



Public and philanthropic investments in AMR R&D related to fungi

- First report January 2021 -

At launch at the end of March 2020 the scope of the Dynamic Dashboard of the Global AMR R&D Hub was limited to human bacterial infections. In July 2020 the scope was expanded to animal health-related R&D addressing all microbial infectious agents. In August a representation of the human antibacterial clinical pipeline and the incentives for human antibacterial R&D were added.

A first analysis report of the data contained in the Dynamic Dashboard as at 8 September was presented in November 2020¹.

The Dynamic Dashboard now also presents projects financed by public and philanthropic funders that support human health-related AMR R&D addressing fungi. This short report provides an initial analysis of the first set of more than 1000 such projects presented in the Dynamic Dashboard.

¹ <https://globalamrhub.org/wp-content/uploads/2020/11/GlobalAMRHubReportDD.Nov2020.pdf>

The Dynamic Dashboard now includes information about AMR R&D projects not only addressing human bacterial drug resistant research, but also addressing research on drug resistant fungi in human, alongside the projects addressing animal health-related AMR R&D.

Projects addressing human fungal infections were collected by searching relevant funder databases and the UberResearch Dimensions database² by either using the set of standard search terms as described in “Dynamic Dashboard – Data collection, processing, categorization and presentation”³ or by using a fungi specific set of keywords⁴ developed by members of the Global AMR R&D Hub Secretariat in consultation with external experts.

As at 8 January 2021, \$362 million USD invested into 1047 fungal R&D projects had been captured in the Dynamic Dashboard. The majority of this investment is provided to human-related research projects (93%) (Table 1), compared to the overall investment where 89% goes towards the human sector. Relatively more funds are invested in fungal R&D projects in the human sector than in the animal sector or for projects that are cross-sectoral or where the sector is not specified. The overall set of data captured in the Dynamic Dashboard as at 8 January consisted of 9,618 projects representing a total investment of almost 7.2 billion USD (referred to as complete data set).

Table 1 - Investment (USD) and number of projects for fungi by sector compared to the complete data set

Sector	Fungi		Complete data set	
	Investment USD	Number of projects	Investment USD	Number of projects
Animal	988,096	18	511,685,856	761
Cross sector	8,343,532	11	151,404,203	251
Human	338,939,712	919	6,379,576,914	8,201
Not specified	14,184,243	99	144,109,736	405
Total	362,455,582	1,047	7,186,776,710	9,618

Note - only projects addressing AMR R&D on bacteria and fungi are currently collected for the human sector. Projects addressing all infectious agents (bacteria, viruses, parasites, fungi and other) are collected for the animal sector.

² <https://www.dimensions.ai/>

³ Dynamic Dashboard – Data collection, processing, categorization and presentation (<https://globalamrhub.org/dynamic-dashboard/library/dynamic-dashboard-data-collection-processing-categorization-and-presentation/>)

⁴ Cryptococcus, “Cryptococcus gatti”, “Aspergillus fumigatus”, “Aspergillus spp”, “Pneumocystis jirovecii”, Mucormycetes, Mucorales, “Cryptococcus neoformans”, “C. tropicalis”, “Candida tropicalis”, “Candida auris”, “C. auris”, “Candida parapsilosis”, “C. parapsilosis”, “C. glabrata”, “Candida glabrata”, “C. albicans”, “Candida albicans”, Aspergillosis, “Candida spp.”, Candidemia, Histoplasmosis, Sporothrix, Chromoblastomycosis, Coccidioides, “Fusarium solani”, “F. solani”, “F. verticillioides”, “Fusarium verticillioides”, “F. moniliforme”, “Fusarium moniliforme”, “F. proliferatum”, “Fusarium proliferatum”, “F. oxysporum”, “Fusarium oxysporum”, Blastomyces, “amphotericin B deoxycholate”, “trimethoprim/ sulfamethoxazole”, echinocandins, “liposomal amphotericin B”, “Fluconazole resistance”, “amphotericin B resistance”, “Azole-resistant”, “Azole resistance”, antimycotic, carrionii, Lomentospora, Phialophora, zygomycosis, mycetoma, pedrosoi, verrucosa, Fonsecaea, terbinafine, “C. gatti”, Scedosporium, Talaromyces, Cladosporium, mucormyc*, jirovecii, auris, Histoplasma*, Pneumocystis, amphotericin, neoformans, fumigatus, fluconazole, clotrimazole, econazole, miconazole, ketoconazole, antifungal, “fungal pathogen”, Cladophialophora, Rhizopus, Mucor, Trichophyton, Microsporium, Epidermophyton, Lichtheimia, Ascomycota, Basidiomycota



Noting there are only a small number of projects captured as at 8 January 2021 for the animal sector and cross sector projects and where the sector is not specified (18, 11 and 99, respectively) no conclusions can be drawn for these yet. In the human sector, the majority of the projects (86%) researching drug resistant fungi is focused only on fungi (Table 2).

