

**Single IHC Staining\***

Antibody code	Antibody - primary designation	Antibody - secondary designation	Source	Cat#	Ab type	Validated species reactivity	Primary classification	Control tissue - human	Control tissue - mouse	Comments
AKT1	Akt1/PKBa		Cell Signaling Technology	4685	rabbit monoclonal	human	Signal transduction	Colon cancer	N/A	A Ser/Thr protein kinase whose activity plays a key role in various cellular functions, including apoptosis, glycogen synthesis, and cell growth.
AKT-pS473	Akt1/PKBa (pS473)		Abcam	Ab81283	rabbit monoclonal	human	Signal transduction	Colon cancer	N/A	Phosphorylation on Thr308, Ser473 and Tyr474 is required for full activity.
Beta catenin	Beta Catenin		Abcam	Ab 32572	rabbit monoclonal	human	Signal transduction, Stem cell marker	colon cancer	N/A	Change of localization from cell surface to nuclear indicates Wnt signalling. Stem cells often have wnt signalling.
BRCA1	BRCA1		EMD Milipore	OP92	mouse monoclonal	human	Genomic stability	Normal breast tissue	N/A	Inactivation of the BRCA1 gene , located at 17q21, is responsible for some forms of familial breast and ovarian cancer and sporadic ovarian cancer. The BRCA1 protein is expressed predominantly in the nucleus and appears to undergo cell cycle regulation.
CD3	CD3		Dako	A0452	Rabbit polyclonal	Human,mouse	T cell marker	Tonsil	spleen	CD3 is non-covalently associated with T cell receptor. The CD3 components of the TCR/CD3 complex mediate signal transduction upon antigen recognition by TCR. CD3 is expressed by T cells in thymus, bone marrow, blood and lymphoid tissues.
CD4(H)	CD4		Ventana	790-4423	rabbit monoclonal	Human	T cell marker	Tonsil	N/A	CD4 a membrane glycoprotein of T lymphocytes that interacts with major histocompatibility complex class II antigens and is also a receptor for the human immunodeficiency virus. This antigen is expressed not only in T lymphocytes, but also in B cells, macrophages, and granulocytes. It is also expressed in specific regions of the brain. The protein functions to initiate or augment the early phase of T-cell activation.

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CD4(M)	CD4		Abcam	Ab183685	rabbit monoclonal	mouse	T cell marker	N/A	spleen	CD4 a membrane glycoprotein of T lymphocytes that interacts with major histocompatibility complex class II antigens and is also a receptor for the human immunodeficiency virus. This antigen is expressed not only in T lymphocytes, but also in B cells, macrophages, and granulocytes. It is also expressed in specific regions of the brain. The protein functions to initiate or augment the early phase of T-cell activation.
CD8(H)	CD8		Dako	M7103	mouse monoclonal	Human	T cell marker	Tonsil	N/A	The CD8 antigen is a cell surface glycoprotein found on most cytotoxic T lymphocytes that mediates efficient cell-cell interactions within the immune system. The CD8 antigen acts as a coreceptor with the T-cell receptor on the T lymphocyte to recognize antigens displayed by an antigen presenting cell in the context of class II MHC molecules.
CD8(M)	CD8		Abcam	Ab209775	rabbit monoclonal	mouse	T cell marker	N/A	spleen	The CD8 antigen is a cell surface glycoprotein found on most cytotoxic T lymphocytes that mediates efficient cell-cell interactions within the immune system. The CD8 antigen acts as a coreceptor with the T-cell receptor on the T lymphocyte to recognize antigens displayed by an antigen presenting cell in the context of class II MHC molecules.
Cd11b	CD11b		Abcam	Ab133357	rabbit monoclonal	Mouse	Macrophage marker	N/A	spleen	CD11b is a leukocyte-specific receptor and is regarded as a marker for monocyte/macrophages, granulocytes, and natural killer cells.
CD19( H)	CD19		Abcam	Ab134114	rabbit monoclonal	human	B cell marker	Tonsil	N/A	CD19 is a biomarker for normal and neoplastic B cells, as well as follicular dendritic cells. CD19 is critically involved in establishing intrinsic B cell signaling thresholds through modulating both B cell receptor-dependent and independent signaling.
CD19(M)	CD19		Abcam	Ab245235	rabbit monoclonal	mouse	B cell marker	N/A	spleen	CD19 is a biomarker for normal and neoplastic B cells, as well as follicular dendritic cells. CD19 is critically involved in establishing intrinsic B cell signaling thresholds through modulating both B cell receptor-dependent and independent signaling.

