CELL AND GENE THERAPY MARKET PRIMER

March 2020

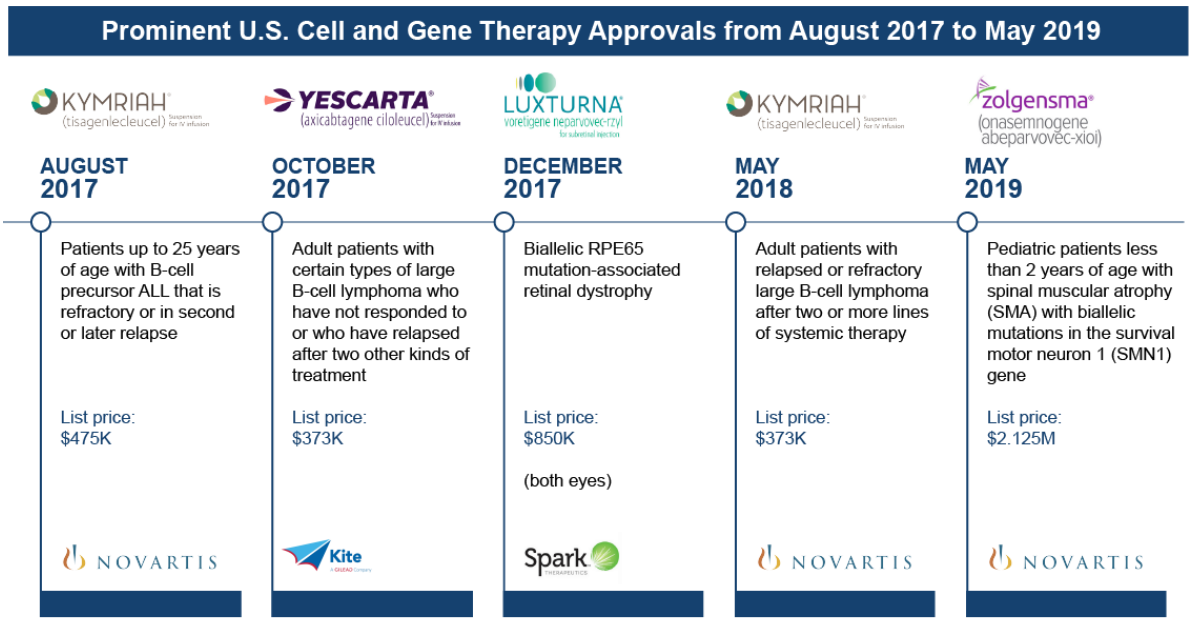
Table of Contents

INTRODUCTION

In recent years, cell and gene therapies have begun to gain traction with the game-changing regulatory approvals of some new therapies that target the causes of disease. Unlike more traditional drugs, these therapies present unique commercial opportunities as well as challenges related to manufacturing, supply chain, reimbursement strategies, and regulatory approval.

Early landmark approvals include CAR T-cell therapies: Novartis' Kymriah™ (approved in August 2017) and Kite's Yescarta®(approved in October 2017). More recently, on May 24, 2019, the FDA approved Novartis' Zolgensma®, the first gene therapy approved to treat children under the age of two with spinal muscular atrophy and only the second gene therapy approved in the United States for an inherited disorder. The approval comes with some controversy; with a reported cost of $2.1 million per treatment, Zolgensma became the most expensive drug ever. Novartis began reaping rewards almost immediately — from July to September 2019, about 100 infants were treated with Zolgensma, earning Novartis about $160 million.[1]

While Zolgensma has the highest price point, multiple other gene therapies have treatment costs that exceed $250,000.



Source: Trinity Life Sciences, "Exploring the Truth of Reimbursement Challenges for Cell and Gene Therapies," June 2019

This report is an overview of this new, lucrative market. Starting with definitions of both cell and gene therapy, we examine the market's prospects and provide a literature review that details some of the impacts the therapies have on various stages of the life sciences ecosystem — clinical trials, manufacturing, and supply chain. We conclude with a look at emerging payment models, regulations, and how service providers present their offerings in this arena.