Table 2 – Number of projects and investment in USD by sector and infectious agent

Sector	Infectious agent	Number of projects	Investment in USD
Animal	Bacteria, Fungi	2	220,816
	Bacteria, Fungi, Parasites	1	315,382
	Fungi	15	772,561
	Total	18	1,308,758
Cross sector (human and animal)	Bacteria, Fungi	1	11,966
	Bacteria, Fungi, Parasites, Virus	1	2,550,357
	Bacteria, Fungi, Virus	1	592,328
	Fungi	8	7,502,516
	Total	11	10,657,168
Human	Bacteria, Fungi	128	38,671,677
	Fungi	791	320,976,633
	Total	919	359,648,309
Not specified	Bacteria, Fungi	22	2,795,760
	Bacteria, Fungi, Parasites	1	19,880
	Fungi	76	12,808,132
	Total	99	15,623,773

RESEARCH AREAS

The research areas addressed by all fungi-related projects are compared to the research areas addressed by the projects in the complete data set (Figure 1).

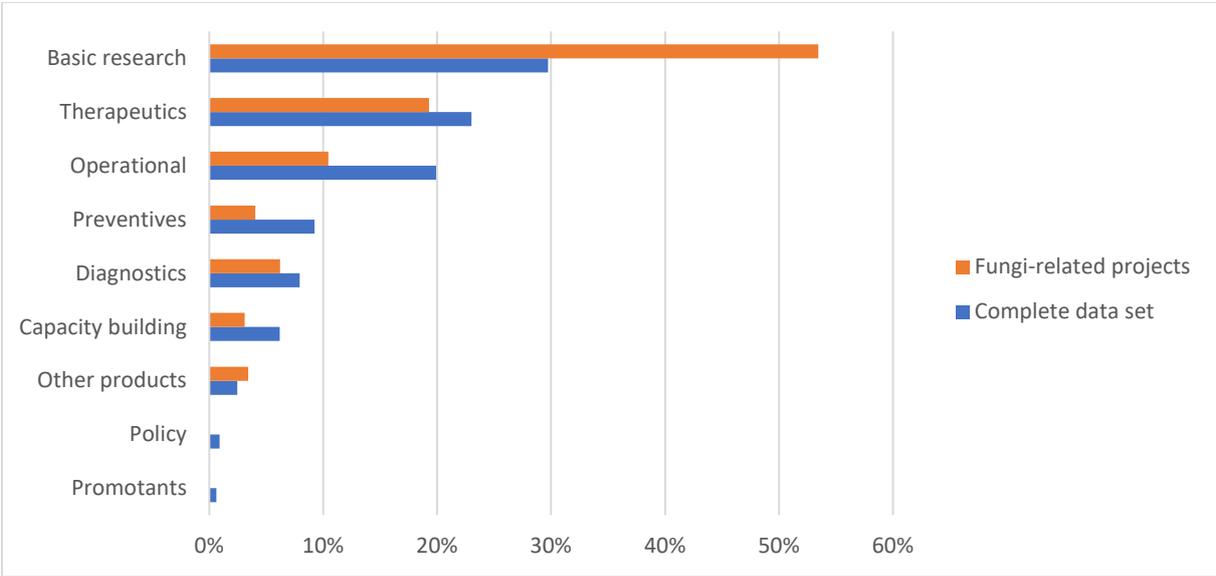


Figure 1: Comparison of % of investment going to different research areas



The majority of the investment for fungi-related projects (53%) goes towards basic research projects, compared to 30% for the complete data set. The share of investment differs also for other research areas. For example, for operational and implementation research the share of investment is 10% for fungi-related projects vs. 20% for the complete data set.

FUNDERS

The fungal R&D investment captured in the Dynamic Dashboard is from 71 different funders across 30 countries.