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CD20	CD20		Leica microsystems	NCL-L-CD20	Mouse monoclonal	Human	B cell marker	tonsil	N/A	CD20 is a membrane-embedded surface molecule which plays a role in the development and differentiation of B-cells into plasma cells.
CD31(H)	CD31	PECAM1	Abcam	Ab 134168	rabbit monoclonal	human	Leukocyte & endothelial differentiation	colon-mucosa	N/A	CD31 is found on the surface of endothelial cells, platelets and leukocytes. It plays a major role in a number of cellular interactions, particularly in adhesion between endothelial cells and leukocytes during inflammation and angiogenesis. Angiogenesis is critical to tumor growth, neoplastic progression and metastasis
CD31(H,M)	CD31	PECAM1	Abcam	ab28364	rabbit polyclonal	human, mouse	Leukocyte & endothelial differentiation	colon	colon	CD31 is found on the surface of endothelial cells, platelets and leukocytes. It plays a major role in a number of cellular interactions, particularly in adhesion between endothelial cells and leukocytes during inflammation and angiogenesis. Angiogenesis is critical to tumor growth, neoplastic progression and metastasis
CD44	CD44		Abcam	Ab216647	rabbit monoclonal	human, mouse	Stem cell marker	tonsil	thymus	Cell surface glycoprotein, expressed in lymphocytes, upregulated in some tumors. Present in some stem cells.
CD45(M)	CD45		Abcam	Ab281586	Rabbit polyclonal	mouse	Leukocyte differentiation	N/A	spleen	CD45 is a transmembrane glycoprotein which is expressed at high level on leukocytes from hematopoietic cells. CD45 isoforms play roles in T-cell and B-cell antigen receptor signaltransduction.
CD45(H)	CD45		Dako	M0701	mouse monoclonal	human	Leukocyte differentiation	tonsil	N/A	CD45 is a transmembrane glycoprotein which is expressed at high level on leukocytes from hematopoietic cells. CD45 isoforms play roles in T-cell and B-cell antigen receptor signaltransduction.
CD56	CD56		Cell Marque	156R-94	Rabbit monoclonal	human	NK cell marker	lymph node	N/A	CD56 is the <b>archetypal phenotypic marker of natural killer cells</b> but can actually be expressed by many more immune cells, including alpha beta T cells, gamma delta T cells, dendritic cells, and monocytes
CD68(H)	CD68		Novus Biologicals	NB100-683	mouse monoclonal	human	Macrophages	Tonsil	N/A	Glycosylated transmembrane protein which is mainly located in lysosomes. It reacts with myeloid precursors and peripheral blood granulocytes.
CD68(M)	CD68		Abcam	Ab125212	Rabbit polyclonal	mouse	Macrophages	N/A	spleen	Glycosylated transmembrane protein which is mainly located in lysosomes. It reacts with myeloid precursors and peripheral blood granulocytes.

