> gene (especially the -1639G>A allele) have been associated with lower dose requirements for warfarin."
Coumadin® (warfarin)	PGx Predict TM : Warfarin	Cardiovascular disease: Determines <i>CYP2C9</i> and <i>VKORC1</i> genotypes to predict likelihood of adverse events with warfarin therapy.
Coumadin® (warfarin)	Protein C deficiencies	Cardiovascular disease: Hereditary or acquired deficiencies of protein C or its cofactor, protein S, has been associated with tissue necrosis following warfarin administration.
Pharmaceutical and lifestyle prevention options	Familion® 5-gene profile	Cardiovascular disease: Guides prevention and drug selection for patients with inherited cardiac channelopathies such as Long QT Syndrome (LQTS), which can lead to cardiac rhythm abnormalities.
Statins	Phyziotype SINM	Cardiovascular disease: Predicts risk of statin-induced neuro-myopathy, based on a patient's combinatorial genotype for 50 genes.
Atorvastatin	<i>LDLR</i>	Cardiovascular disease: "Doses should be individualized according to the recommended goal of therapy. Homozygous Familial Hypercholestermia (10-80mg/day) and heterozygous (10-20mg/day)."
Camptosar® (irinotecan)	<i>UGT1A1</i>	Colon cancer: "Variations in the <i>UGT1A1</i> gene can influence a patient's ability to break down irinotecan, which can lead to increased blood levels of the drug and a higher risk of side effects."
Erbix® (cetuximab) Gefitinib Vectibix® (panitumab)	<i>EGFR</i> expression	Colon cancer: "Patients enrolled in the clinical studies were required to have...evidence of positive <i>EGFR</i> expression using the DakoCytomation <i>EGFR</i> pharmDx TM test kit." <i>EGFR</i> positive individuals are more likely to respond to the drug than those with reduced <i>EGFR</i> expression.
Erbix® (cetuximab) Gefitinib Vectibix® (panitumab)	<i>KRAS</i>	Colon cancer: Certain <i>KRAS</i> mutations lead to unresponsiveness to the drug.
Erbix® (cetuximab) and Vectibix® (panitumab) Fluorouracil Camptosar® (irinotecan)	Target GI TM	Colon cancer: Provides information of the expression of key molecular targets— <i>KRAS</i> , <i>TS</i> , and <i>TOPO1</i> —to guide therapy.
Tagretol (carbamazepine)	<i>HLA-B*1502</i>	Epilepsy and bipolar disorder: Serious dermatologic reactions are associated with the <i>HLA-B*1502</i> allele in patients treated with carbamazepine. "Prior to initiating Tegretol therapy, testing for <i>HLA-B*1502</i> should be performed in patients with ancestry in populations in which <i>HLA-B*1502</i> may be present."
Immunosuppressive drugs	AlloMap® gene profile	Heart transplantation: Monitors patient's immune response to heart transplant to guide immunosuppressive therapy.
Ziagen® (abacavir)	<i>HLA-B*5701</i>	HIV: "Patients who carry the <i>HLA-B*5701</i> allele are at high risk for experiencing a hypersensitivity reaction to abacavir. Prior to initiating therapy with abacavir, screening for the <i>HLA-B*5701</i> allele is recommended."
Selzentry® (maraviroc)	CCR5 receptor (1)	HIV: "Selzentry, in combination with other antiretroviral agents, is indicated for treatment experienced adult patients infected with only CCR5-tropic HIV-1 detectable..."

