

eAppendix Table 1. Drug–Indications Approved by the FDA for Monoclonal Antibodies in 1997-2016^a

Generic Name	Brand Name	Type	Source	Target	Indication	Disease State	Route of Administration	FDA Approval Date	Price per mg (\$)	Annual Price Treatment (\$)
Rituximab	Rituxan	mab	Chimeric	CD20	Non-Hodgkin lymphoma	Oncology/ Hematology	IV	11/26/1997	9.64	52,056
Rituximab	Rituxan	mab	Chimeric	CD20	Chronic lymphocytic leukemia	Oncology/ Hematology	IV	11/26/1997	9.64	49,887
Rituximab	Rituxan	mab	Chimeric	CD20	Rheumatoid arthritis	Immunology	IV	11/26/1997	9.64	38,560
Rituximab	Rituxan	mab	Chimeric	CD20	Granulomatosis with polyangiitis and microscopic polyangiitis	Immunology	IV	11/26/1997	9.64	26,028
Basiliximab	Simulect	mab	Chimeric	CD25	Prevention of organ transplant rejections in renal transplantation	Immunology	IV	5/12/1998	194.00	7760
Palivizumab	Synagis	mab	Humanized	Respiratory syncytial virus	Prevention) of respiratory syncytial virus disease	ID/Allergy	Intramuscular	6/19/1998	35.25	11,897
Infliximab	Remicade	mab	Chimeric	TNF- α	Ankylosing Spondylitis	Immunology	IV	8/24/1998	13.36	37,408
Infliximab	Remicade	mab	Chimeric	TNF- α	Crohn's disease	Immunology	IV	8/24/1998	13.36	28,056
Infliximab	Remicade	mab	Chimeric	TNF- α	Pediatric Crohn's disease	Immunology	IV	8/24/1998	13.36	16,032
Infliximab	Remicade	mab	Chimeric	TNF- α	Psoriatic arthritis	Immunology	IV	8/24/1998	13.36	28,056
Infliximab	Remicade	mab	Chimeric	TNF- α	Rheumatoid arthritis	Immunology	IV	8/24/1998	13.36	16,834
Infliximab	Remicade	mab	Chimeric	TNF- α	Ulcerative colitis	Immunology	IV	8/24/1998	13.36	28,056
Infliximab	Remicade	mab	Chimeric	TNF- α	Pediatric ulcerative colitis	Immunology	IV	8/24/1998	13.36	16,032
Trastuzumab	Herceptin	mab	Humanized	HER2/neu	HER2 overexpressing breast cancer	Oncology/ Hematology	IV	9/25/1998	11.07	82,139
Trastuzumab	Herceptin	mab	Humanized	HER2/neu	HER2 overexpressing gastric cancer	Oncology/ Hematology	IV	9/25/1998	11.07	66,641
Daclizumab	Zenapax	mab	Humanized	CD25	Prevention of organ transplant rejections	Immunology	SQ	12/10/1998	54.67	19,135
Adalimumab	Humira	mab	Human	TNF- α	Rheumatoid arthritis	Immunology	SQ	12/31/2002	61.46	63,914
Adalimumab	Humira	mab	Human	TNF- α	Crohn's disease	Immunology	SQ	12/31/2002	61.46	63,914
Adalimumab	Humira	mab	Human	TNF- α	Plaque psoriasis	Immunology	SQ	12/31/2002	61.46	63,914
Adalimumab	Humira	mab	Human	TNF- α	Psoriatic arthritis	Immunology	SQ	12/31/2002	61.46	63,914
Adalimumab	Humira	mab	Human	TNF- α	Ankylosing spondylitis	Immunology	SQ	12/31/2002	61.46	63,914
Adalimumab	Humira	mab	Human	TNF- α	Juvenile idiopathic arthritis	Immunology	SQ	12/31/2002	61.46	63,914
Omalizumab	Xolair	mab	Humanized	IgE Fc region	Allergic asthma	ID/Allergy	SQ	6/20/2003	7.87	28,922
Omalizumab	Xolair	mab	Humanized	IgE Fc region	Chronic idiopathic urticaria	ID/Allergy	SQ	6/20/2003	7.87	30,693
eAppendix Table 1 continued										