## Core Immunohistochemical Stains

Chro	Chromogranin A		Dako Cytomation	A0430	rabbit polyclonal	human	Neuroendocrine differentiation	Lung carcinoid	N/A	Chromogranin A is a protein prohormone. Potentially biologically active peptides derived from chromogranin A are, vasostatin, chrmocin, pancreastatin, WE-14 etc. It has been used as a marker for neuroendocrine cells and tumors.
Cl Caspase-3	Cleaved Caspase-3		Cell Signaling	9661	rabbit polyclonal	human, mouse	Apoptosis	lymph node	thymus	Caspase 3 is one of the key executioners of apoptosis, as it is either partially or totally responsible for the proteolytic cleavage of many key proteins such as PARP.
Cyc D1(H)	Cyclin D1		Dako	M3642	Rabbit monoclonal	human	Cell cycle	colon cancer	N/A	Cyclin D1 is required for G1/s cell cycle transition. Cyclin D1 phosphorylates and inactivates retinoblastoma protein and promotes progression through G1/s phase. Amplification or over expression of cyclin D1 play a pivotal role in the development of various human cancers.
Cyc D1(M)	Cyclin D1		Abcam	Ab16663	rabbit monoclonal	mouse	Cell cycle	N/A	mouse tumor	Cyclin D1 is required for G1/s cell cycle transition. Cyclin D1 phosphorylates and inactivates retinoblastoma protein and promotes progression through G1/s phase. Amplification or over expression of cyclin D1 play a pivotal role in the development of various human cancers.
Desmin	Desmin		Abcam	Ab32362	rabbit monoclonal	human, mouse	Smooth muscle differentiation	colon smooth muscle	colon	Intermediate filament protein, expressed during the formation of muscle cells or fibers.
Ecad	E-cadherin		Abcam	Ab40772	rabbit monoclonal	human	Cell-cell interaction, epithelial differentiation	normal breast tissue	N/a	E-cadherin is a glycoprotein with an extracellular domain that interacts with other E-cadherin molecules on adjacent cells, thereby establishing adhesion between epithelial cells.
EGFR	Epidermal Growth Factor Receptor		Novus Biologicals	NBP1-84815	rabbit polyclonal	human	Signal transduction, epithelial differentiation	Placenta	N/A	EGFR is type I receptor tyrosine kinase, activated by the EGF family of ligands. EGFR is overexpressed or mutated in many common forms of carcinoma.

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pEGFR	Phospho EGFR (phospho-Tyr845)		Nanotools	0116-100/EGFR-12A3	mouse monoclonal	human	Signal transduction, epithelial differentiation	Brest cancer	N/A	EGFR/erbB receptors are activated upon binding of EGF and EGF-related growth factors such as TGF alpha, beta-cellulin, Hb-EGF, HRG, or NRG. Binding of these ligands leads to receptor homo- and heterodimerization followed by autophosphorylation and activation of downstream signal transduction pathways (MAPK, PI3K/PKB, and STAT). In addition, EGFR becomes fully activated after phosphorylation of Y845 by src family kinases.
EpCAM	Epithelial cell adhesion molecule	GA733-2, EGP, KSA, KS 1/4, Trop-1, CD326	Abcam	Ab32392	rabbit monoclonal	human, mouse	Epithelial differentiation	colon mucosa	colon	A monomeric membrane glycoprotein expressed on virtually all epithelial cells
ER (H)	Estrogen Receptor		Biocare Medical	ACA 301 B	Rabbit monoclonal	Human	Cell differentiation	Follapian tube	N/A	Estrogen receptor acts as an estrogen dependent nuclear hormone receptor. Er is present in the nuclei of epithelial cells in normals breast and endometrial tissues, as well as of breast carcinomas.
ER(M)	Estrogen receptor		Abcam	Ab32063	Rabbit monoclonal	Mouse	Cell differentiation	N/A	Mouse Ovary	Estrogen receptor acts as an estrogen dependent nuclear hormone receptor. Er is present in the nuclei of epithelial cells in normals breast and endometrial tissues, as well as of breast carcinomas.
Fox p3(H)	Fox p3		Leica Bon	PA0263	Mouse monoclonal	human	Regulatory T cell	Lymph node	N/A	The FOXP3 protein, also known as scurfin, is essential for normal immune homeostasis. Specifically, FOXP3 represses transcription through a DNA binding forhead domain, thereby regulating T cell activation.
Fox p3(M)	Fox p3		Thermo Fisher	14-5773-82	Rat	mouse	Regulatory T cell	N/A	Lymph node	The FOXP3 protein, also known as scurfin, is essential for normal immune homeostasis. Specifically, FOXP3 represses transcription through a DNA binding forhead domain, thereby regulating T cell activation.