DEFINITIONS

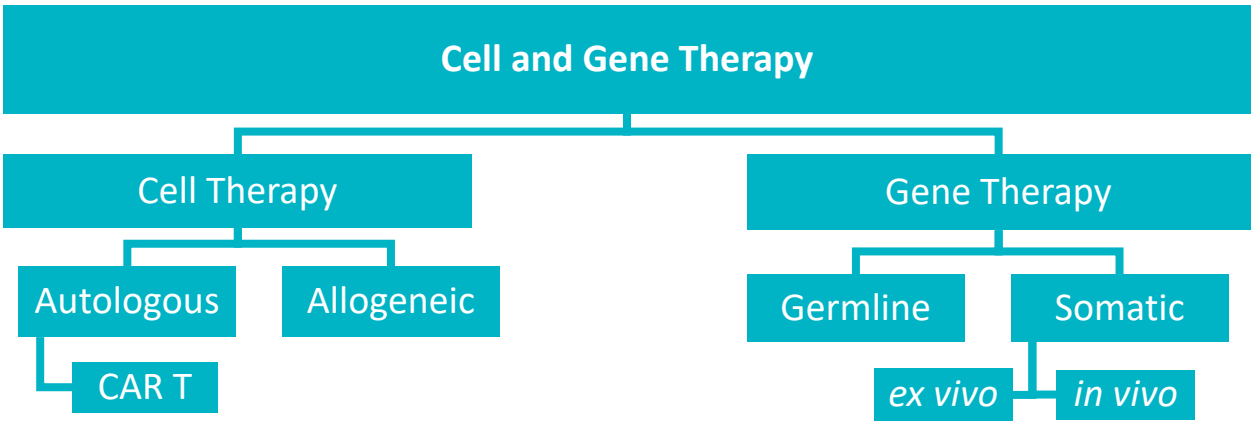
Regenerative medicine is a broad term that encompasses both cell and gene therapy. It is a structural approach that focuses on replacing a patient's damaged tissue or organs instead of treating the symptoms that result from tissue or organ damage.

While cell therapy and gene therapy involve similar protocols — addressing a disease by replacing, manipulating, or eliminating cells — each is distinct. Cell therapy is the treatment of a disease with cells, wherein diseased cells are replaced with healthy ones. Gene therapy is a technique that uses genetic modification to treat or prevent disease. Doctors may treat a disease by inserting a gene into a patient's cells instead of performing surgery or treating the disease with a drug.

Cell therapy can be either autologous or allogeneic. Autologous cell therapy means using cells from the patient. Allogeneic cell therapy refers to the use of cells derived from someone other than the patient (e.g., cells manufactured from bone marrow from a donor). CAR T-cell therapy is a type of autologous treatment wherein a patient's T cells are modified in a lab so they will fight cancer cells.

Gene therapy is applied to either germline or somatic cells. Germline cell therapy yields permanent changes in cells that are passed down from one generation to the next. In contrast, results of somatic cell therapy affect only the patient. Somatic cell therapy can be either *ex vivo* — where cells are treated outside the body before reinsertion — or *in vivo* — where cells are treated while still in the patient's body.

Cord blood is an older type of cell and gene therapy first approved by the FDA in 2011. Blood that is collected from the placenta and umbilical cord after a baby is born is transplanted to patients with blood disorders or diseases such as leukemia. We do not include cord blood in this review of the cell and gene therapy literature.



MARKET OVERVIEW

Cell and gene therapies have the potential to provide significant clinical benefits in ways that existing drug options do not. This has resulted in a proliferation of companies attempting to develop these types of therapies and a sharp increase in the number of cell and gene therapy pipeline projects.

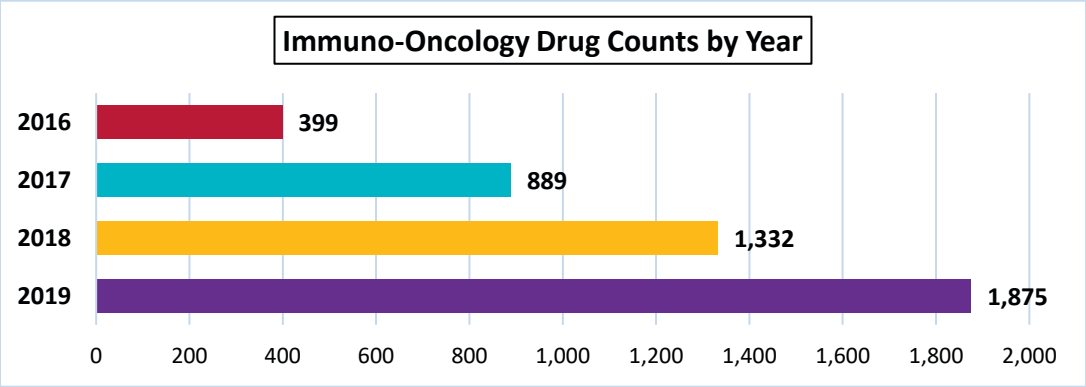
Number of Regenerative Medicine Companies, Worldwide	
Year	**Number of Companies**
2016	772
2017	854
2018	906

Sources: Alliance for Regenerative Medicine Annual Data Reports: 2016 to 2018

Number of Gene Therapy Pipeline Projects	
Year	**Number of Projects**
2015	294
2016	417
2017	547
2018	633
2019	864

Sources: Pharmaprojects Pharma R&D Annual Reviews: 2015 to 2019

Immuno-oncology is a therapeutic strategy that often overlaps with cell and gene therapy. All of this investment in cell and gene therapy R&D has led to the FDA anticipating hundreds of new applications for cell and gene therapies in 2020.[2]



Source: Pharmaprojects Pharma R&D Annual Review: 2019

By all accounts, growth expectations in this market are very high. A Frost & Sullivan report projects the global cell therapy market to grow from $2.7 billion in 2017 to $8.2 billion by 2025 — a CAGR of 14.9%.[3] And a Grand View Research report projects the global gene therapy market to grow from about a half-billion dollars in 2018 to $5.6 billion by 2026 — a CAGR of 33.9%.[4] These growth rates have not only attracted venture capital investments and sparked pharmaceutical company acquisitions and partnerships, but have resulted in the emergence of a variety of new service providers to serve the cell and gene therapy market.

