Table 1

Examples of Polypeptide and Protein (Non-antibody) Therapeutic Agents[a]

THERAPEUTIC CLASS	POLYPEPTIDE/ PROTEIN	MOLECULAR WEIGHT (g/mol)	COMMENTS
Adrenocorticotropic hormone	Cosyntropin	2934	Synthetic polypeptide. Test for adrenal function
Adrenohypophyseal hormones and hypothalamic releasing hormones	Chorionic gonadotropin	36,700	Fertility medication in lieu of luteinizing hormone
	Menotropin	-	Contains follicle-stimulating hormone and luteinizing hormone. Used in treatment of fertility problems
	Sermorelin	3,358	Synthetic human growth hormone-releasing hormone
	Gonadotropin-releasing hormone	1,182	Luteinizing-hormone releasing hormone
	Somatropin	22,124	Human growth hormone
Agents affecting calcific-ation and bone turnover	Calcitonin-Salmon	3432	Used to treat osteoporosis
Agents for control of gastric acidity and treatment of peptic ulcer	Pentagastrin	768	Polypeptide that has effects like gastrin, namely, stimulates secretion of gastric acid, pepsin, and intrinsic factor.
Agents that cause contraction of the uterus	Oxytocin	940	Used during pregnancy to induce labor.
Agents to treat congestive heart failure (acutely decompensated)	Neseritide	3464	Given by intravenous bolus plus infusion.
Agents to treat rheumatoid arthritis	Anakinra	17,258	Given subcutaneously.
	Abatacept	>150,000	Fusion protein of IgG1 and CTLA-4
Agents to treat specific genetic disorders	Agalsidase beta	100,000	Enzyme used to treat Fabry's disease.
	Alglucosidase	105,338	Enzyme used to treat Pompey's disease.
	Laronidase	83,000	Enzyme for treating Huler and Hurler-Schele forms of mucopolysaccharidosis.
	Imiglucerase	60,430	Enzyme for treatment of type I Gaucher disease.

Agents to treat HIV	Enfuvirtide	4,492	Used in combination with other drugs for the treatment of patients with HIV infections.
Agents used for acromegaly and carcinoid syndrome	Octreotide	1,019	Mimics the effects of natural somastatin.
	Pegvisomant	~47,000	Highly selective growth hormone receptor antagonist.
Agents used in cystic fibrosis	Dornase alpha	37,000	Synthetic version of naturally-occuring deoxyribonuclease, an enzyme that cleaves DNA.
Anticoagulant	Lepirudin	6,980	Used in patients who have developed heparin-induced thrombocytopenia.
Antifungal Agents	Anidulafungin	1,140	Used to treat candida infections (intra-abdominal abcess, peritonitis, and esophageal infection).
Antiplatelet drug used to prevent blood clotting	Eptifibatide	832	Cyclic heptapeptide used during acute coronary syndrome or during percutaneous coronary intervention
Antiviral agents and modifiers	Interferon alfacon-1	19,434	Commonly used to treat hepatitis C viral infections..
	Interferon Alpha-2b (pegylated)	20,027	Commonly taken with ribavirin to treat hepatitis C.
	Interferon Beta-1b	~31,000	Used to treat multiple sclerosis.
Debriding agents	Collagenase	112,023	Enzyme that breaks the peptide bound in collagen.
	Fibrinolysin	13,800	Enzyme (inactivates fibrin) combined with deoxyribonuclease (destroys DNA) to enhance wound cleaning and healing.
Digestive Enzymes	Papain	23,000	Commonly used to treat skin wounds.
	Pancrelipase	-	Contains pancreatic enzymes (lipases, amylases and preteases) in an enteric coated dosage form.
Drugs affecting renal Function	Vasopressin	1084	Used to treat diabetes insipidus.
Hematopoietic agents	Aldesleukin	15,300	Used to treat metastatic renal cell carcinoma and melanoma.
	Filgrastim	18,800	Decrease the incidence of infection in patients with non-myeloid malignancies and who are receiving anti-cancer drugs.
	Interleukin-11	19,000	Used to prevent low platelets counts and to reduce the need for blood transfusions following cancer treatments.

