APPROVED LONG-TERM TREATMENTS FOR MS:

SELF-INJECTED MEDICATIONS

NAME AND TYPE OF MEDICATION	HOW ADMINISTERED AND SIDE EFFECTS	ADDITIONAL NOTES
Avonex® (interferon beta-1a); immune system modulator with antiviral properties	30 micrograms taken via weekly intermuscular injection; side effects include flu-like symptoms and headache, blood count and liver test abnormalities	Side effects may be prevented and/or managed effectively through various treatment strategies; side effect problems are usually temporary. Blood tests may be given periodically to monitor liver enzymes, blood-cell counts, and neutralizing antibodies.
Betaseron® (interferon beta-1b); immune system modulator with antiviral properties	250 micrograms taken via subcutaneous injection every other day; side effects include flu-like symptoms, injection-site skin reaction, blood count and liver test abnormalities	Side effects may be prevented and/or managed effectively through various treatment strategies; side effect problems are usually temporary. Blood tests may be given periodically to monitor liver enzymes, blood-cell counts, and neutralizing antibodies.
Copaxone® (glatiramer acetate); synthetic chain of four amino acids found in myelin; it is an immune system modulator that blocks attacks on myelin	20 (daily) or 40 (three times weekly) milligrams taken via subcutaneous injection; side effects include injection-site skin reaction as well as an occasional systemic reaction – occurring at least once in approximately 10 percent of those tested	Systemic reactions occur about five to 15 minutes following an injection and may include anxiety, flushing, chest tightness, dizziness, palpitations, and/or shortness of breath. Usually lasting for only a few minutes, these symptoms do not require specific treatment and have no long-term negative effects. Copaxone was originally approved at 20 milligrams daily, but in 2014, a new dose of 40 milligrams three times weekly was approved by the FDA. Both dosing regimens remain available.
Extavia® (interferon beta-1b); immune system modulator with antiviral properties	250 micrograms taken via subcutaneous injection every other day; side effects include flu-like symptoms, injection-site skin reaction, blood count and liver test abnormalities	Side effects may be prevented and/or managed effectively through various treatment strategies; side effect problems are usually temporary. Blood tests may be given periodically to monitor liver enzymes, blood-cell counts, and neutralizing antibodies.

NAME AND TYPE OF MEDICATION	HOW ADMINISTERED AND SIDE EFFECTS	ADDITIONAL NOTES
Glatopa® (glatiramer acetate); as a generic version of Copaxone, Glatopa is a synthetic chain of four amino acids found in myelin; it is an immune system modulator that blocks attacks on myelin	20 milligrams taken daily via subcutaneous injection; using study results from trials with Copaxone, side effects include injection-site skin reaction as well as an occasional systemic reaction – occurring at least once in approximately 10 percent of those tested with Copaxone	Using study results from trials with Copaxone, systemic reactions occur about five to 15 minutes following an injection and may include anxiety, flushing, chest tightness, dizziness, palpitations, and/or shortness of breath. Usually lasting for only a few minutes, these symptoms do not require specific treatment and have no long-term negative effects.
Plegridy® (interferon beta-1a); immune system modulator with antiviral properties	125 micrograms taken via subcutaneous injection once every two weeks; side effects include flu-like symptoms, injection-site skin reaction, blood count and liver test abnormalities	Side effects may be prevented and/or managed effectively through various treatment strategies; side effect problems are usually temporary. Blood tests may be given periodically to monitor liver enzymes, blood-cell counts, and neutralizing antibodies.
Rebif® (interferon beta-1a); immune system modulator with antiviral properties	44 micrograms taken via subcutaneous injection three times weekly; side effects include flu-like symptoms, injection-site skin reaction, blood count and liver test abnormalities	Side effects may be prevented and/or managed effectively through various treatment strategies; side effect problems are usually temporary. Blood tests may be given periodically to monitor liver enzymes, blood-cell counts, and neutralizing antibodies.
Zinbryta® (daclizumab); genetically engineered monoclonal antibody that binds to CD25, a receptor on T cells that is thought to become activated in response to MS	150 milligrams taken via subcutaneous injection once per month; side effects include cold symptoms, upper-respiratory tract infection, rash, influenza, throat pain, eczema, enlargement of lymph nodes, depression, and increased liver enzymes	Zinbryta has a boxed warning stating that the drug can cause severe liver injury and monthly blood tests to monitor the patient's liver function are required. Other risks include: immune conditions, hypersensitivity reactions (anaphylaxis or angioedema), increased risk of infections, and depression and/or suicidal ideation. Zinbryta should be used only in patients who have had an inadequate response to two or more MS drugs.

