GMP Strategy

Achieve impact:
- At least 40% decrease in mortality rate & case incidence
- Elimination in ≥10 countries by 2020
- No re-establishment

I. In collaboration with the malaria community, address key strategic questions related to malaria control and elimination

II. Set, communicate & disseminate evidence-based normative guidance, policy advice and implementation guidance to support country action

III. Coordinate WHO capacity building & technical support to member states, jointly with Regions, ISTs and countries

IV. Help countries develop & implement robust surveillance systems to generate quality data and use that data to achieve greater impact

Global Malaria Programme

World Health Organization

WORLD MALARIA REPORT 2017

20 NOVEMBER 2017
KEY MESSAGES
Independent score of global progress: are we on track?

WORLD MALARIA REPORT 2017

29 NOVEMBER 2017

KEY MESSAGES
Number of malaria cases, 2016

### TABLE 6.1.

**Estimated malaria cases, 2010–2016** Estimated cases are shown with 95% upper and lower confidence intervals. *Source: WHO estimates*

<table>
<thead>
<tr>
<th></th>
<th>Number of cases (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower 95% CI</strong></td>
<td>218 000</td>
</tr>
<tr>
<td><strong>Estimated total</strong></td>
<td>237 000</td>
</tr>
<tr>
<td><strong>Upper 95% CI</strong></td>
<td>278 000</td>
</tr>
</tbody>
</table>

**Estimated *P. vivax***

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower 95% CI</strong></td>
<td>10 490</td>
<td>11 170</td>
<td>9 930</td>
<td>6 800</td>
<td>6 440</td>
<td>6 060</td>
<td>6 420</td>
</tr>
<tr>
<td><strong>Estimated total</strong></td>
<td><strong>15 860</strong></td>
<td><strong>14 730</strong></td>
<td><strong>13 200</strong></td>
<td><strong>10 250</strong></td>
<td><strong>8 750</strong></td>
<td><strong>8 160</strong></td>
<td><strong>8 550</strong></td>
</tr>
<tr>
<td><strong>Upper 95% CI</strong></td>
<td>21 680</td>
<td>19 630</td>
<td>18 000</td>
<td>14 600</td>
<td>11 520</td>
<td>10 640</td>
<td>11 140</td>
</tr>
</tbody>
</table>
Number of malaria cases worldwide, 2000-2016

Cases

### Table 6.2.

**Estimated malaria cases by WHO region, 2016**  
Estimated cases are shown with 95% upper and lower confidence intervals (CI). *Source: WHO estimates*

<table>
<thead>
<tr>
<th></th>
<th>African (000's)</th>
<th>Americas</th>
<th>Eastern Mediterranean</th>
<th>South-East Asia (000's)</th>
<th>Western Pacific</th>
<th>World (000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower 95% CI</strong></td>
<td>176 000</td>
<td>665</td>
<td>3600</td>
<td>10 900</td>
<td>1200</td>
<td>198 000</td>
</tr>
<tr>
<td><strong>Estimated total</strong></td>
<td>194 000</td>
<td>875</td>
<td>4300</td>
<td>14 600</td>
<td>1600</td>
<td>216 000</td>
</tr>
<tr>
<td><strong>Upper 95% CI</strong></td>
<td>242 000</td>
<td>1190</td>
<td>5900</td>
<td>19 800</td>
<td>2100</td>
<td>265 000</td>
</tr>
</tbody>
</table>