IMPACT ON CLINICAL TRIALS

Clinical trials for testing cell and gene therapies might require different trial designs than the randomized controlled trials (RCTs) used for more traditional pipeline drugs. In particular, trial designs for these types of studies may include more endpoints to sufficiently test for efficacy and safety and additional safeguards to maintain data quality.

This means cell and gene therapy clinical trials are often longer and more complex than most other clinical trials. They may require additional patient education and a greater need to overcome logistical hurdles such as patient travel and site limitations. To address specific challenges facing cellular and gene therapy companies, the FDA has issued several guidances, including one for long term follow-up observational studies after gene therapy treatment has been administered to patients.[5]

Because many cell and gene therapies are for rare diseases, these studies often have smaller sample sizes than typically used for RCTs. These types of treatments are driving the trend toward individualized medicines that are, in essence, a sample size of one. (Treatments for individualized medicine also lead to supply chain challenges that will be discussed further in the Impact on Supply Chain section.) And since some unapproved cell and gene therapy treatments address diseases for which patients may find themselves in dire circumstances, with no alternative treatment options available, there are occasions when these therapies are allowed to be administered to patients via the expanded access (or "compassionate use") pathway. These factors can contribute to an evidence crisis wherein there is greater uncertainty over the safety and efficacy of a treatment than for those in trials with larger sample sizes.[6]

Recruiting patients for these studies may also require different tactics than recruitment for RCTs. Two online sites that facilitate this process are the Stem Cells Portal[7] and the American Society of Gene & Cell Therapy's Clinical Trials Finder.[8]

Regenerative Medicine Clinical Trials by Therapeutic Area		
Therapeutic Area	**2017**	**2018**
Oncology	497	598
Cardiovascular	81	67
Musculoskeletal	49	58
Central Nervous System	62	57
Endocrine, Metabolic, and Genetic Disorders	40	42

Sources: Alliance for Regenerative Medicine Annual Data Reports: 2017 and 2018

IMPACT ON MANUFACTURING

The primary challenge to cell and gene therapy manufacturers is the development of a reliable, replicable, and scalable system for producing therapies. Manufacturers also face manufacturing controls challenges that impact the development of any cell or gene therapy treatment. Among the hurdles are the lack of standardization of source cells and variability of ancillary materials used in production.

Product-Specific Challenges for Each Product Type			
	Autologous	**Off-the-Shelf (No Match)**	**Off-the-Shelf (Minimal Match)**
Donor Eligibility	No	Yes	Yes
Qualification of Cell Bank	No	Yes	Yes
Reproducibility of Master Cell Bank	No	Yes	Yes
Stability of MCB	No	Yes	Yes
Short Half-Life	Yes (Fresh Products)	No (Frozen Products)	No (Frozen Products)
Product Tracking, Segregation, and Logistics	Extremely Complicated	Less Complicated	Complicated
Scale-up or Scale-out	Scale-out	Scale-up	Scale-out and scale-up?
Material Qualification	Yes	Yes	Yes
Specification	Yes	Yes	Yes
Process Validation	Difficult	Less Difficult	Difficult
Shipping and Handling	Difficult	Less Difficult	Difficult
Handling Major Manufacturing Changes	Extremely Difficult	Difficult	Difficult

Source: RAPS, "Establishing Manufacturing Controls: A Hurdle for the Cell and Gene Therapy Industry," 4/25/19

Autologous cell therapy production in its entirety cannot be scaled up because each batch is ultimately customized for one patient. While some aspects of production that precede the involvement of the patient's cells may be scaled, relatively few benefits can be derived from economies of scale in autologous cell therapy production because once the patient's cells are introduced, the final batch size is a batch of one.

