Pharma R&D Annual Review
Navigating the Landscape
Introduction

The drug R&D pipeline in 2022, and how it is changing
  • Total pipeline size
  • Success stories in 2021
  • Top companies
  • Leading therapies and diseases
  • Mechanisms and targets

Key trends
  • COVID, rare diseases, cell and gene therapy, China

Outlook for 2022
  • Launches expected from 2021 drug approvals
  • Drug approvals to look out for in 2022

Conclusions and Q&A
The total drug R&D pipeline in 2022
Total pipeline size has grown by 8.2%

20,109 drugs under active development

Expansion rate accelerated
- 2021 was up 4.8%
- Above 5-year average of 6.3%

1,527 more drugs in development
- 6,343 new drugs identified during the year
- Vs 5,544 the previous year
- But 4,658 drugs left the pipeline

New drugs statistics
- 38.8% were anticancers
- 14.7% neurologicals
- 12.0% anti-infectives

Source: Pharmaprojects®, January 2022
Successes in 2021 – New active substance drug launches
A record year for new drug launches

Pandemic fails to halt new active substance (NAS) roll-outs once again

97 New Active Substances launched

- Across 95 products
- Includes 13 vaccines

5-year mean hits new heights

- 2017-2021, 63 drugs per year
- Vs 42 in 2012-2016
- > Double seen in the noughties

NAS statistics

- 17 were first in class
- 30 were orphans (31%)
- Cancer most popular
- AstraZeneca had most NAS launches

Number of NAS launches by year, 2001–21

Source: Pharmaprojects®, February 2022
Novel new drug launches 2021

Cancer

**Amgen’s Lumakras (sotorasib)**
- K-Ras inhibitor
- Non-small cell lung cancer
- First launched in the US in August

**Merck & Co’s Welireg (belzutifan)**
- First hypoxia-inducible factor 2 alpha antagonist. HIF-2α
- For patients with von Hippel-Lindau disease
- First launched in the US in September

**Rhizen Pharmaceuticals and TG Therapeutics’ Ukoniq (umbralisib)**
- PI3 kinase delta inhibitor with the additional, novel pharmacology of casein kinase 1 inhibition
- Marginal zone lymphoma
- First launched in the US in August

*Source: Scrip*
Novel new drug launches 2021

Autoimmune/Inflammation

AstraZeneca’s Saphnelo (anifrolumab)
• First interferon (type I) receptor antagonist
• Systemic lupus erythematosus
• First launched in Japan in November

RemeGen, part of Rongchang Pharmaceuticals’ Tai’ai (telitacicept)
• First APRIL inhibitor
• Fusion protein which jointly targets BLYs
• Launched in China in August for SLE

Hansa Biopharma’s Idefirix (imlifidase)
• First drug classified as an endopeptidase stimulant
• Kidney transplant rejection
• Launched in Finland, the Netherlands and Sweden in September
Novel new drug launches 2021

Autoimmune/Inflammation

ChemoCentryx’s Tavneos/Vynpenta (avacopan)
- First to target complement C5a receptor 1.
- Anti-neutrophil cytoplasmic autoantibody-associated vasculitis
- First launched in the US in October

Apellis’ Empaveli (pegcetacoplan)
- First complement C3 convertase inhibitor
- Paroxysmal nocturnal haemoglobinuria
- Launched in the US in July

Source: Scrip
Novel new drug launches 2021

Dermatology

Leo Pharma’s Adbry (tralokinumab)
- First interleukin-13 antagonist
- For atopic eczema
  - Launched in the US in December, ahead of rivals

UCB’s Bimzelx (bimekizumab)
- A dual interleukin-17A and -17F antagonist
- For use in moderate-to-severe plaque psoriasis
  - Debuted in Germany in September

Source: Scrip
Novel new drug launches 2021

Others

**Biogen and Eisai’s Aduhelm (aducanumab)**
- The first beta-amyloid protein antagonist
- For Alzheimer’s disease
- Launched in US in July to much controversy

**Regeneron’s Evkeeza (evinacumab)**
- Angiopoietin-like 3 inhibitor
- For homozygous familial hypercholesterolaemia.
- Launched in US in February