Funders located in the United States provided 45% of the investment into fungal R&D, followed by funders in the European Union (18%) and the United Kingdom (16%). No other country provided more than 3.2% of the total funding, each, where the combined share of all countries apart from the United States, the United Kingdom and the European Union represents 21%. Funding for AMR R&D related to fungi is thus concentrated in its origin.

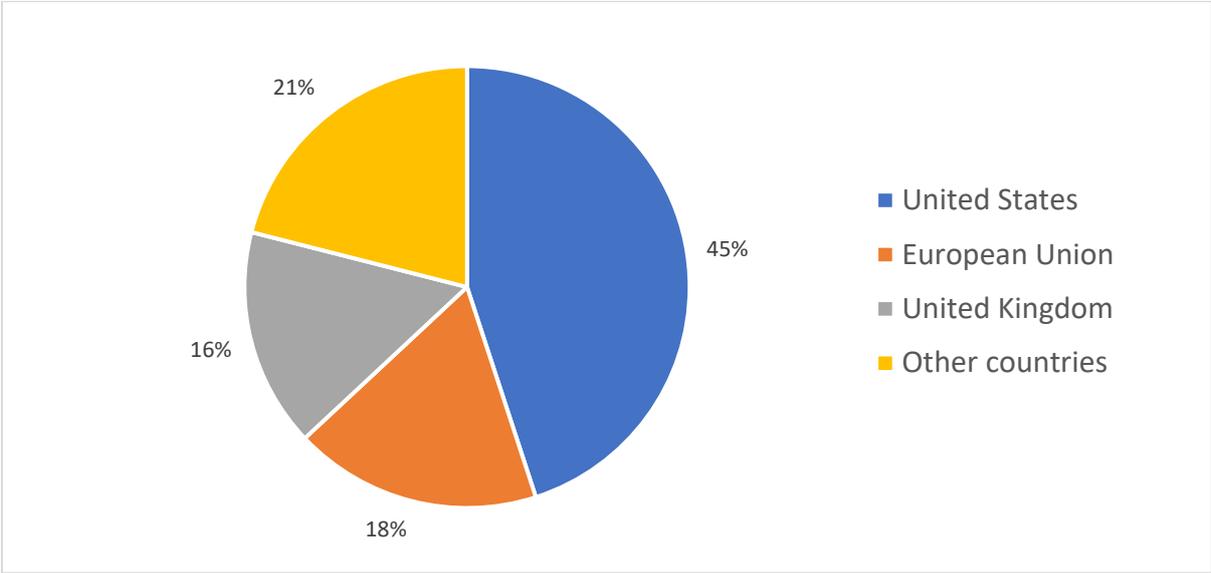


Figure 2 - Percentage of funding for fungi-related AMR R&D provided by countries/EU

Seventy-nine percent (288 million USD) of the investment from the 71 funders, captured in the Dynamic Dashboard, is provided to research organisations in the same country where the funder is located (considered domestic funding). When excluding European Union funding that is provided to research organisations in European Union countries the percentage of domestic funding increases to 97% (378 million USD).