APPROVED LONG-TERM TREATMENTS FOR MS: INFUSED MEDICATIONS

NAME AND TYPE OF MEDICATION	HOW ADMINISTERED AND SIDE EFFECTS	ADDITIONAL NOTES
Lemtrada® (alemtuzumab); humanized monoclonal antibody that rapidly depletes or suppresses immune system cells (T and B cells), which can damage the myelin and nerves of the CNS	Five-day course of 12 mgs daily via intravenous (IV) infusion and followed one year later by a second three-day course; side effects include rash, itching, headache, pyrexia, nasopharyngitis, nausea, diarrhea and vomiting, insomnia, numbness/ tingling, dizziness, pain, flushing, and infection	Adverse events include infusion reactions, increased risk of infection, emergent autoimmune diseases, a potentially severe bleeding disorder called ITP, and an increased risk of malignancies including thyroid cancer, melanoma, and lymphoproliferative disorders. Lemtrada is only available through the Lemtrada REMS (Risk Evaluation and Mitigation Strategy) program.
Novantrone® (mitoxantrone); antineoplastic agent; immune system modulator and suppressor	IV infusion once every three months (for two to three years); side effects include nausea, thinning hair, loss of menstrual periods, bladder infections, and mouth sores; urine and whites of the eyes may temporarily turn bluish	Carries risk of cardiotoxicity (heart damage) and leukemia; it may not be given beyond two or three years. Testing required for cardiotoxicity, white blood cell counts, and liver function. Due to risks, Novantrone is seldom prescribed for MS. Those taking Novantrone now or previously need annual heart evaluations.
Ocrevus™ (ocrelizumab); humanized monoclonal antibody designed to selectively target CD20-positive B cells, a type of immune cell important to the MS-disease process.	600-milligram dose given via IV every six months; initial dose given in two 300-milligram doses; side effects include infusion reactions, which can be serious, increase in infections (upper and lower respiratory tract infections and skin infection most commonly seen in studies)	Should not be used in patients with hepatitis B infection or a history of life-threatening infusion-related reactions to Ocrevus. Other rare adverse events, including cancer and progressive multifocal leukoencephalopathy (PML), could potentially occur, but these risks are still being investigated; as of the time of approval, no cases of PML had occurred.
Tysabri® (natalizumab); humanized monoclonal antibody; inhibits adhesion molecules; thought to prevent damaging immune cells from crossing the blood-brain barrier	300 mg dose given via IV infusion every four weeks; side effects include headache, fatigue, depression, joint pain, abdominal discomfort, and infection	Risk of infection (including pneumonia) was most common serious adverse event during studies. The TOUCH Prescribing Program monitors patients for signs of PML; risk factors include: the presence of JC virus antibodies, previous treatment with immunosuppressive drugs, and taking Tysabri for more than two years.

APPROVED LONG-TERM TREATMENTS FOR MS: ORAL MEDICATIONS

NAME AND TYPE OF MEDICATION	HOW ADMINISTERED AND SIDE EFFECTS	ADDITIONAL NOTES
Aubagio® (teriflunomide); immunomodulator affecting the production of T and B cells; may also inhibit nerve degeneration	7 or 14 milligram tablet taken orally, once per day; side effects include headache, elevations in liver enzymes, hair thinning, diarrhea, nausea, neutropenia (a condition that reduces the number of certain white blood cells), and paresthesia (tingling, burning, or numbing sensation)	More severe adverse events include the risk of severe liver injury and the risk of birth defects if used during pregnancy. A TB test and blood tests for liver function must be performed within six months prior to starting Aubagio, and liver function must be checked regularly. If liver damage is detected, or if someone becomes pregnant while taking this drug, accelerated elimination of the drug is prescribed.
Gilenya® (fingolimod); S1P-receptor modulator, which blocks potentially damaging T cells from leaving lymph nodes	0.5 milligram capsule taken orally once per day; side effects include headache, flu, diarrhea, back pain, abnormal liver tests, and cough	Adverse events include: a reduction in heart rate (dose-related and transient); infrequent transient AV conduction block of the heart; a mild increase in blood pressure; macular edema (swelling behind the eye); reversible elevation of liver enzymes; and a slight increase in lung infections (primarily bronchitis). Infections, including herpes infection, are also of concern. A six-hour observation period is required immediately after the first dose, to monitor for cardiovascular changes.*
Tecfidera® (dimethyl fumarate); immunomodulator with anti-inflammatory properties; may have neuroprotective effects, potentially protecting the nerves and myelin covering	240-milligram tablet taken twice daily; side effects include flushing and gastrointestinal events; reduced white blood cell (lymphocyte) counts; elevated liver enzymes in small percentage of patients	Adverse events include mild or moderate upper respiratory infection, pruritus (chronic itching), and erythema (skin redness or rash). Gastroenteritis (an inflammation of the lining of the intestines) and gastritis (an inflammation of the stomach lining) have also occurred. Reduced white-blood cell counts were seen during the first year of treatment. Liver enzymes were elevated in 6 percent of individuals taking Tecfidera, compared to 3 percent on placebo.*

**Progressive multifocal leukoencephalopathy (PML), a potentially fatal, viral infection of the brain, has occurred in a few patients taking either Gilenya or Tecfidera. The Tecfidera cases have been associated with low counts of lymphocytes, a type of white blood cell.*