Source: Scrip
Novel new drug launches 2021

Anti-Infectives

**Pfizer’s Paxlovid (nirmatrelvir/ritonavir)**
- First SARS 3 cysteine-like protease inhibitor
- For COVID-19
- Second direct anti-SARS-CoV-2 antiviral to make it to market

**Takeda and GlaxoSmithKline’s Livtencity (maribavir)**
- First cytomegalovirus UL97 protein kinase inhibitor
- For post-transplant cytomegalovirus infection/disease
- Launched in the US in December

Source: Scrip
Novel new drug launches 2021

Metabolic

BridgeBio Pharma’s Nulibry (fosdenopterin)
- First molybdenum cofactor replacement therapy
- Molybdenum cofactor deficiency
- Launched in the US in May with $500,000 per year price tag

Eiger BioPharmaceuticals Zokinvy (Lonafarnib)
- Hutchinson-Gilford syndrome (progeria) - affects one in 18 million people
- Two novel mechanisms: P-glycoprotein inhibition and MRP inhibition
- Launched in US in January at price of $1m per year

Lexicon Pharmaceuticals’ Zynquista (Sotagliflozin)
- Sodium/glucose cotransporter 1 and 2 inhibitor
- First launched for type 1 diabetes in EU and US in December
- It is also awaiting approval for use in type 2 diabetes and heart failure

Source: Scrip
### Other selected new drug launches 2021

#### COVID-19 Vaccines

<table>
<thead>
<tr>
<th>Vaccine Type</th>
<th>Company</th>
<th>Name</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>COVID-19 vaccine, Bharat Biotech-1</td>
<td>Covaxin</td>
<td>Bharat Biotech</td>
<td>COVID-19 prophylaxis</td>
</tr>
<tr>
<td>COVID-19 vaccine, CanSino Biologics</td>
<td>Convidecia</td>
<td>CanSino Biologics</td>
<td>COVID-19 prophylaxis</td>
</tr>
<tr>
<td>COVID-19 vaccine, CIGB-2</td>
<td>Abdala</td>
<td>CIGB</td>
<td>COVID-19 prophylaxis</td>
</tr>
<tr>
<td>COVID-19 vaccine, Finlay Institute-2</td>
<td>Soberana 2</td>
<td>Finlay Institute</td>
<td>COVID-19 prophylaxis</td>
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<tr>
<td>COVID-19 vaccine, Medigen Vaccines Biologics Co.</td>
<td>MVC COVID-19 Vaccine</td>
<td>Dynavax Technologies/Medigen Biotechnology</td>
<td>COVID-19 prophylaxis</td>
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<tr>
<td>COVID-19 vaccine, Shifa Pharmed</td>
<td>COVIran Barakat</td>
<td>Shifa Pharmed</td>
<td>COVID-19 prophylaxis</td>
</tr>
<tr>
<td>COVID-19 vaccine, Sinopharm</td>
<td>Sinovac</td>
<td>Wuhan Inst of Biological Sciences/Sinopharm/Chinal National Biotec Group</td>
<td>COVID-19 prophylaxis and treatment</td>
</tr>
<tr>
<td>COVID-19 vaccine, Vaxine</td>
<td>SpikoGen</td>
<td>Vaxine/CinnaGen</td>
<td>COVID-19 prophylaxis and treatment</td>
</tr>
</tbody>
</table>

Source: Scrip
Other selected new drug launches 2021

**COVID-19 Treatments**

<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celltrion’s Regkirona (regdanvimab)</td>
<td>COVID-19 prophylaxis and treatment</td>
</tr>
<tr>
<td>Eli Lilly’s etesevimab</td>
<td>COVID-19 prophylaxis and treatment</td>
</tr>
<tr>
<td>Merck &amp; Co/Ridgeback’s Lagevrio (molnupiravir)</td>
<td>COVID-19 infection</td>
</tr>
<tr>
<td>Pfizer’s Paxlovid (nirmatrelvir)</td>
<td>COVID-19 infection</td>
</tr>
<tr>
<td>GlaxoSmithKline’s Xevudy (sotrovimab)</td>
<td>COVID-19 infection</td>
</tr>
<tr>
<td>AstraZeneca’s Evusheld (cilgavimab + tixagevimab)</td>
<td>COVID-19 infection and prophylaxis</td>
</tr>
</tbody>
</table>