## Core Immunohistochemical Stains

pERK	Phospho-p44/42 MAPK (ERK1/2)(Thr202/Tyr204)		Cell Signaling	9101	rabbit polyclonal	human,mouse	Signal transduction	colon cancer	mouse tumor	MAPKs are a widely conserved family of serine/threonine protein kinases involved in many cellular programs such as cell proliferation, differentiation, motility, and death. The p44/42 MAPK (Erk1/2) signaling pathway can be activated in response to a diverse range of extracellular stimuli including mitogens, growth factors, and cytokines (1-3) and is an important target in the diagnosis and treatment of cancer
FGF2	Basic fibroblast growth factor		BD Biosciences	610073	mouse monoclonal	Human	Cell differentiation	Adenoid cystic carcinoma	N/A	FGF2 is a family member of cell differentiating and growth promoting factors. At the cellular level, bFGF2 is a potent mitogen and promotes cell survival by inhibiting apoptosis. At the tissue level, it is involved in wound repair and induced angiogenesis.
pFGFR(Tyr653/654)	Phospho-fibroblast growth factor		Nonotool	0116-1001	mouse monoclonal	Human	Cell differentiation	Adenoid cystic carcinoma	N/A	FGFs produce mitogenic and angiogenic effects in target cells by signaling through cell surface receptor tyrosine kinase. Tyrosine 653 and 654 are important for catalytic activity of activated FGFR and are essential for cell signaling.
FGFR2	Fibroblast growth factor receptor 2 alpha	Bek receptor	R&D system	MAB 6841	Mouse monoclonal	Human	Cell differentiation	Adenoid cystic carcinoma	N/A	FGFR family members differ from one another in their ligand affinities and tissue distribution. A full-length representative protein consists of an extracellular region, composed of three immunoglobulin-like domains, a single hydrophobic membrane-spanning segment and a cytoplasmic tyrosine kinase domain. The extracellular portion of the protein interacts with fibroblast growth factors, setting in motion a cascade of downstream signals, ultimately influencing mitogenesis and differentiation.
FRS2	Fibroblast growth factor substrate 2	FRS2A, FRS2alpha, SNT-1, SNT1	Protein tech	11503-1-AP	Rabbit polyconal	Human	Cell differentiation	Adenoid cystic carcinoma	N/A	FRS2 has been shown to interact with PRKCI, Grb2, PTPN11, Fibroblast growth factor receptor 1, TrkA,Cbl gene and SOS1. FRS2 play an important role in cell differentiation.
GFP	Green Fluorecent Protein		Novus Biologicals	NB600-303	Rabbit polyclonal	GFP tagging protein	Fluorescence marker	GFP control	GFP control	The green fluorescent protein (GFP) is a protein that exhibits bright green fluorescence when exposed to light in the blue to ultraviolet range