	Epoietin alfa	30,400	Stimulate the body to produce red blood cells. Used in anemic conditions, especially chronic kidney disease and chemotherapy.
Immunomodulators	Cyclosporine	1,203	May be used to treat several diseases including: rheumatoid arthritis, psoriasis, nephrotic syndrome and Crohn's disease.
Insulin and Related Agents	Glucagon	3,483	Treatment of severe hypoglycemia.
	Insulin	5,808 (natural hormone)	Treatment of diabetes mellitus. Insulin comes in many forms and variations.
Oncolytic Agents	Asparaginase	~175,000	Treatment of acute lymphocytic leukemia.
	Leuprolide	1,209	Palliative treatment of advanced prostate cancer and treatment of anemia due to uterine leiomyomas.
Parathyroid Hormone	Teriparatide	4118	Synthetic polypeptide of the active part of the parathyroid hormone.
Thrombolytic and Related Agents	Alteplase	59,042	Used to break up and dissolve blood clots after acute heart attack or pulmonary embolism.
	Antihemophilic factor (Factor VIII)	~200,000	Used to treat or prevent bleeding in patients with hemophilia A.
	Antithrombin III	58,000	Thromboembolism associated with hereditary antithrombin III deficiency.
	Aprotinin	6,512	Protease inhibitor that modulates the systemic inflammatory response associated with cardiopulmonary bypass surgery.
	Clotting Factor IX	~55,000	Therapy of factor IX deficiency, Hemophilia B or Christmas Disease.
	Clotting Factor VIIa	~50,000	Treating or preventing bleeding in patients with hemophilia A or B, acquired hemophilia, or congenital factor VII deficiency.
	Urokinase	32,400	Enzyme which breaks up and dissolves blood clots.
Tuberculostatic agent	Viomycin	686	Used in combination with other anti-tubercular drugs.

[a]Selected from drugs listed in Physician's Desk Reference 2008. Some information obtained from searches on the internet.

Table 2.

Examples of Monoclonal Antibodies, Their Therapeutic Use, Half-life, Route of Administration and Dosing Interval.

SOURCE	ANTIBODY (BRAND NAME)	THERAPEUTIC USE	AVERAGE HALF-LIFE (HR)	ADMINISTRATION (ROUTE AND DOSING INTERVAL)
Murine Monoclonal Antibodies				
	Ibritumomab tiuxetin (ZEVALIN)	Non-Hodgkin lymphoma	67 In^{111} 64 Y^{90}	i.v. (radiotherapeutic regimen of In^{111} and Y^{90} chelated with the antibody to which a chelator moiety is attached)
	Muromomab-CD3 (ORTHOCLONE OKT3)	Transplant rejection	-	i.v. (5 mg daily for 10-14 days)
	Tositumomab (BEXXAR)	Non-Hodgkin's lymphoma	67 (label)	Given in two steps: dosimetric and 7-14 days later therapeutic with I^{131}-tositumomab
Chimeric Monoclonal Antibodies				
	Abciximab (REOPRO) (Fab fragment)	Percutaneous coronary intervention (PCI)	30 min[1]	i.v. (0.25 mg/kg bolus 10 to 60 min prior to PCI, then infuse 0.125 µg/kg/min for 12 hours)
	Basiliximab (SIMULECT)	Transplant rejection	173[2]	i.v. (2 mg by 20-30 min infusion prior to transplantation and a second dose 4 days later)
	Brentuximab vedotin (ADCETRIS)	Anaplastic large call lymphoma and Hodgkin lumphoma	120	i.v. (30-min infusions of 1.8 mg/kg every 3 weeks)
	Cetuximab (EBITUX)	Squamous cell carcinoma of the head and neck and colorectal cancer	97[2]	i.v. (400 mg/m^2 infused over 2 hr, then 250 mg/m^2 over 1 hour weekly)
	Infliximab (REMICADE)	Crohn's disease, ulcerative colitis, Rheumatoid arthritis, plaque psoriasis	204	i.v. (5 mg/kg infusion at 0, 2, and 6 weeks then every 8 weeks)
	Rituximab (RITUXAN, MABTHERA)	Chronic lymphocytic anemia, Non-Hodgkin lymphoma, rheumatoid arthritis	528	i.v. (multiple 30-min infusions guided by reaction to infused drug)