Source: Scrip
Other selected new drug launches 2021

CAR-Ts

**Bristol Myers Squibb’s Abecma (idecabtagene vicleucel)**
- For the treatment of relapsed or refractory multiple myeloma
- First launched in the US in May
- Via Celgene acquisition

**Bristol Myers Squibb’s Breyanzi (lisocabtagene maraleucel)**
- For large B-cell lymphoma
- First launched in the US in May
- Via Juno Therapeutics

**JW Therapeutics’ Relma-cel (remacabtagene autoleucel)**
- For large B-cell lymphoma
- First launched in China in November

Source: Scrip
Other selected new drug launches 2021

Metabolic Disorders

**Albireo Pharma’s Bylvay (odevixibat)**
- Ileal bile acid transport inhibitor
- For progressive familial intrahepatic cholestasis (PFIC)
- Launched in the US in August

**Mirum Pharmaceuticals’ Livmarli (maralixibat)**
- Ileal bile acid transport inhibitor
- For Alagille syndrome – PFIC indication dropped
- Launched in the US in November

**Rhythm Pharmaceuticals’ Imcivree (setmelanotide)**
- Melanocortin (MC)- 4 receptor agonist and melanocyte-stimulating hormone receptor agonist
- For POMC deficiency/Leptin receptor deficiency obesity
- Launched in the US in September

Source: Scrip
Other selected new drug launches 2021

Additional therapeutic areas

**Novartis Leqvio (inclisiran)**
- Heterozygous familial hypercholesterolemia
- RNA interference product obtained via The Medicines Company
- Launched in the EU in November

**Sarepta Therapeutics’ Amondys 45 (casimersen)**
- Third exon-skipping splice switching oligomer
- For Duchenne's muscular dystrophy
- Launched in the US in June following accelerated approval

**Bayer and Merck & Co’s Verquvo (vericiguat)**
- Guanylate cyclase stimulant
- For use in heart failure patients
- Launched in Japan in September

Source: Scrip
Most successful companies for drug launches in 2021

AstraZeneca leads the charge

AZ launches five NASs
- COVID-19 vaccine and dual Mab therapy included

Four firms launch NAS trios
- Of these Bayer leads in NAS launch to pipeline size ratio
- Roche missing from top 10

Chinese firms make mark
- Four launch two apiece
- Guangzhou Pharmaceuticals has best NAS:size ratio

Source: Pharmaprojects
The 2022 drug pipeline in detail
Breakdown of the pipeline by phase

More drugs at each development stage

Biggest increases at early stages
- Preclinical up by 11.0%
- Phase I up by 10.1%
- 6,343 drugs added during 2021

Later clinical stages also rise
- Phase II up by 6.4%
- Phase III up by 8.7%

Source: Pharmaprojects
Trends in drug R&D by clinical phase

Phase III numbers on the rise again after years of stagnation

Source: Pharmaprojects
Novartis spends 6th year at the top

- Top 4 unchanged
- Lilly re-enters Top 10 at the expense of AbbVie

Most pipelines shrink

- Only AZ, Sanofi and Lilly grow
- AZ acquired Alexion
- But overall, another quiet year for M&A amongst the Top 10

Table: Top 10 pharma companies by pipeline size

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (1)</td>
<td>Novartis</td>
<td>213 (232)</td>
<td>129</td>
<td>↓</td>
</tr>
<tr>
<td>2 (2)</td>
<td>Roche</td>
<td>200 (227)</td>
<td>120</td>
<td>↓</td>
</tr>
<tr>
<td>3 (3)</td>
<td>Takeda</td>
<td>184 (199)</td>
<td>68</td>
<td>↓</td>
</tr>
<tr>
<td>4 (4)</td>
<td>Bristol-Myers Squibb</td>
<td>168 (177)</td>
<td>98</td>
<td>↔</td>
</tr>
<tr>
<td>5 (6)</td>
<td>Pfizer</td>
<td>168 (170)</td>
<td>101</td>
<td>↔</td>
</tr>
<tr>
<td>6 (9)</td>
<td>AstraZeneca</td>
<td>161 (157)</td>
<td>89</td>
<td>↔</td>
</tr>
<tr>
<td>7 (5)</td>
<td>Merck &amp; Co</td>
<td>158 (176)</td>
<td>77</td>
<td>↓</td>
</tr>
<tr>
<td>8 (7)</td>
<td>Johnson &amp; Johnson</td>
<td>157 (162)</td>
<td>86</td>
<td>↔</td>
</tr>
<tr>
<td>9 (10)</td>
<td>Sanofi</td>
<td>151 (141)</td>
<td>87</td>
<td>↔</td>
</tr>
<tr>
<td>10 (11)</td>
<td>Eli Lilly</td>
<td>142 (126)</td>
<td>76</td>
<td>↑</td>
</tr>
</tbody>
</table>