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Her2	c-erbB-2,neu		Cell Signaling Technology	CS 4290	Rabbit monoclonal	human	Signal transduction / oncogene	Breast cancer	N/A	This protein is a member of the epidermal growth factor (EGF) receptor family of receptor tyrosine kinases. This protein is involved in kinase-mediated activation of downstream signalling pathways, such as those involving mitogen-activated protein kinase and phosphatidylinositol-3 kinase. Amplification and/or overexpression of this gene has been reported in numerous cancers, including breast and ovarian tumors
K5/6	cytokeratin 5/6	CK5/6	Dako cytomation	M7237	mouse monoclonal	human	Epithelial differentiation	skin	N/A	Cytokeratins are alpha-type fibrous polypeptide. They are held to be the most ubiquitous markers of epithelial differentiation.
K10	cytokeratin 10	CK10	Abcam	Ab76318	rabbit monoclonal	human,mouse	Epithelial differentiation	squamous carcinoma	skin	Intermediate filament protein, expressed in suprabasal layers of stratified squamous epithelium. Expression is related to degree of keratinocyte differentiation.
K18	cytokeratin 18	CK18	Abcam	Ab76318	rabbit monoclonal	human, mouse	Epithelial differentiation	colon mucosa	salivary gland	Intermediate filament protein, expressed preferentially in simple glandular epithelia.
Pan CK	Pan Cytokeratin	AE1/AE3	Cell Marque	313M-1	mouse monoclonal	Human	Epithelial differentiation	Colon	N/A	a broad-spectrum keratin antibody cocktail.1-3 It is composed of mouse monoclonal antibody AE1 that recognizes acidic type I keratins 10, 14, 15, 16, 19, and AE3 that reacts with basic type II keratins 1, 2, 3, 4, 5, 6, 7, and 8. B This antibody is useful for identifying cells of epithelial origin and detects most carcinomas of different primary sites
Ki67	Ki67		Abcam	Ab16667	rabbit monoclonal	human, mouse	Proliferation / Cell cycle	tonsil	thymus	Present in active phases of the cell cycle (late G1, S, G2, and mitosis), but absent in resting cells.
Napsin A	Napsin A		Leica microsystems	NCL-L-NapsinA	mouse monoclonal	human	Differentiation - lung adenocarcinoma	normal lung	N/A	Napsin is a pepsin-like aspartic proteinase. There are three isoforms. Napsin-A is also termed napsin-1, or TA02, a Tumor Adenocarcinoma marker. Napsin A may be involved in processing of pneumocyte surfactant precursors.
NFKB-p65	Nuclear factor kappa B, p65 subunit		Abcam	Ab32536	rabbit monoclonal	human	Signal transduction	colon cancer	N/A	Inducible transcription factor involved in apoptosis resistance. Bound to inhibitor (IKB) and retained in cytoplasm. During activation, the p65 subunit is released from IKB and translocates to the nucleus.

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pMEK(Ser221)	Phospho-MEK 1/2(Ser221)	MAPK	Cell Signaling	2338	rabbit monoclonal	human, Mouse, Rabbit, Dog	Signal transduction	Pancreatic cancer	mouse tumor	MEK1 and MEK2 are dual-specificity protein kinases that function in a mitogen activated protein kinase cascade controlling cell growth and differentiation
c-Myb	c-Myb		Abcam	Ab177510	rabbit polyclonal	human	Transcription factor / oncogene	ACC	N/A	The c-Myb proto-oncogene is a protein involved in growth regulation and differentiation in many different cell types. C-Myb activity is directly regulated by cyclin D and CDKs.
p16	p16	cyclin-dependent kinase inhibitor 2A, CDKN2A	BD Pharmingen	550834	mouse monoclonal	human	Tumor suppressor gene	Severe squamous dysplasia of cervix	N/A	p16 protein is a specific inhibitor of cdk4, which regulates Rb and Rb related proteins, p107 and p130. p16 is inactivated in many tumor types by gene mutation or silencing, and its protein level is influenced by papillomavirus oncoproteins.
p21	p21	WAF1/Cip1	Santa Cruz	sc-6246	mouse monoclonal	human, mouse	Proliferation/ cell cycle	Colon cancer	N/A	Promotes cell cycle transitions.
p53	p53		Dako Cytomation	M7001	mouse monoclonal	Human	Tumor suppressor gene	Colon cancer	N/A	p53 plays a major role in the cellular response to DNA damage and other genomic aberrations. Activation of p53 can lead to either cell cycle arrest and DNA repair, or apoptosis.
p63	p63		Biocare Medical	CM 163A	mouse monoclonal	human, mouse	Epithelial differentiation	prostate	N/A	Expressed in many types of basal epithelium. Differentiates between basal and surface/luminal epithelium.
PARP1	PARP-1 (Cleaved p25)		Abcam	Ab 32064	rabbit monoclonal	human, mouse	Apoptosis	tonsil	thymus	Cleaved in vivo by caspase 3, hence is a marker of activated apoptotic pathway.
Plectin	Plectin 1		Abcam	ab32528	rabbit monoclonal	human, mouse	Epithelial differentiation / cancer biomarker	cancer-pancreas	N/A	An intermediate filament binding protein, Could also bind muscle proteins such as actin to membrane complexes in muscle.
PR	Progesterone receptor		Dako Cytomation	M3569	Mouse monoclonal	human	Cell differentiation	Folliapian tube	N/A	Progesterone receptor acts as a progesterone dependent nuclear hormone receptor. The absence of PR predicts early recurrence and poor survival of breast cancer patients.
SARS -CoV2-NP	SARS-CoV-2 (COVID-19) Nucleocapsid		ProSci	9099	Rabbit polyclonal	Covid-19 NP	Covid-19 NP marker	Covid 19 infected tissue	Covid-19 mouse model	Predicted reactivity based on immunogen sequence: SARS-CoV Nucleocapsid proteins: (100%)
SMA	smooth muscle actin	alpha actin	Abcam	Ab32575	rabbit monoclonal	human, mouse	Dsmooth muscle differentiation	colon-smooth muscle	colon	Contractile protein that makes up the cytoskeleton. SMA is restricted to smooth muscle cells (including vascular smooth muscle) and myoepithelial cells.