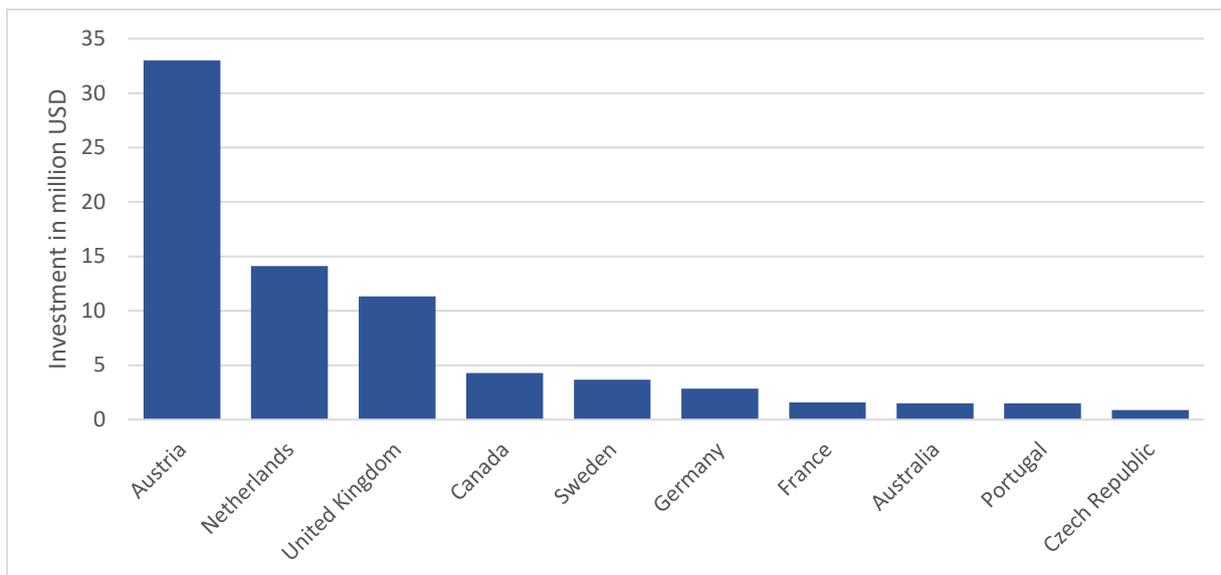


Figure 3 – Top 10 countries of RO receiving international investment, including EU funding

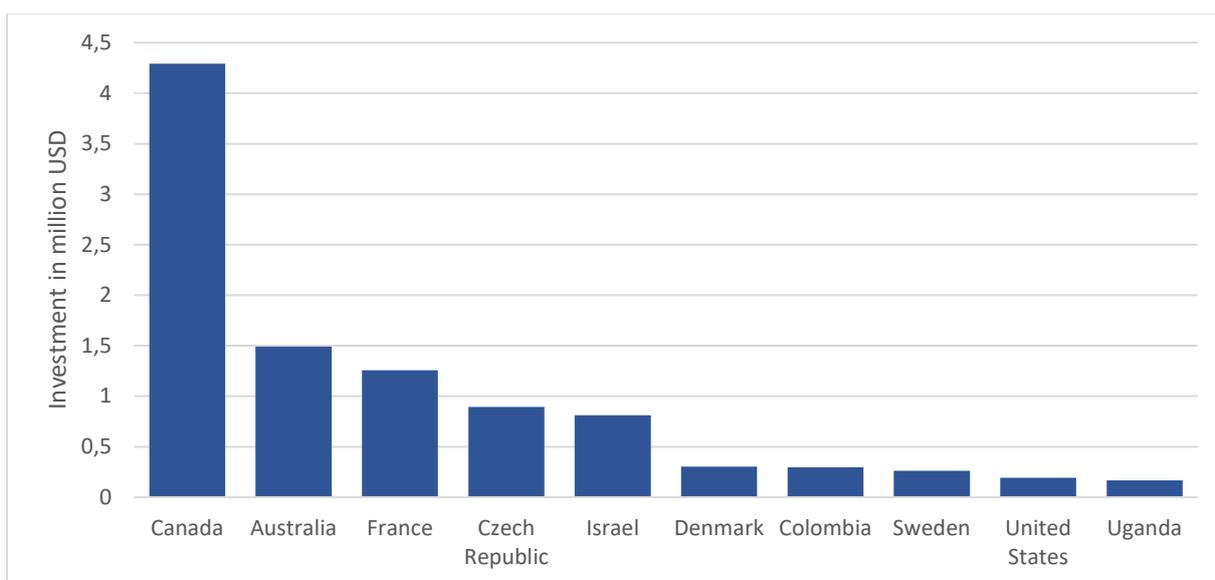


Figure 4 – Top 10 countries of RO receiving international investment, excluding EU funding to EU countries

RESEARCH ORGANISATIONS

Fungal research was funded in 462 different organisations in 35 countries. Most of these research organisations were universities (71%) followed by public research institutions / facilities (20%) (Figure 5).

Forty-four percent of the investment into fungal R&D is provided to research organisations in the United States. Research organisations in the United Kingdom and Austria received 18% and 10% of the funding respectively. No other countries received more than 4% of the overall investment each.