Source: Pharmaprojects
Big pharma providing a diminishing slice of the pipeline

Mid-tier companies fuel growth

**Top 10 provides 4.6% of all R&D**
- Down from 5.3%
- Rate of decline increased somewhat

**Top 25 down to 8.5%**
- Less than half the % of 10 years ago

**% from minnows remains around 17%**
- Fall despite a similar number of companies
- Mid-size companies fuelling pipeline growth

Source: Pharmaprojects
Disease focus areas of the Top 10 pharma companies

Big pharma active in all Therapeutic Areas

Cancer major focus for all
• BMS has biggest focus on cancer
• Leading TA for all except Eli Lilly

Big pharma still favours broad portfolios
• 8/10 active in all 14 TAs
• Merck & Co has largest % anti-infective pipeline

Source: Pharmaprojects
Total number of companies with active pipelines 2001-2022

Pharma’s world expands by another 6.2%

Over 1,000 new companies
- 1,042 firms join pharma family
- Net of 725 left
- 19.2% of companies emerged in past year

Over half are tiny
- 759 companies with 2 drugs
- 1,883 with just a single project

Source: Pharmaprojects
The R&D pipeline by Therapeutic Area

Cancer stays top

Cancer ever more dominant
• 39.0% of all drugs have an oncology target
• Up from 37.5% one year go; 29.5% ten years ago
• Grew by 14% this year

Neurologicals in second
• Grew by 7.8%

Anti-infectives third
• Up by 4.7%
• Much slow growth rate than 22.4% seen in 2021

Source: Pharmaprojects
Top 10 diseases/indications
Cancer still takes 7 of the Top 10

Breast cancer top target
• But growth stalls

NSCLC catching up
• 11.5% pipeline expansion

COVID still expanding
• Up by 22.4%

Alzheimer’s rallies
• Aduhelm effect?

<table>
<thead>
<tr>
<th>Position</th>
<th>Disease</th>
<th>No of Active Drugs 2022 (2021)</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (1)</td>
<td>Cancer, breast</td>
<td>888 (886)</td>
<td>↔</td>
</tr>
<tr>
<td>2 (2)</td>
<td>Cancer, lung, non-small cell</td>
<td>832 (746)</td>
<td>↑↑</td>
</tr>
<tr>
<td>3 (5)</td>
<td>Infection, coronavirus, novel coronavirus</td>
<td>677 (553)</td>
<td>↑↑</td>
</tr>
<tr>
<td>4 (3)</td>
<td>Cancer, colorectal</td>
<td>663 (653)</td>
<td>↔</td>
</tr>
<tr>
<td>5 (4)</td>
<td>Cancer, pancreatic</td>
<td>591 (570)</td>
<td>↔</td>
</tr>
<tr>
<td>6 (6)</td>
<td>Cancer, ovarian</td>
<td>530 (518)</td>
<td>↔</td>
</tr>
<tr>
<td>7 (7)</td>
<td>Cancer, prostate</td>
<td>509 (481)</td>
<td>↔</td>
</tr>
<tr>
<td>8 (9)</td>
<td>Alzheimer’s disease</td>
<td>496 (436)</td>
<td>↑</td>
</tr>
<tr>
<td>9 (8)</td>
<td>Cancer, brain</td>
<td>485 (460)</td>
<td>↔</td>
</tr>
<tr>
<td>10 (11)</td>
<td>Cancer, leukaemia, acute myelogenous</td>
<td>462 (430)</td>
<td>↑</td>
</tr>
</tbody>
</table>