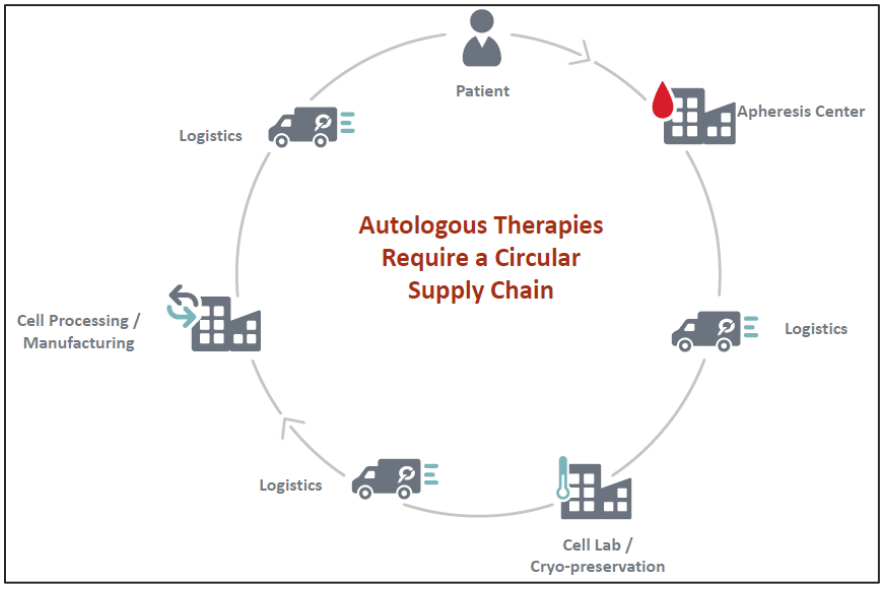
Allogeneic cell therapy manufacturing is similar in some ways to how biologics are produced. However, there is limited manufacturing capacity for allogeneic cell therapy manufacturing, and this restraint has delayed commercial launches by as much as eight months.[9] There is a bigger backlog for the manufacture of larger batches to scale in Phase III trials and during the commercialization stage than there is for Phase I trials with smaller patient populations. Furthermore, the projected rapid growth of cell and gene therapy treatments is expected to exacerbate the production bottlenecks that already exist.

IMPACT ON SUPPLY CHAIN

Traditional drugs have a supply chain process that can be described as linear. The manufacturer makes drugs and the drugs get transported to a location such as a pharmacy, clinic, or hospital where they are distributed or administered to the patient.

Source: Global Clinical Supplies Group, "Cell Gene Therapy Supply Chain," 11/16/18

The supply chain for autologous cell and gene therapies, sometimes referred to as vein-to-vein supply chain, is more aptly described as circular. It begins and ends with the patient. The patient initially goes to a site where cells can be extracted. From there, the cells are transported to a cell lab for preservation, and then on to a processing/manufacturing lab. Finally, the circle is completed when the cells arrive at a location where they may be infused into the patient.



Source: Global Clinical Supplies Group, "Cell Gene Therapy Supply Chain," 11/16/18

Compared to traditional drug products, the pain points for the cell and gene therapy supply chain process include more restrictive storage requirements, tighter timelines, and lower margins for error.

Storage for most cell and gene therapy products requires at least very low, and sometimes cryogenic, temperatures. There is little actual output; what is eventually produced could fit into a small vial. This limits options for labeling and testing. Since the stability of the product is often low, each stage of the manufacturing and supply chain process is especially time sensitive. Further, seamless execution in the face of such stringent demands can be a mandatory, all-or-nothing proposition, because if anything goes wrong and the treatment is rendered unusable, there is often no second or backup batch available.

The cell and gene therapy chains require both increased standardization and flexibility. Specific infrastructure priorities for the cell and gene therapy supply chain must include a robust chain of identity (COI) and chain of custody (COC).[10] Automation of certain aspects of the supply chain infrastructure is needed to ensure COI and COC, which in turn elevate clinical trust and patient safety.[11] But agility is also a requisite, particularly in the sourcing of raw materials, because of the irregular demand for these single-batch treatments.[12]

Because allogeneic cell therapy production can be batched, the allogeneic supply chain is more forgiving, in some ways, than the supply chain for autologous cell therapy production. Still, there are considerations specific to the allogeneic supply chain, including labeling, inventory management, and distribution, made more difficult given the very small product batch size.[13]

PAYMENT/REIMBURSEMENT ISSUES

The prevailing model for paying for outpatient drugs is "buy-and-bill." The provider is paid for the cost of the drug (including a negotiated margin and administration fees) after each treatment. The buy-and-bill reimbursement model works well for established treatments of chronic diseases, such as high blood pressure.

Several of the recently introduced cell and gene therapies have been designed to be fully administered in just a single dose. From the pharmaceutical company's perspective, the high pricing of these therapies reflects the higher cost of production and the value of the outcome. For payers, the very large upfront price tag creates significant financial and risk/reward challenges.

Under traditional reimbursement models, payers are disincentivized from paying for cell and gene therapies for a variety of reasons, including:

- Even though a patient might be cured, resulting in long-term savings in health care costs, the savings might not be accrued to the payer because patients can switch health insurers.
- Sponsors could attempt to recoup their investment by charging those covered by private insurance much higher rates than they could charge Medicaid.
- In order to determine value, payers need to develop a method to assess the worth of a product relative to the age of the patient and/or the presence of preexisting irreversible damage to organs.[14]

It has quickly become apparent to payers that the traditional buy-and-bill reimbursement model for cell and gene therapies needs to be reworked. There are a number of different health plan payment models being considered as alternatives to the buy-and-bill model for cell and gene therapies. Among them are milestone payments instead of payment in one lump sum, outcomes-based payments that take into account how well the treatment worked, and reinsurance into larger risk pools.