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pSRC	Phospho SRC (Tyr 416)		Abcam	Ab4816	Rabbit polyclonal	human, mouse	Signal transduction / oncogene	Cell lines	N/A	Phosphorylation at two conserved Src regulatory tyrosine residues (Tyr416) are responsible for activation of the SH1 kinase domain (Tyr416). Src activation and signaling through downstream substrates is known to mediate gene transcription, cell adhesion, cell motility, cell cycle progression, apoptosis, and differentiation
Snpt	Synaptophysin		Dako Cytomation	M0776	mouse monoclonal	human	Neuroendocrine differentiation	Lung carcinoid	N/A	The protein is a synaptic vesicle glycoprotein with four transmembrane domains weighing 38kDa. It is present in neuroendocrine cells and in virtually all neurons in the brain and spinal cord that participate in synaptic transmission. It acts as a marker for neuroendocrine tumors
TTF-1	Thyroid transcription factor-1		Leica microsystems	NCL-TTF-1	Mouse monoclonal	human	Differentiation-lung cancer	Normal Lung	N/A	transcription factor that binds and activates the promoter of thyroid specific genes such as thyroglobulin, thyroperoxidase, and thyrotropin receptor. Crucial in the maintenance of the thyroid differentiation phenotype. May play a role in lung development and surfactant homeostasis.
Vim(H)	Vimentin		Abcam	Ab16700	rabbit monoclonal	human	Mesenchymal differentiation	colon-smooth muscle	N/A	Most common member of intermediate filament family and a main component of cytoskeleton structure. Most strongly expressed in mesenchymal cells and other cell types derived from mesoderm.
Vim(H,M)	Vimentin		Abcam	ab45939	rabbit polyclonal	human, mouse	Mesenchymal differentiation	colon	colon	Most common member of intermediate filament family and a main component of cytoskeleton structure. Most strongly expressed in mesenchymal cells and other cell types derived from mesoderm.

## **Multiplex IHC staining\***

### **Double stain**

CD68/Pan CK(Human)

CK18/CD45(Human)

cleaved Caspase3/Ki67 (Human & Mouse)

CD8 /Ki67(Human & Mouse)

Choices of 2 markers for immune cells: CD4/CD8/CD68/CD19/FoxP3 (Human & Mouse)

### **Triple stain**

CK18/CD45/SMA ( Human)

Ki67/CD45/CK18( Human)

Choices of 3 markers for immune cells: CD4/CD8/CD68/CD19/FoxP3 (Human & Mouse)

### **Quadruplex(4-plex) stain**

Choices of 4 markers for immune cells: CD4/CD8/CD68/CD19/FoxP3 (Human & Mouse)

### **Quintuplex(5-plex) stain**

Immune cell markers: CD4/CD8/CD68/CD19/FoxP3 ( Human & Mouse)

**\* Customized IHC is available, please contact Pat Pramoongjago, Ph: 434-982-0487, email : pp6f@virginia.edu**