Source: Pharmaprojects
# Top 10 mechanisms of action (pharmacologies)

Immuno-oncology and associated mechanisms dominate

<table>
<thead>
<tr>
<th>Position</th>
<th>Mechanism of Action</th>
<th>No of Drugs 2022 (2021)</th>
<th>% at PR, R or L</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (1)</td>
<td>Immuno-oncology therapy</td>
<td>3,307 (2,880)</td>
<td>2.1</td>
<td>↑</td>
</tr>
<tr>
<td>2 (2)</td>
<td>Immunostimulant</td>
<td>1,494 (1,410)</td>
<td>8.6</td>
<td>↑</td>
</tr>
<tr>
<td>3 (3)</td>
<td>T cell stimulant</td>
<td>1,062 (906)</td>
<td>1.0</td>
<td>↑</td>
</tr>
<tr>
<td>4 (4)</td>
<td>Immune checkpoint inhibitor</td>
<td>575 (432)</td>
<td>4.9</td>
<td>↑↑</td>
</tr>
<tr>
<td>5 (9)</td>
<td>Genome editing</td>
<td>280 (173)</td>
<td>0</td>
<td>↑↑</td>
</tr>
<tr>
<td>6 (5)</td>
<td>Gene expression inhibitor</td>
<td>262 (191)</td>
<td>1.9</td>
<td>↑</td>
</tr>
<tr>
<td>7 (6)</td>
<td>Angiogenesis inhibitor</td>
<td>198 (190)</td>
<td>26.3</td>
<td>↔</td>
</tr>
<tr>
<td>8 (-)</td>
<td>Protein degrader</td>
<td>197 (-)</td>
<td>1.0</td>
<td>↑↑</td>
</tr>
<tr>
<td>9 (17)</td>
<td>CD3 agonist</td>
<td>196 (100)</td>
<td>2.0</td>
<td>↑↑</td>
</tr>
<tr>
<td>10 (8)</td>
<td>Radiopharmaceutical</td>
<td>183 (174)</td>
<td>9.3</td>
<td>↔</td>
</tr>
</tbody>
</table>

- **IO up a further 14.8%**
  - But only 2% late-stage

- **Other IO-related rises**
  - Checkpoint inhibitors up by a third
  - CD3 nearly doubles

- **Genome editing and gene expression inhibition advance**

- **New entry for protein degraders**

Source: Pharmaprojects
# Top 10 drug protein targets

Cancer and, in particular, IO targets dominate

## CD3e now most popular target
- Key target for bispecific antibodies

## Other IO-related rises
- PD-L1 up to No.2
- CD19, PD-1 also up

## Top 7 all cancer targets

## Boost for 5-HT2A
- 43 new drugs identified in 2021

<table>
<thead>
<tr>
<th>Position 2022 (2021)</th>
<th>Target</th>
<th>No of Active Drugs 2022 (2021)</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (3)</td>
<td>CD3e molecule</td>
<td>199 (149)</td>
<td>↑↑</td>
</tr>
<tr>
<td>2 (6)</td>
<td>CD274 molecule [PD-L1]</td>
<td>194 (141)</td>
<td>↑↑</td>
</tr>
<tr>
<td>3 (1)</td>
<td>erb-b2 receptor tyrosine kinase 2 [Her-2]</td>
<td>177 (16)</td>
<td>↔</td>
</tr>
<tr>
<td>4 (4)</td>
<td>CD19 molecule</td>
<td>174 (144)</td>
<td>↑</td>
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<tr>
<td>5 (2)</td>
<td>epidermal growth factor receptor</td>
<td>161 (151)</td>
<td>↔</td>
</tr>
<tr>
<td>6 (7)</td>
<td>programmed cell death 1 [PD-1]</td>
<td>159 (122)</td>
<td>↑</td>
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<tr>
<td>7 (5)</td>
<td>vascular endothelial growth receptor factor A</td>
<td>158 (142)</td>
<td>↔</td>
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<tr>
<td>8 (10)</td>
<td>glucagon like peptide 1 receptor</td>
<td>116 (98)</td>
<td>↑</td>
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<tr>
<td>9 (8)</td>
<td>opioid receptor mu 1</td>
<td>104 (112)</td>
<td>↓</td>
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<tr>
<td>10 (23)</td>
<td>5-hydroxytryptamine receptor 2A</td>
<td>103 (60)</td>
<td>↑↑</td>
</tr>
</tbody>
</table>