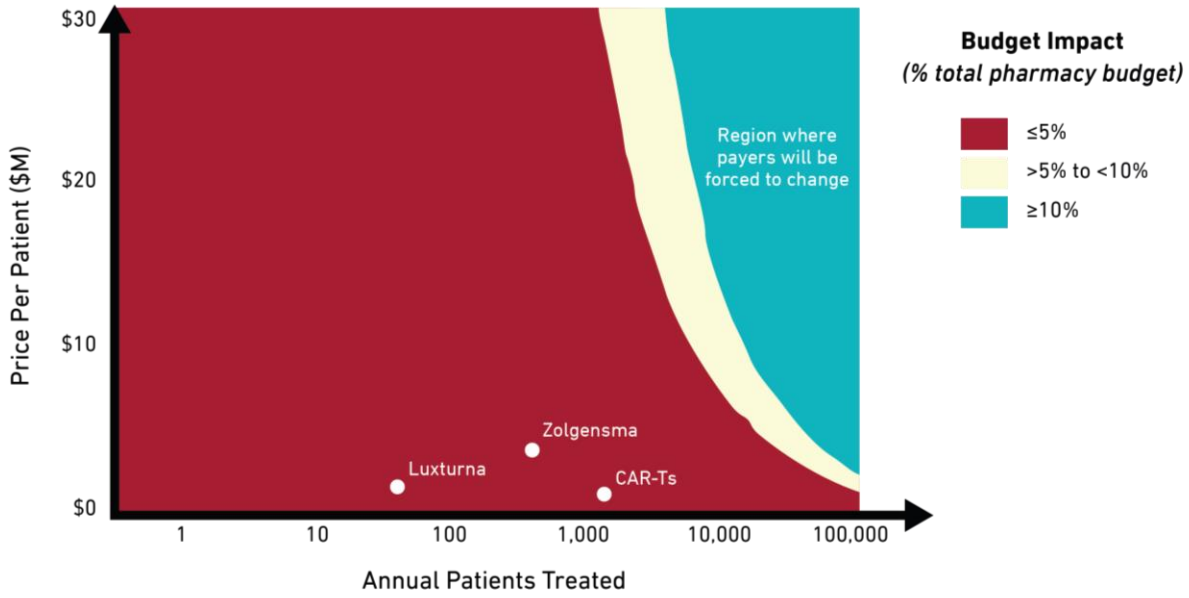
There are also payment models initiated by government entities or pharmaceutical companies themselves:

- Novartis developed an outcomes-based approach for Kymriah® with the Centers for Medicare and Medicaid Services (CMS).[15]
- An MIT-led collaboration is working on a pilot reimbursement program for Novartis' Zolgensma® that combines the milestone and outcomes-based concepts by breaking the cost up into multiple payments, with later payments being conditional depending on how well the patient has responded to the treatment.[16]
- Spark Therapeutics has introduced an outcomes-based rebate reimbursement program for Luxturna®, as well as contract models where it directly sells to the payer, a specialty pharmacy, or the CMS.[17]

Each of these alternatives theoretically encourages greater access to treatment by removing or reducing disincentives or risk, but falls short in practice for payers. Changing the lump-sum payment into a

milestone payment is insufficient because it only addresses timing of payment and not overall cost. Outcomes-based contracts require the payer to develop an infrastructure to define value, measuring and quantifying outcomes for each cell and gene therapy. Payers do not currently have such an infrastructure, and there is doubt over whether its development would be either feasible or cost-effective.

Despite these alternative payment models and pilot programs, there is resistance among payers. In 2017, Steve Miller, M.D., then chief medical officer of Express Scripts, said, "The healthcare system isn't set up for this type of economic model. We need a new payment model."[18] Payers believe the underlying reimbursement model needs to change if cell and gene therapies are to be funded on a larger scale. While payers might be somewhat willing to pay for cell and gene therapy treatments at first, while few patients are receiving them, they would be less willing to do so when there are thousands of such patients.



Source: Trinity Life Sciences, "Exploring the Truth of Reimbursement Challenges for Cell and Gene Therapies," June 2019

REGULATORY ISSUES

As stated earlier, over the past few years, there has been a significant increase in the number of companies developing cell and gene therapies and in the number of cell and gene therapy drugs. And again, this level of cell and gene therapy R&D has the FDA expecting hundreds of new applications for cell and gene therapies in 2020.[19]

The FDA has recently issued more guidances to help cell and gene therapy companies navigate the drug approval process. There has also been collaboration between the FDA and the European Medicines Agency (EMA) to ensure that both agencies are on the same page regarding issues pertaining to cell and gene therapy safety and efficacy.