Generic Name	Brand Name	Type	Source	Target	Indication	Therapeutic Area of Indication	Route of Administration	FDA Approval Date	Price per mg (\$)	Price Annual Treatment (\$)
Bevacizumab	Avastin	mab	Humanized	VEGF-A	Metastatic colorectal cancer	Oncology/ Hematology	IV	2/26/2004	8.71	158,456
Bevacizumab	Avastin	mab	Humanized	VEGF-A	Non-small cell lung cancer	Oncology/ Hematology	IV	2/26/2004	8.71	155,408
Bevacizumab	Avastin	mab	Humanized	VEGF-A	Metastatic breast cancer	Oncology/ Hematology	IV	2/26/2004	8.71	158,456
Bevacizumab	Avastin	mab	Humanized	VEGF-A	Glioblastoma	Oncology/ Hematology	IV	2/26/2004	8.71	158,456
Bevacizumab	Avastin	mab	Humanized	VEGF-A	Metastatic renal cell carcinoma	Oncology/ Hematology	IV	2/26/2004	8.71	158,456
Ranibizumab	Lucentis	Fab	Humanized	VEGF-A	Age-related macular degeneration	Ophthalmology	Intraocular	6/30/2006	4680.00	28,080
Ranibizumab	Lucentis	Fab	Humanized	VEGF-A	Macular edema following retinal vein occlusion	Ophthalmology	Intraocular	6/30/2006	4680.00	28,080
Ranibizumab	Lucentis	Fab	Humanized	VEGF-A	Diabetic macular edema	Ophthalmology	Intraocular	6/30/2006	4680.00	16,848
Ranibizumab	Lucentis	Fab	Humanized	VEGF-A	Myopic choroidal neovascularization	Ophthalmology	Intraocular	6/30/2006	4680.00	7020
Panitumumab	Vectibix	mab	Human	EGFR	Metastatic colorectal cancer	Oncology/ Hematology	IV	9/27/2006	13.08	142,834
Eculizumab	Soliris	mab	Humanized	C-5	Paroxysmal nocturnal hemoglobinuria	Oncology/ Hematology	IV	3/16/2007	25.65	592,654
Eculizumab	Soliris	mab	Humanized	C-5	Atypical hemolytic uremic syndrome	Oncology/ Hematology	IV	3/16/2007	25.65	800,280
Certolizumab pegol	Cimzia	Fab	Humanized	TNF- α	Crohn's disease	Immunology	SQ	4/22/2008	10.53	58,968
Certolizumab pegol	Cimzia	Fab	Humanized	TNF- α	Psoriatic arthritis	Immunology	SQ	4/22/2008	10.53	58,968
Certolizumab pegol	Cimzia	Fab	Humanized	TNF- α	Ankylosing spondylitis	Immunology	SQ	4/22/2008	10.53	58,968
Golimumab	Simponi	mab	Human	TNF- α	Psoriatic arthritis	Immunology	SQ	4/24/2009	52.59	31,554
Golimumab	Simponi	mab	Human	TNF- α	Rheumatoid arthritis	Immunology	SQ	4/24/2009	52.59	31,554
Golimumab	Simponi	mab	Human	TNF- α	Ulcerative colitis	Immunology	SQ	4/24/2009	52.59	73,626
Canakinumab	Ilaris	mab	Human	IL-1	Cryopyrin-associated periodic syndromes	Immunology	SQ	6/17/2009	107.03	96,327
Canakinumab	Ilaris	mab	Human	IL-1	Tumor necrosis factor receptor associated periodic syndrome	Immunology	SQ	6/17/2009	107.03	192,654
Canakinumab	Ilaris	mab	Human	IL-1	Familial Mediterranean fever	Immunology	SQ	6/17/2009	107.03	192,654
Canakinumab	Ilaris	mab	Human	IL-1	Systemic juvenile idiopathic arthritis	Immunology	SQ	6/17/2009	107.03	205,498
eAppendix Table 1 continued										