Source: Pharmaprojects
2022 Key Trends:
COVID-19
Rare diseases
Cell and gene therapy
R&D in China
Response to COVID-19 from pharma continued

New candidates peaked in April 2020

Second year sees fewer new candidates
  • New complication therapies fall back
  • New vaccine R&D sustained

Will 2022 see further declines?
  • Focus likely to switch to antivirals

Source: Pharmaprojects
COVID-19 response from Top 10 pharma companies

All the Top 10 playing their part

Pfizer has the biggest presence
• Leads on vaccines

BMS leads on antivirals

Roche has most complication therapies

Merck has smallest pipeline
• Avoids vaccines entirely

Source: Pharmaprojects
Rise of R&D for rare diseases

Number of rare diseases targeted hits 677

Up from 648 last year
- Almost double that covered in 2014

Number of drugs up too
- 6,080 drugs in development for at least one rare disease
- Up from 5,608 last year
- Represents 30.2% of the pipeline

Source: Pharmaprojects
Therapeutic Area focus of rare disease R&D

Good spread across the TAs

**Alimentary/Metabolic has largest share**
- Includes many single gene defect metabolic and enzyme disorders

**Neurologicals second**
- Cancer third with 14%
- Infectious diseases on 12%

Source: Pharmaprojects
Rare diseases a big focus for Big Pharma

All are in the rare disease Top 20

Novartis tops this chart too
• 138 drugs for rare diseases
• 64.8% of its pipeline

Big pharma dominates
• 9 of the Top 11 are Top 10 pharma companies
• Eli Lilly has smallest %

Niche company features too
• Shape Therapeutics has largest % in the Top 20

### Top 20 pharma companies with a rare disease focus

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>NO. OF DRUGS FOR RARE DISEASES</th>
<th>% OF PIPELINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novartis</td>
<td>138</td>
<td>64.8</td>
</tr>
<tr>
<td>Bristol Myers Squibb</td>
<td>108</td>
<td>64.3</td>
</tr>
<tr>
<td>Pfizer</td>
<td>98</td>
<td>58.3</td>
</tr>
<tr>
<td>Roche</td>
<td>96</td>
<td>48.0</td>
</tr>
<tr>
<td>Sanofi</td>
<td>96</td>
<td>63.6</td>
</tr>
<tr>
<td>Takeda</td>
<td>92</td>
<td>50.0</td>
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<tr>
<td>AstraZeneca</td>
<td>78</td>
<td>48.4</td>
</tr>
<tr>
<td>Johnson &amp; Johnson</td>
<td>69</td>
<td>43.9</td>
</tr>
<tr>
<td>GlaxoSmithKline</td>
<td>68</td>
<td>51.9</td>
</tr>
<tr>
<td>AbbVie</td>
<td>59</td>
<td>48.8</td>
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<tr>
<td>Merck &amp; Co</td>
<td>55</td>
<td>34.8</td>
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<td>Amgen</td>
<td>54</td>
<td>65.1</td>
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<td>Bayer</td>
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<td>46.7</td>
</tr>
<tr>
<td>Biogen</td>
<td>40</td>
<td>60.6</td>
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<tr>
<td>Eli Lilly</td>
<td>40</td>
<td>28.2</td>
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<td>Eisai</td>
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<td>Astellas Pharma</td>
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NOTE: A rare disease is defined as one with a prevalence of 1 in 2,000 people in the EU, or affecting fewer than 200,000 people in the US (equivalent to around 1 in 1,600 people).