Number of FDA Cell and Gene Therapy Guidances	
Years	**Number of Guidances**
2015-2019	15
2010-2014	7
2005-2009	9
2000-2004	0
Before 2000	1

Sources: FDA, "Cell & Gene Therapy Guidances"

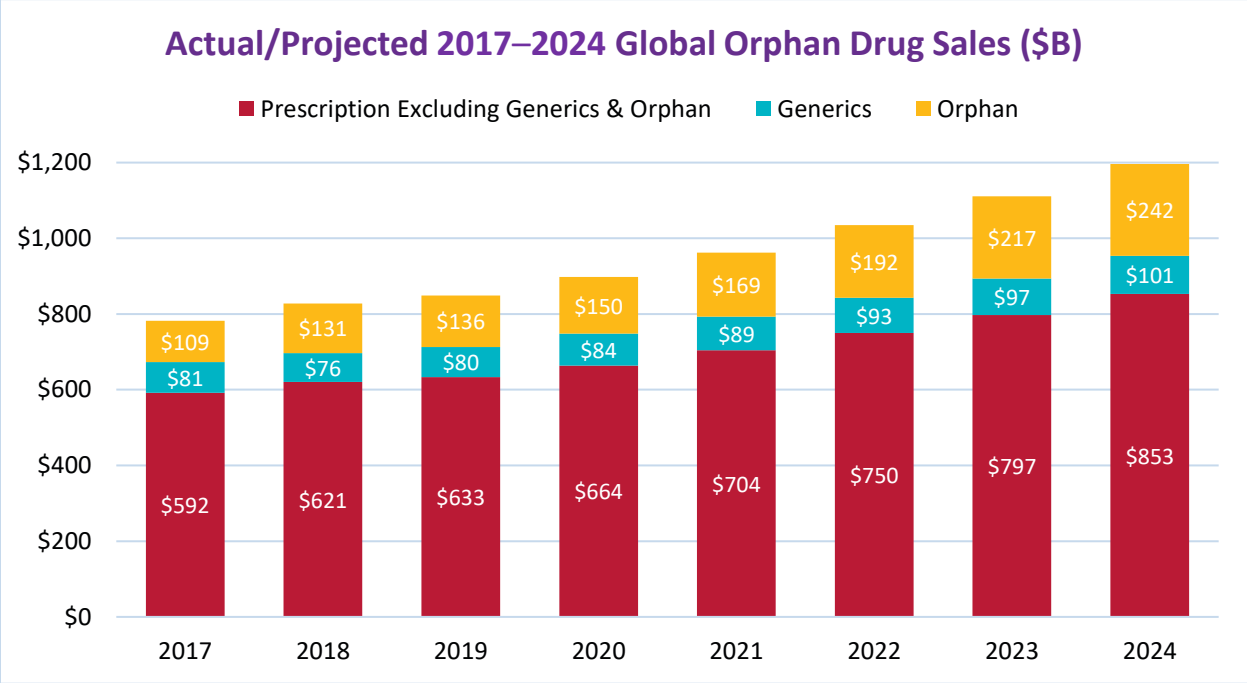
Regulating a new class of drugs from which many patients seek cures requires balancing safety and efficacy concerns with temporal ones. Some advocacy organizations have called upon the FDA to streamline the cell and gene therapy drug approval process. In some instances, the FDA has responded by pledging flexibility.[20]

The FDA has also had to increase enforcement against the burgeoning businesses of thousands of stem cell clinics that offer unproven and untested stem cell treatments to sometimes desperate patients seeking cures for a variety of ailments. The FDA has issued a warning about what it describes as "stem cell treatments that are illegal and potentially harmful."[21]

PRODUCTS/MARKETS FOR ORPHAN INDICATIONS

The Orphan Drug Act (ODA) was passed to encourage research and development of drugs targeting rare diseases — diseases that, taken individually, affect fewer than 200,000 people in the United States. One way it encouraged development of drugs for rare diseases was by granting sponsors seven years of market exclusivity **after** FDA approval. This is in contrast to the typical award: 20 years of exclusive rights **from date of patent**, which often means the vast majority of these two exclusivity-protected decades are burned in development and testing, prior to FDA approval and the opportunity to actually market and monetize the drug. The end result can be a period of commercial exclusivity of **less than** seven years. So drugs that receive Fast Track designation and are granted orphan drug status go through a shorter clinical trial process and then, if approved, face no competition for a full seven years.

There is a huge potential overlap between rare diseases and genetic therapy. Of the approximately 7,000 known rare diseases, roughly three-quarters of them are caused by a defect in a single gene.[22] Furthermore, orphan drugs are projected to grow at a CAGR of 12% from now until 2024; this is twice the rate of projected growth for nonorphan drugs over the same time period.[23] Goldman Sachs estimates the rare disease treatment market could eventually be $5 trillion.[24]



Source: EvaluatePharma, "Orphan Drug Report 2019," April 2019

Though the rare disease market is growing, by definition, rare diseases have patient populations that are relatively small. These smaller patient populations affect the pricing strategy of drugmakers. Fewer patients to serve means fewer opportunities to generate revenue. Consequently, prices for rare disease drugs are 25 times more expensive than for traditional drugs. The average annual cost of an orphan drug increased from about $7,000 in 1997 to more than $186,000 in 2017.[25]

A complicating factor still to be resolved is how the FDA will determine which cell and gene therapies might be granted orphan drug status and, if approved, awarded the seven valuable years of post-approval exclusivity. Recent indications are that a cell and gene therapy might be granted orphan drug status if:

- It has a unique transgene — the DNA sequence introduced into an organism's genome to transform the genetic makeup of the organism.
- The transgene is transmitted by a unique virus or viral vector — the delivery system that carries the transgene.[26]

If a cell and gene therapy does not have a unique transgene or unique viral vector, then the FDA seems unlikely to grant it orphan drug status. And instead of receiving seven years of market exclusivity, it would have to wait until the exclusivity period of the cell and gene therapy that shares the same transgene or viral vector had lapsed before it could enter the market.