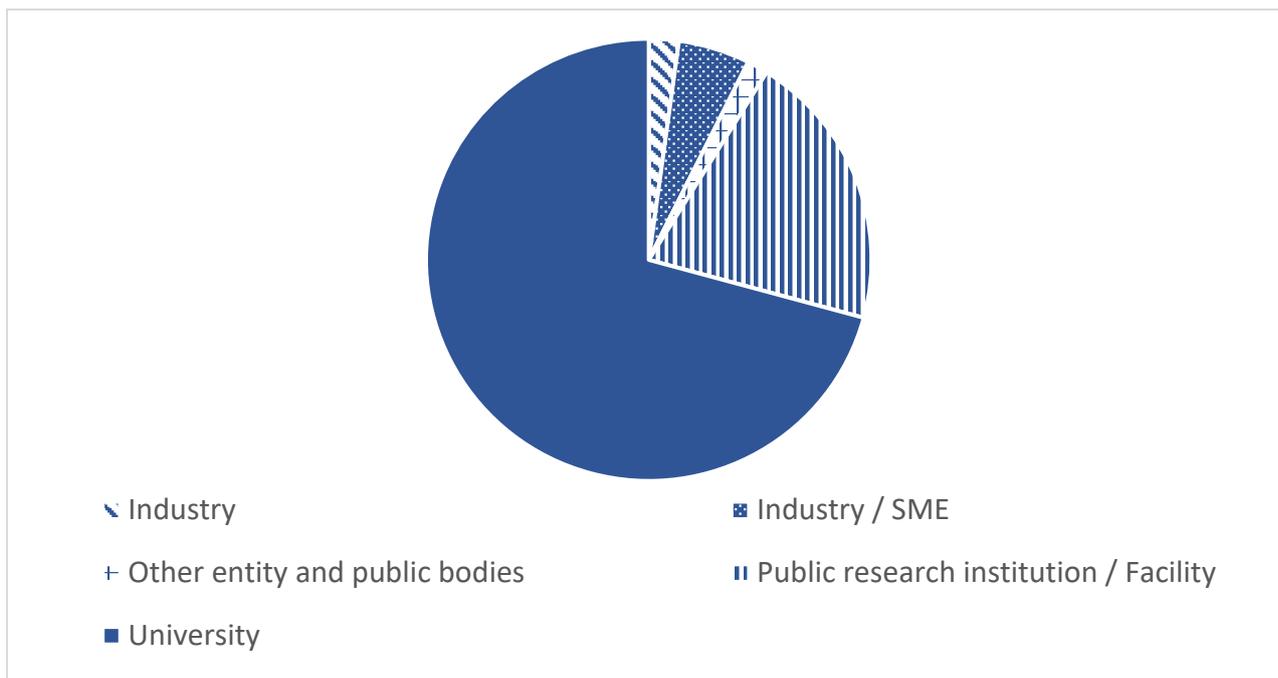


Figure 5 – Proportion of different research organisations types

Human sector only

Over half of all investment in fungal disease research in the human sector is directed towards basic research (55%). Research into fungal therapeutics received 20% of the investment, operational and implementation research 10% and research into diagnostics 6% (Figure 6).

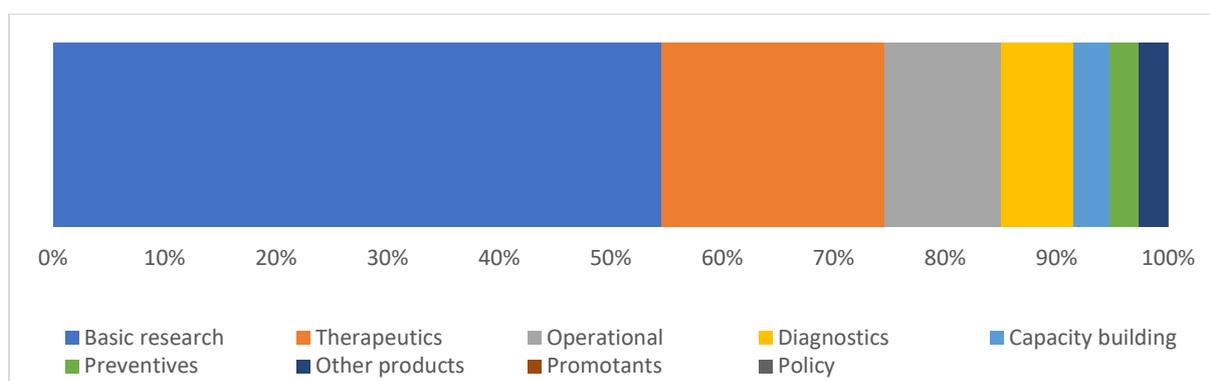


Figure 6 – Proportion of investments into fungal R&D by research area

Nearly three quarters of the \$339 million USD investment into fungal research for the human sector is directed towards research on *Candida* spp. (111 million USD), *Aspergillus* spp. (73 million USD) and *Cryptococcus* spp. (67 million USD) (Figure 7).