Source: Pharmaprojects
Clinical trial starts in rare disease R&D

Record broken in 2021

**2021 saw most rare disease trial starts**
- Followed slight dip in 2020
- Reporting delay means this figure could rise further

**Overall, Trialtrove reports that oncology trials dominate**
- Over 16,000 ongoing oncology trials
- Dwarfs CNS in 2nd with 6,000
- Over 6,500 trials in COVID since the pandemic’s start

Source: Trialtrove
ODS, ERD and EUAs on the rise
Keeping pace with rare disease R&D

381 drugs granted Orphan Drug Status
• 3rd largest on record

341 Expedited Review Designations granted
• Most ever in a single year

39 Emergency Use Authorizations granted

Data for 2013 not complete as we only began systematically recording the dates of these events mid-year. Emergency Authorizations only tracked from 2019.

Source: Pharmaprojects
Cell and gene therapies soaring

Gene therapy regains the lead

**Gene therapy tops 2K**
- Includes in vivo and ex vivo (eg CAR-T)
- Recovery after early ‘00s setbacks
- 17 on market, including 6 CAR-Ts
- Recent regulatory difficulties could put the breaks on

**Cell therapies also top 2K**
- 57% also have a gene therapy component

Source: Pharmaprojects
Viral vectors used in gene therapy

AAV most popular vector

Boom in use of adeno-associated virus
  • 466 use this vector
  • Up from 341 in 2021

Lentivirus claims 2\textsuperscript{nd} place
  • Used in ex vivo gene therapy to transfec cells

Retroviral vectors also showed robust growth

Source: Pharmaprojects
Cell types used in cell therapy

T cells are top choice

Over 900 T cell-based therapeutics in development
• Includes over 700 CAR-Ts

Stem cells next most popular
• Around 450 projects
• NK cells come in third

Source: Pharmaprojects
Landmark year for Chinese pharma R&D

Phenomenal growth takes China into the big league

Chinese companies in the Top 25 companies by pipeline size for the first time

- Jiangsu Hengrui at No. 16, up from 37, with a 71% increase in pipeline size
- Shanghai Fosun at No. 23, up from 66, with a 127% increase in pipeline size
- BeiGene just outside the Top 25

China the first market for 19% of New Active Substances (NASs)

- Up from 8.5% in 2020
- Three Chinese companies delivered >1 NAS (Jiangsu Hengrui, Guangzhou Pharma, RemeGen/Rongchang)
- China-originated NASs starting to make an impact

Source: Pharmaprojects
Chinese HQed companies up nearly 50%

Now account for 12% of all R&D firms

Share leaps up from 9% in 2021
- Number of companies up by 43.3% in a single year
- 792 in 2022 vs 522 in 2021

US and Europe cede ground
- US down 2% to 44%
- Rest of Europe down 1%

Source: Pharmaprojects
Over 20% of drugs in R&D in Chinese development

Second-most important market

A fifth of drugs are now in R&D in China

• US remains way out in front
• China moves into runner-up position ahead of UK

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<th>COUNTRY</th>
<th>NO. OF DRUGS</th>
<th>% OF PIPELINE</th>
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Source: Pharmaprojects
The outlook for pharma in 2022
Notable approvals/launches in 2022 so far

Part 1

Idorsia Pharmaceuticals’ Quviviq (daridoxerant)
- Approved in the US in January for insomnia
- A dual orexin receptor antagonist
- Competition for Merck & Co's rival dual orexin receptor antagonist Belsomra

Immunocore’s Kimmtrak (tebentafusp)
- Approved in the US in January as the first drug for metastatic uveal melanoma
- First approved T-cell receptor (TCR) therapy
- Immunocore’s first approved product

Roche’s Vabysmo (farcimab)
- Approved in the US in January for wet AMD and diabetic macular edema
- Bispecific antibody targets and inhibits two disease pathways: Ang-2 and VEGF-A
- Roche is playing the cost-effectiveness card with Vabysmo cf Eylea

Source: Scrip
Sanofi’s Enjaymo (sutimlimab)
- Approved in the US in February for cold agglutinin disease
- Targets C1s and is meant to prevent destruction of red blood cells
- Sanofi acquired Enjaymo when it bought Bioverativ in 2018 for $11.6bn

Agios Pharmaceuticals’ Pyrukynd (mitapivat)
- Approved in the US in February for hemolytic anemia in adults with pyruvate kinase deficiency
- Pyruvate kinase stimulant
- Significant milestone for Agios, also in development for sickle cell and beta-thalassemia