Generic Name	Brand Name	Type	Source	Target	Indication	Therapeutic Area of Indication	Route of Administration	FDA Approval Date	Price per mg (\$)	Price Annual Treatment (\$)
Ustekinumab	Stelara	mab	Human	IL-12, IL-23	Psoriatic arthritis	Immunology	SQ	9/25/2009	235.74	42,433
Ofatumumab	Arzerra	mab	Human	CD20	Chronic lymphocytic leukemia	Oncology/ Hematology	IV	10/26/2009	6.25	139,375
Tocilizumab	Actemra	mab	Humanized	IL-6 receptor	Rheumatoid arthritis	Immunology	IV	1/8/2010	5.43	19,765
Denosumab	Prolia	mab	Human	RANKL	Post-menopausal osteoporosis	Cardiology/ Endocrinology	SQ	6/1/2010	20.54	2465
Denosumab	Prolia	mab	Human	RANKL	Fracture prevention in men receiving androgen deprivation therapy for prostate cancer	Cardiology/ Endocrinology	SQ	6/1/2010	20.54	2465
Denosumab	Prolia	mab	Human	RANKL	Fracture prevention in women receiving aromatase inhibitor therapy for breast cancer	Cardiology/ Endocrinology	SQ	6/1/2010	20.54	2465
Denosumab	Xgeva	mab	Human	RANKL	Bone metastases from solid tumors	Oncology/ Hematology	SQ	6/1/2010	20.35	29,303
Denosumab	Xgeva	mab	Human	RANKL	Giant cell tumor of bone	Oncology/ Hematology	SQ	6/1/2010	20.35	34,187
Denosumab	Xgeva	mab	Human	RANKL	Hypercalcemia of malignancy	Oncology/ Hematology	SQ	6/1/2010	20.35	34,187
Belimumab	Benlysta	mab	Human	BAFF	Systemic lupus erythematosus	Immunology	IV	3/9/2011	4.92	51,645
Ipilimumab	Yervoy	mab	Human	CTLA-4	Melanoma	Oncology/ Hematology	IV	3/25/2011	164.64	138,304
Brentuximab	Adcetris	ADC	Chimeric	CD-30	Hodgkin lymphoma	Oncology/ Hematology	IV	8/19/2011	151.87	325,310
Brentuximab	Adcetris	ADC	Chimeric	CD-30	Systemic anaplastic large cell lymphoma	Oncology/ Hematology	IV	8/19/2011	151.87	325,310
Pertuzumab	Perjeta	mab	Humanized	HER2/neu	HER2+ metastatic breast cancer	Oncology/ Hematology	IV	6/8/2012	12.72	85,478
Pertuzumab	Perjeta	mab	Humanized	HER2/neu	HER2+ early stage breast cancer	Oncology/ Hematology	IV	6/8/2012	12.72	40,068
Trastuzumab	Kadcyla	mab	Humanized	HER2/neu	HER+ metastatic breast cancer	Oncology/ Hematology	IV	2/22/2013	33.78	147,551
Tocilizumab	Actemra	mab	Humanized	IL-6 receptor	Rheumatoid arthritis	Immunology	SQ	10/21/2013	6.16	25,946
Tocilizumab	Actemra	mab	Humanized	IL-6 receptor	Systemic juvenile idiopathic arthritis	Immunology	SQ	10/21/2013	6.16	51,251
Obinutuzumab	Gazyva	mab	Humanized	CD20	Chronic lymphocytic leukemia	Oncology/ Hematology	IV	11/1/2013	6.72	53,760
Obinutuzumab	Gazyva	mab	Humanized	CD20	Follicular lymphoma	Oncology/ Hematology	IV	11/1/2013	6.72	73,920
eAppendix Table 1 continued										

Generic Name	Brand Name	Type	Source	Target	Indication	Therapeutic Area of Indication	Route of Administration	FDA Approval Date	Price per mg (\$)	Price Annual Treatment (\$)
Siltuximab	Sylvant	mab	Chimeric	IL-6	Multicentric Castleman's disease	Oncology/ Hematology	IV	4/23/2014	10.29	134,773
Vedolizumab	Entyvio	mab	Humanized	Integrin receptor	Ulcerative colitis	Immunology	IV	5/20/2014	20.84	56,292
Vedolizumab	Entyvio	mab	Humanized	Integrin receptor	Crohn's disease	Immunology	IV	5/20/2014	20.84	56,292
Pembrolizumab	Keytruda	mab	Humanized	PD-1	Melanoma	Oncology/ Hematology	IV	9/4/2014	53.36	126,992
Pembrolizumab	Keytruda	mab	Humanized	PD-1	Non-small cell lung cancer	Oncology/ Hematology	IV	9/4/2014	53.36	181,417
Pembrolizumab	Keytruda	mab	Humanized	PD-1	Head and neck cancer	Oncology/ Hematology	IV	9/4/2014	53.36	181,417
Alemtuzumab	Lemtrada	mab	Humanized	CD52	Multiple sclerosis	Immunology	IV	11/14/2014	2,024.38	121,463
Blinatumomab	Blinicyto	BiTE	Murine	CD-19 and CD3	B-cell acute lymphoblastic leukemia	Oncology/ Hematology	IV	12/3/2014	114,318.85	432,925
Nivolumab	Opdivo	mab	Human	PD-1	Melanoma	Oncology/ Hematology	IV	12/22/2014	30.09	164,291
Secukinumab	Cosentyx	mab	Human	IL-17A	Plaque psoriasis	Immunology	SQ	1/21/2015	16.26	78,038
Dinutuximab	Unituxin	mab	Chimeric	GD-2	Pediatric patients at high risk of neuroblastoma	Oncology/ Hematology	IV	3/10/2015	564.68	284,602
Alirocumab	Praluent	mab	Human	PCSK9	Heterozygous familial hypercholesterolemia	Cardiology/ Endocrinology	SQ	7/24/2015	8.96	17,472
Alirocumab	Praluent	mab	Human	PCSK9	Clinical atherosclerotic cardiovascular disease	Cardiology/ Endocrinology	SQ	7/24/2015	8.96	17,472
Evolocumab	Repatha	mab	Human	PCSK9	Heterozygous familial hypercholesterolemia	Cardiology/ Endocrinology	SQ	8/27/2015	4.65	15,624
Evolocumab	Repatha	mab	Human	PCSK9	Clinical atherosclerotic cardiovascular disease	Cardiology/ Endocrinology	SQ	8/27/2015	4.65	15,624
Evolocumab	Repatha	mab	Human	PCSK9	Homozygous familial hypercholesterolemia	Cardiology/ Endocrinology	SQ	8/27/2015	4.65	23,436
Mepolizumab	Nucala	mab	Humanized	IL-5	Severe asthma	Immunology	SQ	11/4/2015	30.90	40,170
Daratumumab	Darzalex	mab	Human	CD-38	Multiple myeloma	Oncology/ Hematology	IV	11/16/2015	5.55	136,752
Necitumumab	Portrazza	mab	Human	EGFR	Non-small cell lung cancer	Oncology/ Hematology	IV	11/24/2015	6.00	163,200
Elotuzumab	Empliciti	mab	Humanized	SLAMF7	Multiple myeloma	Oncology/ Hematology	IV	11/30/2015	7.10	134,266
Ixekizumab	Talz	mab	Humanized	IL-17A	Plaque psoriasis	Immunology	SQ	3/22/2016	67.03	91,168
Reslizumab	Conqair	mab	Humanized	IL-5	Severe asthma	ID/Allergy	IV	3/23/2016	10.02	40,381
Atezolizumab	Tecentriq	mab	Humanized	PD-L1	Urothelial carcinoma	Oncology/ Hematology	IV	5/18/2016	8.62	175,848
eAppendix Table 1 continued										