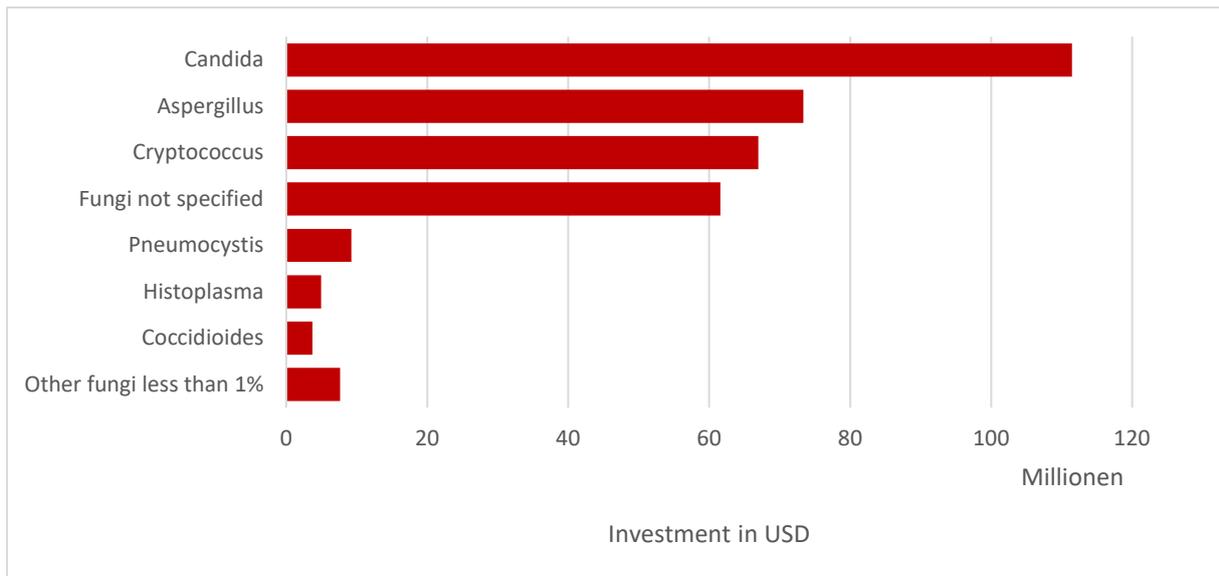


Figure 7 – Investment (millions of USD) in the human sector by fungal species where known

Candida spp.

Of the \$111 million USD invested into *Candida* spp. research, 74% is directed towards basic research. Therapeutics research received 12% of the investment, and operational and implementation research and diagnostics received 4% each (Figure 8).

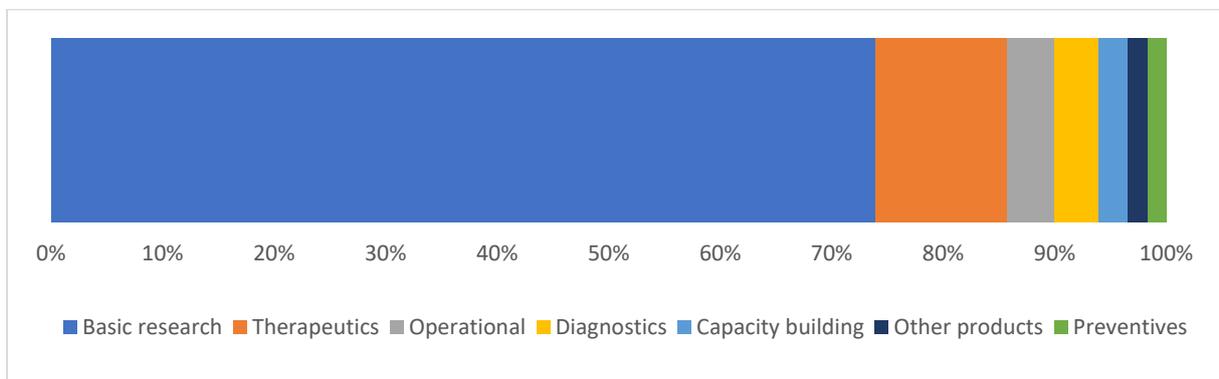


Figure 8 - Proportion of investments into *Candida* spp. R&D by research area – human sector only

Aspergillus spp.