Janssen and Legend Biotech’s Carvykti (ciltacabtagene autoleucel)
- Approved in the US in February for multiple myeloma
- CAR-T therapy that targets B-cell maturation antigen (BCMA)
- Priced at a premium to BMS/2seventy Bio’s Abecma – the first anti-BCMA CAR-T

Source: Scrip
Notable approvals/launches in 2022 so far

Part 3

CTI BioPharma’s Vonjo (pacritinib)
• Accelerated approved in the US in February for myelofibrosis
• JAK2/IRAK1 inhibitor, CTI’s first commercial product
• Unlike other JAK inhibitors, Vonjo’s label does not carry a black box warning

Bristol Myers Squibb’s Opdualag (relatlimab/nivolumab)
• Approved in the US in March for melanoma
• LAG-3 blocker relatlimab in a fixed-dose combination with Opdivo
• Third class of checkpoint inhibitor

Merck & Co/Kyorin’s Lyfnua (gefapixant)
• Approved in Japan in January for refractory or unexplained chronic cough
• P2X3 receptor antagonist
• CRL from the US FDA in January

Source: Scrip
Notable approvals/launches so far in 2022

China

**Jiangsu Hengrui Pharmaceuticals’ AiRuiKang (dalpiciclib)**
- Approved in China in January for HR+/HER2- advanced breast cancer
- First domestically developed CDK4/6 inhibitor to gain marketing approval in China
- Designed to reduce hepatotoxicity

**Jiangsu Hengrui Pharmaceuticals’ henagliflozin**
- Approved in China in January for type 2 diabetes
- Sodium-glucose transport protein 2 (SGLT2) inhibitor
- Beijing’s determination to prop up domestic pharma innovation

**Henlix Biotech’s Hansizhuang (serplulimab)**
- Launched in March for advanced unresectable or metastatic MSI-H solid tumors
- Recombinant humanized anti-PD-1 monoclonal antibody
- Innovative product among a number of biosimilars for the firm

Source: Scrip
Notable approvals/launches expected in 2022

Part 1

Gilead Sciences’ lenacapavir
- Longer-acting drug for HIV/AIDS - first-in-class HIV-1 capsid inhibitor
- Complete response letter received from the FDA - no new studies needed
- Could have use in PrEP and catalyze this market

Eli Lilly’s tirzepatide
- Filed in US and EU for type 2 diabetes in October 2021
- First glucose-dependent insulinotropic polypeptide (GIP)/GLP-1 co-agonist
- Competing against entrenched once-weekly GLP-1 agonists

Sanofi’s Xenpozyme (olipudase alfa)
- Recombinant sphingomyelinase enzyme for Niemann-Pick disease
- The only approved therapy globally for the rare genetic disorder
- Firm’s first product to be approved under Japan’s “sakigake” designation

Source: Scrip
Notable approvals/launches expected in 2022

Part 2

Roche’s mosunetuzumab
- Filed in EU and US for follicular lymphoma
- CD20 x CD3 bispecific antibody
- Breakthrough therapy designation and EU accelerated assessment

Johnson & Johnson (Janssen)’s teclistamab
- Under review for relapsed or refractory multiple myeloma
- Bispecific antibody targeting B-cell maturation antigen (BCMA) and CD3
- FDA 20 July user fee goal - breakthrough therapy designation

Bristol Myers Squibb’s mavacamten
- First-in-class cardiac myosin inhibitor for obstructive hypertrophic cardiomyopathy
- 28 April PDUFA date - breakthrough therapy designation
- Peak annual sales predicted at more than $4bn

Source: Scrip
Concluding Thoughts

**Pharma R&D seems to be going from strength to strength**
- Pipeline growth accelerated in 2022
- More drugs and companies, more diseases and targets being studied
- Record for new drug launches in a single year smashed again

**Key trends in 2021-2022**
- COVID response continued, albeit at a lower level
- Rare disease R&D booming
- Cell and gene therapy continue to be hot
- China becoming a major pharma powerhouse

**Positive outlook for 2022 as world returns to ‘normal’**
- 12 approvals for NASs to date from the FDA in Q1
- The impact of the COVID-19 era continues
Thank you for your attention

Questions?
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