**Estimated *P. vivax***

<table>
<thead>
<tr>
<th></th>
<th>African (000's)</th>
<th>Americas</th>
<th>Eastern Mediterranean</th>
<th>South-East Asia (000's)</th>
<th>Western Pacific</th>
<th>World (000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower 95% CI</strong></td>
<td>182</td>
<td>405</td>
<td>1360</td>
<td>3280</td>
<td>214</td>
<td>6430</td>
</tr>
<tr>
<td><strong>Estimated total</strong></td>
<td>859</td>
<td>556</td>
<td>1790</td>
<td>4960</td>
<td>385</td>
<td>8550</td>
</tr>
<tr>
<td><strong>Upper 95% CI</strong></td>
<td>2090</td>
<td>786</td>
<td>2340</td>
<td>7234</td>
<td>592</td>
<td>11 140</td>
</tr>
<tr>
<td><strong>Proportion of <em>P. vivax</em> cases</strong></td>
<td>0.4%</td>
<td>64%</td>
<td>42%</td>
<td>34%</td>
<td>24%</td>
<td>4%</td>
</tr>
</tbody>
</table>
TABLE 6.4.
Estimated number of malaria deaths by WHO region, 2010–2016

Source: WHO estimates

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>African</td>
<td>538,000</td>
<td>484,000</td>
<td>445,000</td>
<td>430,000</td>
<td>423,000</td>
<td>409,000</td>
<td><strong>407,000</strong></td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>7,200</td>
<td>7,100</td>
<td>7,700</td>
<td>7,800</td>
<td>7,800</td>
<td>7,600</td>
<td>8,200</td>
</tr>
<tr>
<td>European</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Americas</td>
<td>830</td>
<td>790</td>
<td>630</td>
<td>620</td>
<td>420</td>
<td>450</td>
<td>650</td>
</tr>
<tr>
<td>South-East Asia</td>
<td>41,700</td>
<td>34,000</td>
<td>29,000</td>
<td>22,000</td>
<td>25,000</td>
<td>26,000</td>
<td>27,000</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>3,800</td>
<td>3,300</td>
<td>4,000</td>
<td>4,300</td>
<td>2,900</td>
<td>2,600</td>
<td>3,300</td>
</tr>
<tr>
<td>World</td>
<td>591,000</td>
<td>529,000</td>
<td>487,000</td>
<td>465,000</td>
<td>459,000</td>
<td>446,000</td>
<td><strong>445,000</strong></td>
</tr>
</tbody>
</table>
Number of malaria deaths worldwide, 2000-2016

Deaths
Decreases and increases in cases >20%, 2015-2016

<table>
<thead>
<tr>
<th>Region</th>
<th>&gt;20% decrease, 2015–2016</th>
<th>&gt;20% increase, 2015–2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEAR</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>WPR</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>EMR</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>AFR</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>AMR</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: WHO estimates
AFR, WHO African Region; AMR, WHO Region of the Americas; EMR, WHO Eastern Mediterranean Region; SEAR, WHO South-East Asia Region; WPR, WHO Western Pacific Region
High-burden countries (300,000 cases or more) with a change in cases of at least 50,000 from 2015-2016

FIG. 6.4.
Differences in malaria cases in 2015 and 2016 in countries with more than 300,000 malaria cases in 2015. Positive values indicate an increase, and negative values indicate a decrease. Source: WHO estimates.

- Rwanda
- Nigeria
- Democratic Republic of the Congo
- Papua New Guinea
- Niger
- Mali
- United Republic of Tanzania
- Mozambique
- Burkina Faso
- Ghana
- Uganda
- Afghanistan
- Guinea
- Pakistan
- Côte d’Ivoire
- Malawi
- Yemen
- Cameroon
- South Sudan
- Zambia
- Mauritania
- Togo
- Kenya
- Chad
- Gambia
- Ethiopia
- Zimbabwe
- Senegal
- Madagascar

Decrease ➡ Increase ↩
FIG. 6.2.
Estimated country share of total malaria cases, 2016 Source: WHO estimates

- Nigeria: 27%
- Democratic Republic of the Congo: 20%
- India: 10%
- Mozambique: 6%
- Ghana: 4%
- Mali: 4%
- Burkina Faso: 4%
- Niger: 4%
- Uganda: 4%
- United Republic of Tanzania: 4%
- Cameroon: 4%
- Côte d’Ivoire: 3%
- Guinea: 3%
- Rwanda: 2%
- Malawi: 2%
- Others: 2%
Malaria mortality by country, 2016