Of the \$73 million USD invested into *Aspergillus* spp. research, 47% is going to therapeutics. Basic research received 32% of the investment, diagnostics 10% and operational and implementation research 6% (Figure 9).



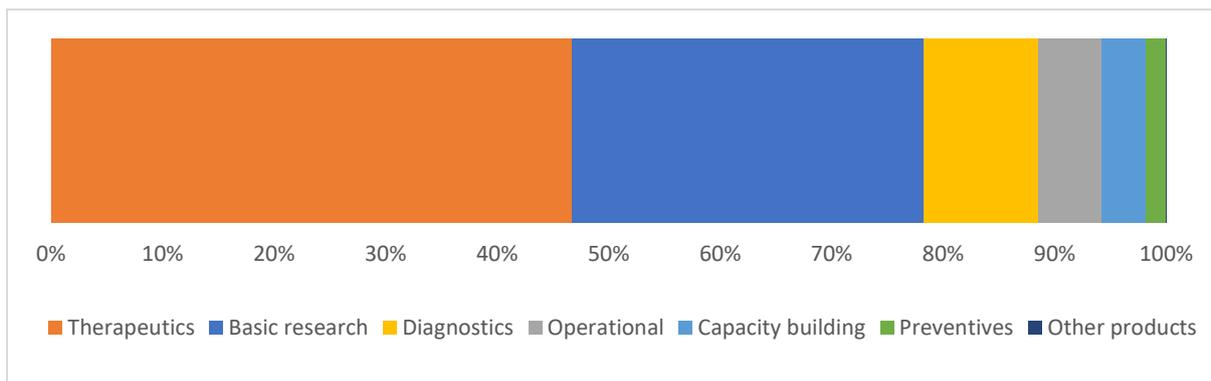


Figure 9 - Proportion of investments into *Aspergillus spp.* R&D by research area – human sector only

Cryptococcus spp.

Of the \$67 million USD invested into *Cryptococcus spp.* research, 50% is going to basic research. Operational and implementation research received 27% of the investment, therapeutics 8% and preventives and capacity building received 5% each (Figure 10).

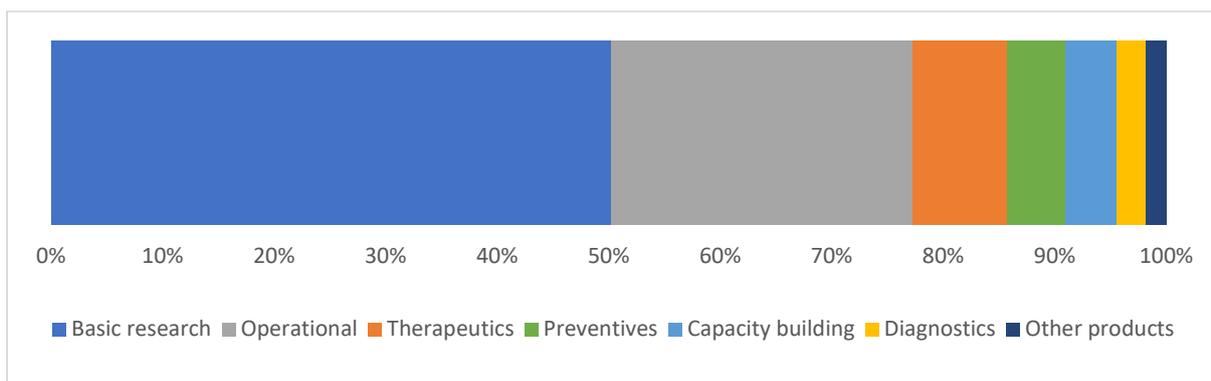


Figure 10 - Proportion of investments into *Cryptococcus spp.* R&D by research area – human sector only

PRODUCT RESEARCH AND DEVELOPMENT – HUMAN

For this analysis, product research is considered therapeutics, diagnostics and preventives. Only 14% of projects (31/919) have a product component that is in the development phase and the majority of this is for diagnostics (n=23) (Figure 11).