SERVICE PROVIDERS

While most of the large CROs provide cell and gene therapy development services, there are not many large CDMOs/CMOs that manufacture cell and gene therapies. There are several companies that offer supply chain logistical services.

Selected CROs and Their Cell and Gene Therapy Web Page	
CRO	**Web Page Heading and Link**
Covance	Cell and Gene Therapy Solutions
IQVIA	Cell & Gene Therapy Center
Medpace	Advanced Therapies
Parexel	Regenerative Medicine
PPD	Immuno-oncology Experience
PRA Health Sciences	Gene Therapy Research and Rare Diseases
Syneos Health	Cell and Gene Therapy Consortium
Worldwide Clinical Trials	Stem Cell Therapy

Selected CDMOs/CMOs and Their Cell and Gene Therapy Web Page	
CDMO/CMO	**Web Page Heading and Link**
Catalent Biologics	Gene Therapy
Cognate BioServices	Unparalleled Cellular Immunotherapy Experience
Lonza	Cell Therapy
Pfizer	Discovering Breakthroughs With Gene Therapy

Selected Cell and Gene Therapy Supply Chain Companies and Their Logistics Web Page	
Company	**Web Page Heading and Link**
AIT Worldwide Logistics	Clinical Trials Logistics
Be The Match BioTherapies	Cell Therapy Supply Chain Solutions
Cardinal Health	Cell and Gene Therapies
Cryoport	Unmatched Logistics Solutions for the Life Sciences Industry
Fisher Clinical Services (part of Thermo Fisher Scientific)	Cell and Gene Therapy
Marken (a UPS Company)	Cell and Gene Supply Chain Services
McKesson	Cell & Gene Therapy
World Courier (AmerisourceBergen)	Cell and Gene Therapy

SUMMARY

Cell and gene therapies have the potential to treat, or even cure, patients with diseases for which there are currently no satisfactory treatments or cures. Combined with dynamic financial opportunities, this has driven investment in cell and gene therapy R&D. The unique characteristics of cell and gene therapies affect every aspect of the pharmaceutical ecosystem.

- **Impact on Clinical Trials** – Cell and gene therapy clinical trials may require trial designs that differ from those of the randomly controlled trials prevalent in traditional studies. They may be more complex, with more endpoints needed to test for efficacy and safety. And their smaller sample sizes affect the robustness of their resultant clinical trial data.

- **Impact on Manufacturing** – Manufacturing for cell and gene therapies is much less scalable and more complex than for traditional drugs.

- **Impact on Supply Chain** – The cell and gene therapy supply chain is characterized by more-controlled shipping and storage conditions, shorter timelines, increased tracking, and a much lower margin for error.

- **Pricing, Payment, and Reimbursement** – Previously approved cell and gene therapies all have small patient populations. Because of this, reimbursement models have not yet been tested for larger populations. For the cell and gene therapy market to grow, the industry players need to figure out a scalable model that works for larger populations. A complicating factor is that cell and gene therapies encompass a variety of therapies and populations, so no one approach fits all. Industry players are experimenting with various models, more recently based on outcomes.

REFERENCES

[1] "Novartis' Zolgensma starts strong as about 100 infants are treated with gene therapy," Biopharma Dive, October 22, 2019, https://www.biopharmadive.com/news/novartis-zolgensma-sma-gene-therapy-strong-launch/565546/

[2] "FDA prepares for huge growth in cell and gene therapy," Chemical & Engineering News, January 16, 2019, https://cen.acs.org/business/investment/FDA-prepares-huge-growth-cell/97/i3

[3] "Cell therapy market to triple in size by 2025," BioPharma-Reporter, March 4, 2019, https://www.biopharma-reporter.com/Article/2019/03/04/Cell-therapy-market-to-triple-in-size-by-2025

[4] "Gene Therapy Market Size, Share & Trends Analysis Report By Vector, By Indication, And Segment Forecasts, 2019–2026," Grand View Research, April 2019, https://www.grandviewresearch.com/industry-analysis/gene-therapy-market

[5] "Long Term Follow-up After Administration of Human Gene Therapy Products," U.S. FDA, January 2020, https://www.fda.gov/regulatory-information/search-fda-guidance-documents/long-term-follow-after-administration-human-gene-therapy-products

[6] "Cell and Gene Therapy Trials: Are We Facing an 'Evidence Crisis'?," EClinicalMedicine, February 1, 2019, https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370(19)30021-5/fulltext

[7] Clinical Trials: Stem Cells and Regenerative Medicine, Stem Cells Portal, undated, https://stemcellsportal.com/stem-cells-translational-medicine-clinical-trials-portal