**FIG. 6.7.**
Proportion of estimated malaria deaths attributable to the 15 countries with nearly 80% of malaria deaths globally in 2016  
*Source: WHO estimates*
Number of countries that were endemic in 2000 with <10,000 malaria cases in 2010 and 2016, by WHO region

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of countries with &lt;10,000 cases in 2010</th>
<th>Number of countries with &lt;10,000 cases in 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>37</td>
<td>44</td>
</tr>
<tr>
<td>AMR</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>EUR</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>AFR</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>SEAR</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>WPR</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>EMR</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

AFR, WHO African Region; AMR, WHO Region of the Americas; EMR, WHO Eastern Mediterranean Region; EUR, WHO European Region; SEAR, WHO South-East Asia Region; WPR, WHO Western Pacific Region

Source: National malaria control programme reports
Malaria funding, 2010-2016 – source

FIG. 2.1.
Investments in malaria control and elimination by source of funds\(^3\) (constant 2016 US$), 2010–2016

- Governments of endemic countries
- USA
- UK
- France, Germany, Japan
- Other funders

US$ (billion)

Global Malaria Programme
Malaria funding in 41 high-burden countries

Fig. 8.2.
Percentage change in average of funding (US$) per capita population at risk in 2011–2013 and 2014–2016 in 41 high burden countries. Sources: ForeignAssistance.gov; Global Fund to Fight AIDS, Tuberculosis and Malaria; national malaria control programmes; Organisation for Economic Co-operation and Development creditor reporting system; the World Bank Data Bank; Department for International Development.
Coverage of insecticide-treated nets (ITNs) in sub-Saharan Africa, 2010-2016

FIG. 3.1.
Proportion of population at risk with access to an ITN and sleeping under an ITN, and proportion of households with at least one ITN and enough ITNs for all occupants, sub-Saharan Africa, 2010–2016

Source: Insecticide-treated mosquito net coverage model from Malaria Atlas Project®

Households with at least one ITN
Households with enough ITNs for all occupants
Population with access to an ITN in household
Population sleeping under an ITN

ITN, insecticide-treated mosquito net
Population protected by indoor residual spraying (IRS), 2010-2016

People at risk of malaria protected by IRS:
- **2010**: 180 million
- **2016**: 100 million
Intermittent preventive treatment of malaria in pregnancy (IPTp) in sub-Saharan Africa, 2010-2016

Figure 3.7
Proportion of pregnant women attending ANC at least once and receiving IPTp, by dose, sub-Saharan Africa, 2010–2016
Source: National malaria control programme reports

ANC, antenatal care; IPT, intermittent preventive treatment in pregnancy
In 2016, 15 million children in 12 countries protected by SMC leaving a coverage gap of 13 million children.
FIG. 4.1.
Proportion of febrile children for whom care was sought, by health sector, sub-Saharan Africa, 2014–2016
Sources: Nationally representative household survey data from demographic and health surveys, and malaria indicator surveys
In many countries with a high malaria burden, health systems remain under-resourced.

- **43%** People not covered by ITNs or IRS
- **69%** Pregnant women not receiving 3 doses of
- **36%** Children with fever not taken for care
The challenges: insecticide resistance

FIG. 8.8.
Reported pyrethroid resistance status of malaria vectors measured with insecticide bioassays, 2010–2016 Data are from standard WHO insecticide susceptibility or Centers for Disease Control and Prevention (CDC) bottle bioassays. Where multiple insecticide classes or types, mosquito species or time points were tested, the most recent resistance status is shown. Sources: National malaria control programme reports, African Network for Vector Resistance, Liverpool School of Tropical Medicine, Malaria Atlas Project, US President’s Malaria Initiative and scientific publications.
The challenges: insecticide resistance