Generic Name	Brand Name	Type	Source	Target	Indication	Therapeutic Area of Indication	Route of Administration	FDA Approval Date	Price per mg (\$)	Price Annual Treatment (\$)
Ustekinumab	Stelara	mab	Human	IL-12, IL-23	Crohn's disease	Immunology	IV	9/23/2016	14.77	5,760
Olaratumab	Lartruvo	mab	Human	PDGFR- α	Soft tissue sarcoma	Oncology/ Hematology	IV	10/29/2016	5.66	95,088

ADC indicates antibody-drug conjugates; BiTE, bi-specific T-cell engagers; Fab, antigen-binding fragment antibody; ID, infectious diseases; IV, intravenous; mab, monoclonal antibody; SQ, subcutaneous.

^aData are sorted by FDA approval date.

eAppendix Table 2. Summary Statistics for the Annual Price of Treatment for Drug-Indications Approved by the FDA for Monoclonal Antibodies in 1997-2016

Indication	Annual Price of Treatment (\$)			
	Median	IQR	Minimum	Maximum
Oncology/Hematology ^a (n = 43)	142,833	73,920-164,291	29,303	800,280
Hematology ^b (n = 13)	134,773	52,056-325,310	40,302	800,280
Bone (n = 4)	34,187	34,745-64,638	29,303	95,088
Breast (n = 5)	85,478	82,139-147,551	40,068	158,456
GI (n = 5)	158,456	142,834-162,086	66,641	187,242
Lung, head, or neck (n = 6)	163,746	162,086-181,417	155,408	181,417
Melanoma (n = 6)	137,528	134,266-138,306	126,992	164,291
Other ^c (n = 4)	167,152	158,456-230,225	158,456	284,602
Cardiology/Endocrinology ^d (n = 8)	15,624	2465-17,472	2465	23,436
Immunology ^e (n = 48)	53,969	28,056-68,770	5760	205,498
ID/Allergy (n = 4)	29,808	20,410-35,537	11,897	40,381
Ophthalmology (n = 4)	22,464	11,934-28,080	7020	28,080

GI indicates gastrointestinal; ID, infectious diseases; IQR, interquartile range.

^aOncology and hematology indications include solid tumors, hematologic malignancies, and other hematologic disorders, including paroxysmal nocturnal hemoglobinuria and atypical hemolytic uremic syndrome.

^bHematology indications include hematologic malignancies, and other hematologic disorders, including paroxysmal nocturnal hemoglobinuria and atypical hemolytic uremic syndrome.

^cOther types of cancer included glioblastoma, metastatic renal cell carcinoma, urothelial carcinoma, and neuroblastoma.

^dCardiology and endocrinology indications included atherosclerotic cardiovascular disease, hypercholesterolemia, and metabolic bone disease.

^eImmunology indications included autoimmune disorders, and prevention of organ transplant rejection.