Medicines in Development for Sickle Cell Disease

Sickle Cell Disease

Drug Name	Sponsor	Indication	Development Status
Altemia™ complex mixture of lipids ORPHAN DRUG	Micelle BioPharma Nashville, TN	sickle cell disease	Phase II www.micellebiopharma.com
BCL11a shRNA(miR) (RNA interference)	bluebird bio Cambridge, MA Boston Children's Hospital Boston, MA	severe sickle cell disease	Phase I www.bluebirdbio.com
BIVV-003 (ZFN gene-edited cell therapy)	Sangamo Therapeutics Richmond, CA Sanofi Genzyme Cambridge, MA	sickle cell disease	Phase I/II www.sangamo.com www.sanofigenzyme.com
Brilinta® ticagrelor	AstraZeneca Wilmington, DE	prevention of vaso-occlusive crises in sickle cell disease (pediatric)	Phase III www.astrazeneca.com
canakinumab (IL-1β mAb)	Novartis East Hanover, NJ	sickle cell anemia	Phase II www.novartis.com
crizanlizumab (P selectin inhibitor) ORPHAN DRUG	Novartis East Hanover, NJ	prevention of vaso-occlusive crises in sickle cell disease (Breakthrough Therapy)	Phase III www.novartis.com

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CTX001 (autologous gene-edited hematopoietic stem cell therapy)	CRISPR Therapeutics Cambridge, MA Vertex Pharmaceuticals Boston, MA	sickle cell disease (Fast Track)	Phase I/II www.crisprtx.com www.vrtx.com
EPI01 (decitabine/tetrahydrouridine) ORPHAN DRUG	Novo Nordisk Princdeton, NJ	sickle cell disease (Fast Track)	Phase I www.novonordisk.com
IMR-687 (PDE9 inhibitor) ORPHAN DRUG	Imara Cambridge, MA	sickle cell disease (homozygous HbSS or sickle-ß0 thalassemia)	Phase II www.imaratx.com
LentiGlobin® beta-globin gene therapy ORPHAN DRUG	bluebird bio Cambridge, MA	severe sickle cell disease (Fast Track)	Phase I/II www.bluebirdbio.com
NiCord® cord blood stem cell therapy	Gamida Cell Boston, MA	sickle cell disease	Phase I/II www.gamida-cell.com
olinciguat (IW-1701) (sGC agonist) ORPHAN DRUG	Ironwood Pharmaceuticals Cambridge, MA	sickle cell disease	Phase II www.ironwoodpharma.com
PF-04447943 (PDE9 inhibitor) ORPHAN DRUG	Pfizer New York, NY	sickle cell disease	Phase I www.pfizer.com

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rivipansel (GMI-1070) (pan-selectin antagonist) ORPHAN DRUG	GlycoMimetics Rockville, MD Pfizer New York, NY	vaso-occlusive crises in sickle cell disease (Fast Track)	Phase III www.glycomimetics.com www.pfizer.com
RVT-1801 (gene therapy)	Aruvant Sciences Basel, Switzerland	sickle cell disease	Phase II www.aruvant.com
Sanguinate® PEGylated hemoglobin and carbon monoxide ORPHAN DRUG	Prolong Pharmaceuticals South Plainfield, NJ	vaso-occlusive crises in sickle cell disease	Phase II www.prolongpharma.com
voxelotor (GBT440) (sickle hemoglobin modulator) ORPHAN DRUG	Global Blood Therapeutics South San Francisco, CA	sickle cell disease (Fast Track)	Phase III www.gbt.com

The content of this report has been obtained through public, government and industry sources, and the Springer "Adis Insight" database based on the latest information. Report current **as of February 20, 2019.** The medicines in this listing include medicines being developed by U.S.-based companies conducting trials in the United States abroad, PhRMA-member companies conducting trials in the United States and abroad, and foreign companies conducting clinical trials in the United States. Some products may not be in active clinical trials. The information may not be comprehensive. For more, specific information about a particular product, contact the individual company directly or go to www.clinicaltrials.gov. The entire series of *Medicines in Development* is available on PhRMA's website: www.phrma.org.

Definitions

Application Submitted—An application for marketing has been submitted by the company to the U.S. Food and Drug Administration (FDA).

Breakthrough Therapy—Upon request by a sponsor, the FDA can grant this designation to expedite the development and review of a drug or biologic intended, alone or in combination with one or more other drugs, to treat a serious or life threatening disease or condition and preliminary clinical evidence indicates that it may demonstrate substantial improvement over existing therapies on one or more clinically-significant endpoints, such as substantial treatment effects observed early in clinical development. If a drug or biologic is designated as a Breakthrough Therapy, the FDA will expedite the development and review. With this designation, all Fast Track features convey to the medicine.

Fast Track—Upon request by a sponsor, the FDA can grant this designation to facilitate the development and expedite the review of a drug or biologic to treat a serious condition and fill an unmet medical need. When considering a biopharmaceutical company's request for Fast Track designation for an investigational drug or biologic, the FDA evaluates whether it will affect factors such as survival, day-to-day functioning, or the likelihood that the disease, if left untreated, will progress from a less severe condition to a more serious one, and whether a condition can be adequately addressed by available therapy. With Fast Track designation, early and frequent communication between the FDA and the biopharmaceutical company is encouraged throughout the entire drug development and review process to help to quickly resolve any questions or issues that arise, potentially leading to an earlier approval and access by patients.

Orphan Designation—Upon request by a sponsor, the FDA can grant special status ("orphan status") to a drug or biologic to treat a rare disease or condition. In order to receive an orphan designation, a qualifying drug or biologic must be intended for the treatment, diagnosis, or prevention of a rare disease or condition that affects usually fewer than 200,000 people in the United States.

Phase I—Researchers test the investigational drug or biologic in a small group of people, usually between 20 and 100 healthy adult volunteers, to evaluate its initial safety and tolerability profile, determine a safe dosage range, and identify potential side effects.

Phase II—The investigational drug or biologic is given to volunteer patients, usually between 100 and 500, to determine whether it is effective, identify an optimal dose, and to further evaluate its short-term safety.

Phase III—The investigational drug or biologic is given to a larger, more diverse patient population, often involving between 1,000 and 5,000 patients (but sometimes many more), to generate statistically significant evidence to confirm its safety and effectiveness. Phase III studies are the longest studies and usually take place in multiple sites around the world.