- Mosquito resistance to at least one insecticide reported from 60 countries
- A WHO-coordinated 5-country evaluation showed that ITNs still remained effective
The challenges: drug resistance

- The colour scale in the map denotes the number of ACTs that have failed across the subregion.
- Currently, the first-line treatments in all 5 countries are efficacious.
Conclusion 1

We are not on track to meet the 2020 morbidity and mortality targets

The world increasingly divided into 2 distinct groups
Conclusion 2

New challenges and opportunities in estimating burden of disease
Transitioning from modelling to use of routine data

Number of persons tested, household surveys vs routine data, SSA

921 million vs 1.7 million tests between 2006 and 2016
### TABLE 6.3.
Cases estimated using: parasite rate-to-incidence model (current WHO approach); cases confirmed in the public health sector; and cases confirmed in the public health sector, adjusted for confirmation, reporting and treatment seeking rates

Source: National malaria control programme reports and WHO estimates

<table>
<thead>
<tr>
<th>Country</th>
<th>Method I: Parasite-to-incidence model (current WHO approach)</th>
<th>Method II: Confirmed cases in the public health sector</th>
<th>Method III: Cases confirmed in the public health sector, adjusted for confirmation, reporting and treatment seeking rates</th>
<th>Ratio of cases (Method I:Method III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>3,465,156</td>
<td>3,794,253</td>
<td>7,369,301</td>
<td>0.47</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>7,892,794</td>
<td>9,779,154</td>
<td>17,751,661</td>
<td>0.44</td>
</tr>
<tr>
<td>Burundi</td>
<td>1,643,872</td>
<td>8,274,062</td>
<td>15,468,564</td>
<td>0.11</td>
</tr>
<tr>
<td>Guinea-Bissau</td>
<td>132,566</td>
<td>150,903</td>
<td>253,423</td>
<td>0.52</td>
</tr>
<tr>
<td>Kenya</td>
<td>3,519,272</td>
<td>2,783,846</td>
<td>9,583,406</td>
<td>0.37</td>
</tr>
<tr>
<td>Liberia</td>
<td>1,093,659</td>
<td>1,191,137</td>
<td>4,659,583</td>
<td>0.23</td>
</tr>
<tr>
<td>Malawi</td>
<td>4,506,310</td>
<td>4,827,373</td>
<td>9,890,653</td>
<td>0.46</td>
</tr>
<tr>
<td>Mozambique</td>
<td>8,872,978</td>
<td>8,520,376</td>
<td>14,503,748</td>
<td>0.61</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>2,244,481</td>
<td>1,775,306</td>
<td>2,977,452</td>
<td>0.75</td>
</tr>
<tr>
<td>United Republic of Tanzania</td>
<td>6,880,659</td>
<td>5,193,520</td>
<td>10,865,481</td>
<td>0.63</td>
</tr>
<tr>
<td>Uganda</td>
<td>7,768,405</td>
<td>9,385,132</td>
<td>31,288,839</td>
<td>0.25</td>
</tr>
<tr>
<td>Zambia</td>
<td>3,148,638</td>
<td>4,851,319</td>
<td>8,541,200</td>
<td>0.37</td>
</tr>
<tr>
<td>Total</td>
<td>51,166,610</td>
<td>60,526,361</td>
<td>133,153,311</td>
<td>0.36</td>
</tr>
</tbody>
</table>
Challenges in improving mortality estimates: severe malaria, direct and indirect mortality
What are the implications?