Budesonide	IBD Serology 7	Inflammatory bowel disease: Identifies subset of patients who will benefit from budesonide.
Gleevec® (imatinib mesylate)	<i>BCR-ABL</i>	Leukemia: “Gleevec® (imatinib mesylate) is indicated for the treatment of newly diagnosed adult and pediatric patients with Philadelphia chromosome positive [indicated by presence of <i>BCR-ABL</i>] chronic myeloid leukemia (CML) in chronic phase.”
Dasatinib	Philadelphia Chromosome	Leukemia: “Dasatinib is indicated for the treatment of adults with Philadelphia chromosome-positive acute lymphoblastic leukemia (Ph+ ALL) with resistance or intolerance to prior therapy”
Busulfan	Philadelphia Chromosome	Leukemia: “Busulfan is clearly less effective in patients with chronic myelogenous leukemia who lack the Philadelphia (Ph1) chromosome.”
Purinethol® (mercaptopurine) Thiaguanine Azathioprine	TPMT	Leukemia: Guides adjustment of dose in treatment of acute lymphoblastic leukemia: “Patients with inherited little or no thiopurine S-methyltransferase (TPMT) activity are at increased risk for severe Purinethol toxicity from conventional doses...”
Tarceva® (erlotinib)	<i>EGFR</i> expression	Lung cancer: The test determines patients most likely to respond.
Capecitabine	DPD	Multiple cancers: “Rarely, unexpected severe toxicity (e.g., stomatitis, diarrhea, neutropenia and neurotoxicity) associated with 5-fluorouracil has been attributed to a deficiency of dihydropyrimidine dehydrogenase (DPD) activity.”
Pharmaceutical and surgical treatment options and surveillance	<i>MLH1, MSH2, MSH6</i>	Multiple cancers: Guides surveillance and preventive treatment based on susceptibility risk for colon and other cancers.
Chemotherapy	CupPrint™	Multiple cancers: Determines cancer classification for tumors of unknown primary origin.
Chemotherapy	Aviara CancerTYPE ID®	Multiple cancers: Classifies 39 tumor types from tumors of unknown primary origin, using a gene expression profile.
Elitek® (rasburicase)	G6PD deficiency	Multiple cancers: “Rasburicase administered to patients with glucose- phosphate dehydrogenase (G6PD) deficiency can cause severe hemolysis. ... It is recommended that patients at higher risk for G6PD deficiency ... be screened prior to starting ELITEK therapy.”
Drugs metabolized by CYP P450 2C19: Celecoxib, Codeine, Diazepam, Esomeprazole, Nelfinavir, Omeprazole, Pantoprazole, Rabeprazole, Voriconazole 2D6: Acetaminophen, Aripiprazole, Atomoxetine, Carvedilol, Cevimeline hydrochloride, Clozapine, Fluoxetine HCl, Fluoxetine HCl and Olanzapine, Metoprolol, Propranolol, Propafenone, Protriptyline HCl, Risperidone, Tamoxifen, Terbinafine, Thioridazine, Timolol maleate, Tiotropium bromide inhalation, Tolerodine, Tramadol, Venlafaxine	Amplichip® <i>CYP2D6/CYP2C19</i>	Multiple diseases: FDA classification 21 CFR 862.3360: “This device is used as an aid in determining treatment choice and individualizing treatment dose for therapeutics that are metabolized primarily by the specific enzyme about which the system provides genotypic information.”
Rifampin Isoniazid Pyrazinamide	NAT	Multiple diseases: N-acetyltransferase slow and fast acetylators and toxicity- “slow acetylation may lead to higher blood levels of the drug, and thus, an increase in toxic reactions.”
Rituximab	PGx Predict™: Rituximab	Non-Hodgkin’s lymphoma: Detects CD-20 variant (polymorphism in the IgG Fc receptor gene <i>FcgRIIIa</i>) to predict response to cancer drug rituximab.
Celebrex® (celecoxib)	<i>CYP2C9</i>	Pain: “Patients who are known or suspected to be P450 2C9 poor metabolizers based on a previous history should be administered celecoxib with caution as they may have abnormally high plasma levels due to reduced metabolic clearance.”
Risperdal® (risperidone) Zyprexa® (olanzapine)	Phyziotype PIMS	Psychiatric disorders: Predicts risk of psychotropic-induced metabolic syndrome, based on a patient’s combinatorial genotype for 50 genes.
Gleevec® (imatinib mesylate)	<i>c-KIT</i>	Stomach cancer: “Gleevec® is also indicated for the treatment of patients with Kit (<i>CD117</i>) positive unresectable and/or metastatic malignant gastrointestinal stromal tumors (GIST).”

*This list is not intended to be comprehensive but reflects commonly used or available products as of March 2009. Some products, for which the FDA recommends or requires pharmacogenomic testing or which have pharmacogenomic information in their label, are listed at the FDA’s Web site (http://www.fda.gov/cder/genomics/genomic_biomarkers_table.htm). Other listed products that are novel, and/or that address large populations, have been identified via websites and public announcements.

Indications in quotes are taken from the therapeutic product label.

BCR-ABL = breakpoint cluster region – Abelson
BRCA 1,2 = breast cancer susceptibility gene 1 or 2
c-KIT = tyrosine kinase receptor
CYP = cytochrome P450 enzyme

DPD = dihydropyrimidine dehydrogenase
G6PD = glucose 6 phosphate dehydrogenase
HER2 = human epidermal growth factor receptor 2
NAT = N-acetyltransferase

TOP01 = topoisomerase 1
TPMT = thiopurine S-methyltransferase
TS = thymidylate synthase
UGT1A1 = UDP-glucuronosyltransferase 1A1