Humanized Monoclonal Antibodies

Alemtuzumab (CAMPATH)	Chronic lymphocytic leukemia	144[2]	i.v. (escalating dose from 3 mg daily to 30 mg 3 times per week, guided by adverse reactions)
Bevacizumab (AVASTIN)	Colorectal cancer, lung cancer, glioblastoma, and renal cell carcinoma	480	i.v. (5 to 15 mg by infusion every 2-3 weeks with other agents, depends on cancer)
Certolizumab pegol (CIMZIA)	Crohn's Disease	336	s.c. (400 mg stat, 200 mg every other week)
Daclizumab (ZENAPAX)	Prophylaxis of organ rejection in renal transplantation	480	i.v. (1 mg/kg within 24 hr of transplant and then every 2 weeks for a total of 5 doses)
Eculizumab (SOLIRIS)	Paroxysmal nocturnal hemoglobinuria	272	i.v. (35-min infusion, 900 mg weekly for 4 weeks, then 1200 mg every 2 weeks)
Natalizumab (TYSABRI)	Multiple Sclerosis and Crohn's Disease	264[2]	i.v. (1-hr infusion of 300 mg every 4 weeks)
Omalizumab (XOLAIR)	Allergy-related asthma	624	s.c. (150 to 375 mg every 2-4 weeks)
Palivizumab (SYNAGIS)	Respiratory Syncytial virus infection in children	480	i.m. (monthly)
Ranibizumab (LUCENTIS)	Macular degeneration	-	Intravitreal Injection (monthly)
Gentuzumab ozogamicin (MYLOTAG)	Acute myelogenous leukemia	-[2]	i.v. (9 mg/m^2 infused over 2 hr and repeated in 14 days)
Tocilizumab (ACTEMRA)	Rheumatoid arthritis	151[2]	i.v. (4 mg/kg initially by infusion followed every 4 weeks by an increase to 8 mg/kg based on clinical response)
Trastuzumab (HERCEPTIN)	Breast cancer	200[2]	i.v. (4 mg/kg initially, then 2 mg/kg once weekly once weekly as a 90-min infusion)

Human Monoclonal Antibodies

Adalimumab (HUMIRA)	Auto-immune inflammatory disorders	336	s.c. (40 mg every other week)
Canakinumab (ILARIS)	Cryopin-associated periodic syndromes	624	s.c. (150 mg every 8 weeks)
Denosumab (PROLIA)	Postmenopausal osteoporosis	672[2]	s.c. (60 mg every 6 months)
Golimumab (SIMPONI)	Rheumatoid arthritis, Psoriatic arthritis, ankylosing spondylitis	336	s.c. (50 mg once a month, given with methotrexate)
Ipilimumab (YERVOY)	Melanoma	353	i.v. (3 mg/kg infused over 90 min every 3 weeks for 4 doses)
Panitumumab (VECTIBIX)	Colorectal cancer	180[2]	i.v. (1 mg/kg every 2 weeks)

Antibody Fragments

Abatacept (ORENCIA) (T-lynphocyte-associated Antigen linked to Fc portion of IgG1)	Rheumatoid arthritis	314	i.v. (30-min infusion, 750 mg at 0, 2, and 4 weeks, then every 4 weeks) s.c. (750 mg stat, then 125 mg in 24 hr the once weekly)
Aflibercept (EYLEA) (human vascular endothelial growth factor receptors 1 and 2 fused to the constant region (Fc) of human IgG1	Macular degeneration	130[3]	Intravitreal injection (2 mg every 4 weeks for 12 weeks then 2 mg every 8 weeks)
Alefacept (AMEVIVE) human leukocyte function antigen linked to the Fc of human IgGl.	Chronic plaque psoriasis	270	i.m. (15 mg once weekly for 12 weeks)
Etanercept (EMBREL) (tumor necrosis factor linked to Fc portion of IgG1)	Rheumatoid arthritis Psoriatic arthritis ankylosing spondylitis	102	i.v. (50 mg weekly)

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[1]Platelet-bound form detected for 15 days.
[2]Kinetics notably nonlinear.
[3]Kinetics notably nonlinear at anticancer doses, but not at doses used in the eye.

Table 3

FDA-Approved Polyclonal Immune Globulins and Antibody Fragments.

Crotalidae immune Fab	Pertussis immune globulin
Digoxin immune Fab	Rabies immune globulin
Hepatitis B immune globulin	Rho(D) immune globulin
Intravenous gamma globulin	Tetanus immune globulin
Lymphocyte anti-thymocyte immune globulin	Vaccinia immune globulin
Normal immune globulin	Varicella-zoster immune globulin