How do we get back on track to meet the GTS morbidity and mortality 2020 / 2025 targets?
Assumptions for the next five years

• Challenging financial landscape
• Unlikely to see new transformative tools
• Malaria can be diagnosed and is entirely treatable. No one should be dying of malaria
• Malaria deaths are not evenly distributed
• Status quo is not an option
API in India, 2016

Contributes to >62% of cases outside Africa


U5M (surveys in 32 countries)  PfPR (surveys in 22 countries)
11 countries contribute to 71% of cases and 70% of deaths globally
The 10 + 1 Initiative

- Non-malaria endemic
- Endemic
- Ten plus 1
Rationale for focusing on 10+1

All the 10 countries in sub-Saharan Africa had an increase in estimated case incidence in 2016 compared to 2015.
Response elements (tiers)

1. Political and financial dialogue, advocacy, and resource mobilization
2. Improved technical guidance on policies and strategies adaptable to the country situations
3. Intensified technical support to countries to prioritize interventions for impact
4. Country action
The elimination countries
• E-2020 – Initiative launched in 2017
• Annual Forum in Costa Rica in June 2018
• Regional focal points in five Regions
Mekong Malaria Elimination Programme
Progress in malaria elimination in the GMS

Malaria cases in GMS countries

Malaria deaths in GMS countries

Global Malaria Programme
Epidemiology of malaria in the GMS (2017)

Regional Map of Confirmed Cases by State/Province

Annual Parasite Incidence (API) by District*

Source: WHO subregional database

*Provincial levels in Viet Nam and Thailand; State/Region level in Myanmar
GMP strategy refresh - core roles

1. In collaboration with the malaria community, address key strategic questions related to malaria control and elimination.

2. Set, communicate & disseminate evidence-based normative guidance, policy advice and implementation guidance to support country action.

3. Coordinate WHO capacity building & technical support to member states, jointly with Regions, ISTs and countries.

4. Help countries develop & implement robust surveillance systems to generate quality data and use that data to achieve greater impact.

5. Keep an independent score of global progress in malaria control and elimination, including drug & insecticide resistance.

Achieve impact:
- At least 40% decrease in mortality rate & case incidence
- Elimination in ≥10 countries by 2020
- No re-establishment

Global Malaria Programme
Normative and policy-making process

Pre-submission package for vector control product submitted to WHO

WHO Pre-submission Coordination Committee determines product pathway

- Product class WITH a WHO policy recommendation
- Product class WITHOUT a WHO policy recommendation

Prequalification Pathway (see Fig. 3)

New Intervention Pathway (See Fig. 4)

Product prequalified by WHO (WHO-PQT)

Post-prequalification activities* (WHO-PQT)
Key products

**October 2017**

- Rectal artesunate for pre-referral treatment of severe malaria

**December 2017**

- Data requirements and methods to support the evaluation of new vector control products
- WHO external quality assurance scheme for malaria nucleic acid amplification testing
  
  **Operational Manual**
  
  Version 1.0
  
  1 December 2017

**January 2018**

- Countries of the Greater Mekong making inroads in the race towards elimination

**April 2018**

- Protocol for estimating the prevalence of pfhrp2/pfhrp3 gene deletions among symptomatic falciparum patients with false-negative RDT results

- Recommended selection criteria for procurement of malaria rapid diagnostic tests
GMP strategy refresh - core roles

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Achieve impact:
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V. Keep an independent score of global progress in malaria control and elimination, including drug & insecticide resistance.
Malaria in complex situations

- WHO malaria response in Venezuela, Nigeria, South Sudan and Yemen
Malaria in complex situations

Venezuela

**FIG. 8.5.**
Malaria cases in the Bolivarian Republic of Venezuela, 2010–2016
Sources: National malaria control programme reports and WHO estimates

Number of malaria cases

- 240,613

Malaria in complex situations

Yemen

FIG. 8.4.
Malaria cases in Yemen, 2010–2016 Sources: WHO estimates
Malaria in the current areas of food insecurity

Malaria transmission seasons

First month of season
- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December
- All-year transmission

Last month of season

IDP and Refugee locations in areas of malaria transmission
Custom tailored response

- Analytical framework to estimate potential impact
- Use of evidence based malaria tools and strategies
- Support to the WHE
- Integration and use of delivery platforms
Planned WHO response to excess all-cause child mortality caused by malaria, malnutrition and other comorbidities in South Sudan