[8] American Society of Gene & Cell Therapy's Clinical Trials Finder, American Society of Gene & Cell Therapy, undated, https://app.emergingmed.com/asgct/home/

[9] "Continued and Consistent Investment in Manufacturing Facilities," Contract Pharma, September 23, 2019, https://www.contractpharma.com/contents/view_experts-opinion/2019-09-23/continued-and-consistent-investment-in-manufacturing-facilities/

[10] "On the industrialization of cell and gene therapy manufacturing: No scale without a seamless supply chain," Outsourcing-Pharma, August 14, 2019,https://www.outsourcing-pharma.com/Article/2019/08/14/On-the-industrialization-of-cell-and-gene-therapy-manufacturing-No-scale-without-a-seamless-supply-chain

[11] "Cell Therapy Manufacturing: The Supply Chain Challenge," Genetic Engineering News, November 16, 2018, https://www.genengnews.com/insights/cell-therapy-manufacturing-the-supply-chain-challenge/

[12] "Cell and Gene Therapy: Agility in the Material Supply Chain," Healthcare Packaging, May 10, 2019, https://www.healthcarepackaging.com/home/article/13296162/cell-and-gene-therapy-agility-in-the-material-supply-chain

[13] "Recalibrating The Supply Chain For Allogeneic Cell Therapies," Cell & Gene, February 25, 2019, https://www.cellandgene.com/doc/recalibrating-the-supply-chain-for-allogeneic-cell-therapies-0001

[14] "How will we pay for the coming generation of potentially curative gene therapies?," STAT News, June 12, 2019, https://www.statnews.com/2019/06/12/paying-for-coming-generation-gene-therapies/

[15] "How to cover Novartis' $475K CAR-T drug Kymriah? A 'new payment model' is the only way, Express Scripts says," FiercePharma, September 22, 2017, https://www.fiercepharma.com/financials/car-t-and-other-gene-therapies-need-new-payment-model-says-express-scripts

[16] "Paying for high-cost drugs like you'd pay a mortgage–and with strings attached," Managed Care, July 15, 2019, https://www.managedcaremag.com/archives/2019/7/paying-high-cost-drugs-you-d-pay-mortgage-and-strings-attached

[17] "New Approaches to Reimbursement for Gene Therapy: What Can We Learn from Models Currently in Place?" BIOtechNOW, June 3, 2019, https://www.bio.org/blogs/new-approaches-reimbursement-gene-therapy-what-can-we-learn-models-currently-practice

[18] "Express Scripts CMO: Healthcare System Isn't Set Up to Pay for Novartis' $475K Cancer Drug," Becker's Hospital Review, September 22, 2017, https://www.beckershospitalreview.com/supply-chain/express-scripts-cmo-healthcare-system-isn-t-set-up-to-pay-for-novartis-475k-cancer-drug.html

[19] "FDA prepares for huge growth in cell and gene therapy," Chemical & Engineering News, January 16, 2019, https://cen.acs.org/business/investment/FDA-prepares-huge-growth-cell/97/i3

[20] "FDA Promises Flexibility for Stem Cell Trials," WCG, March 21, 2019, https://www.fdanews.com/articles/190649-fda-promises-flexibility-for-stem-cell-trials

[21] "FDA Warns About Stem Cell Therapies," U.S. FDA, September 3, 2019, https://www.fda.gov/consumers/consumer-updates/fda-warns-about-stem-cell-therapies

[22] "4 Barriers To Cell And Gene Therapy Development For Rare Diseases — And How To Overcome Them," Cell & Gene, September 27, 2018, https://www.cellandgene.com/doc/barriers-to-cell-and-gene-therapy-development-for-rare-diseases-and-how-to-overcome-them-0001

[23] "EvaluatePharma Orphan Drug Report 2019," EvaluatePharma, April 25, 2019, https://www.evaluate.com/thought-leadership/pharma/evaluatepharma-orphan-drug-report-2019

[24] "Industry Leaders Outline Five Important Elements Impacting Rare Disease Drug Development," BioBuzz, April 30, 2019, https://biobuzz.io/industry-leaders-outline-five-important-elements-impacting-rare-disease-drug-development/

[25] "Drug Prices for Rare Diseases Skyrocket While Big Pharma Makes Record Profits," AHIP, September 10, 2019, https://www.ahip.org/drug-prices-for-rare-diseases-skyrocket-while-big-pharma-makes-record-profits/

[26] "An Expanding Orphan Drug Market," Pharma's Almanac, May 24, 2019, https://www.pharmasalmanac.com/articles/an-expanding-orphan-drug-market

About SCORR Marketing

SCORR Marketing is the leading full-service marketing and communications firm in the health science industry. We are a global partner for organizations around the world involved in research, development, and commercialization of biopharmaceutical and device products and the delivery of health care products and services. At SCORR, we provide integrated programs that help our clients achieve their goals and improve health and well-being worldwide. For more information, visit www.scorrmarketing.com.