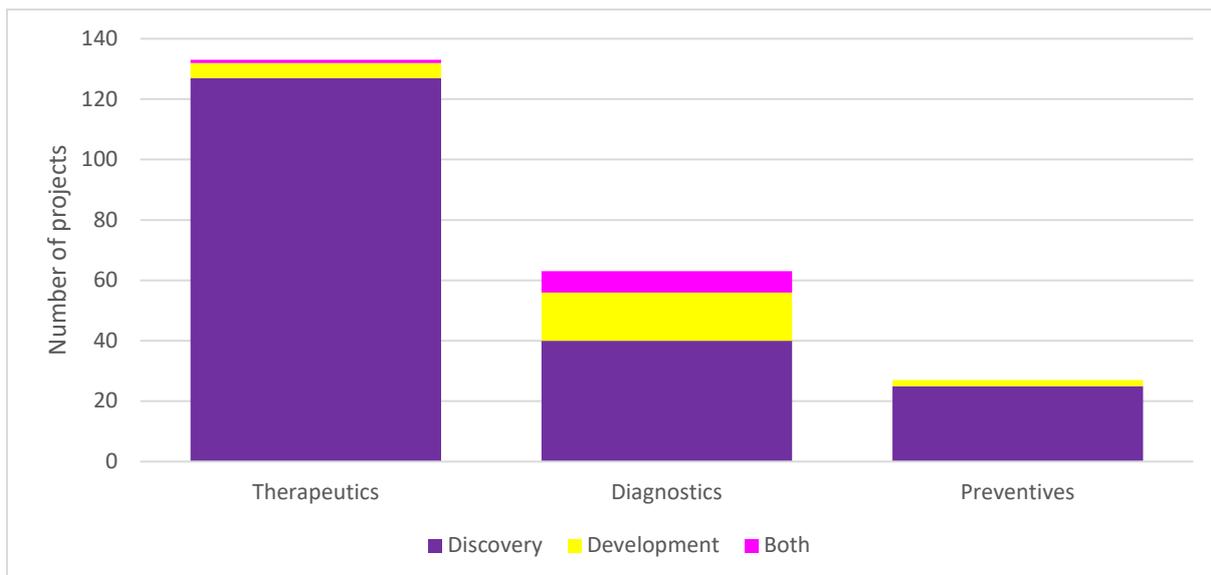


Figure 11 – R&D stage for fungal product research

Preventives

Vaccines

There are 20 projects looking to develop vaccines for human pathogenic fungi. Seven of these projects are looking to develop a vaccine for *Candida* spp. with one of these projects in combination with *Aspergillus* spp. Four projects each for *Pneumocystis* spp. and *Aspergillus* spp (noting the combined project with *Candida*), three projects for *Cryptococcus* spp, two for *Sporothrix* spp and one project where the fungal genus was not specified. There is only one vaccine project in the development phase – Vesivax® for *Aspergillus fumigatus*. The remaining 19 projects are in the discovery phase.

Interestingly, of these vaccine projects there are three projects looking to develop a vaccine for bacteria and fungi (2 include *Candida* spp and 1 is for *Aspergillus* spp as the target).

Other preventives

There are seven projects looking at using other methods/products to prevent fungal infection. All of these projects are researching the prevention of *Candida*. One of these projects in the development phase – a vaginal probiotic to prevent thrush (*Candida*) and bacterial infection. The remaining six projects are in discovery.

Therapeutics

There are 133 projects investigating therapeutics for human fungal pathogens. Of these only five projects are in the development phase and one project is in both discovery and development.

Of the projects in development, four are developing therapeutics for systemic fungal infections. These are one for *Aspergillus* and other rare molds (Olorofim), one for *Candida* (invasive and drug resistant infection including *C. auris*) and one for *Coccidioides* (systemic infection and pneumonia). The project in discovery and development is progressing BSG005 as a therapeutic for systemic fungal



infections (no further detail provided). The remaining two development projects are for a combined treatment for bacterial vaginosis and vulvovaginal candidiasis.

Over half of the 127 projects in the discovery phase are researching a therapeutic for *Candida* (n=69). There are 19 projects researching *Aspergillus* spp, 16 on *Cryptococcus* and 36 projects do not specify the fungi of interest.

Diagnostics

There are 64 projects researching diagnostics, detection or screening assays for human fungal pathogens. Of these, 47 are in the discovery phase (7 of these are in both discovery and development). Over half of these discovery projects are focused on a single fungal genus (n=25) and 14 projects are researching a diagnostic for *Aspergillus*. There are 23 projects in the development phase and as with the discovery projects over half of these are focused on one fungal genus (n=13 with 6 of these on *Candida*). There is one project in the approval & post approval stage.