Malaria emergency response interventions:
Strengthening the NMCP through financial and technical support to stratify and deliver:

1. Securing supplies to health facilities remaining functional
2. Include malaria into activities of mobile WFP-UNICEF-FAO Integrated Rapid Response Mechanism to highest risk groups of malaria and malnutrition including age-targeted MDA and LLIN distribution during food distributions
GMP strategy refresh - core roles

I. In collaboration with the malaria community, address key **strategic questions** related to malaria control and elimination

II. Set, communicate & disseminate evidence-based **normative guidance**, policy advice and implementation guidance to support country action

III. **Achieve impact**:
- At least 40% decrease in mortality rate & case incidence
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IV. Help countries develop & implement robust **surveillance** systems to generate quality data and use that data to achieve greater impact

V. Keep an **independent score** of global progress in malaria control and elimination, including **drug & insecticide resistance**
GMP strategy refresh - core roles

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Strategic Advisory Group on malaria eradication

- Purpose of the SAGme:
  - Analyze future scenarios for malaria
    - Biological, technical, socioeconomic, political and environmental determinants
    - Potential products of innovation
  - Provide advice to WHO on the feasibility, expected cost and potential strategies of malaria eradication over the ensuing decades

- Meetings in August 2016, February and November 2017
- Subgroup meeting in June 2018
- Likely final meeting in Q4 2018
RTS,S Malaria Vaccine Implementation Programme (MVIP)

- RTS,S/AS01 Phase 3 trial
  - 15,499 children, 11 sites, 7 African countries
- Children 5-17 months, 4 doses over 4 years:
  - 39% reduction in clinical malaria,
  - 31% reduction in severe malaria
  - 62% reduction severe malaria anaemia
  - 29% reduction blood transfusions
Indicative timeline to start vaccination in first country

<table>
<thead>
<tr>
<th>2018</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
</tr>
</thead>
</table>

**Cross-cutting**
- Funding avail to WHO
- AVAREF meeting
- NRA review
- NRA decision
- MVIP area randomization

**Regulatory**
- MOH intro plan and budget
- WHO ERB approval
- Country protocol
- Ethical review
- Cold chain, waste management upgrades
- Vaccine pack.
- Vaccine ship.
- Customs/delivery
- Injection supplies ship/delivery

**Vaccine intro/supply**
- Intro prep/operational planning, including supply & logistics
- Preparations
- SOP/prep and monitoring set up
- SOP/prep and hosp strengthening
- Baseline household survey
- Community-based monitoring operational
- Sent. Hosp. baseline
- Ongoing PV strengthening and AEFI surveillance

**Pilot evaluations**
- Eval partner agreement
- Sent Hosp selected
- Sent Hosp baseline

**GSK PAP**
- Phase 4 study

**Malaria Vaccine Implementation Programme**
- Phase 4 baseline PV study

All components need to be ready for vaccination to begin.

Feasibility
- Ongoing PV strengthening and AEFI surveillance

Impact
- Phase 4 baseline PV study

Safety surveillance
- Ongoing PV strengthening and AEFI surveillance

Phase 4 study
- Ongoing PV strengthening and AEFI surveillance
Ruth Nussenzweig was born in 1928 in Vienna. In 1939, her family fled to Brazil. After graduating in Medicine from the University of Sao Paulo, Nussenzweig dedicated herself to research, most of it carried at New York University.

In 1967, she provided the first evidence that protection against Plasmodium falciparum stages of malaria existed and that it could be extremely effective at inhibiting parasite infection; that it was mediated by adaptive immune responses specific for parasite antigens such as the CS protein and that it could be mimicked at least in part by immunization with sub-unit vaccines.

She published more than 200 scientific papers in her lifetime, most recently coauthoring a study in Scientific Reports on vaccines against Plasmodium vivax in January of this year.
Thank you