

# Package ‘optimalFlowData’

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**Type** Package

**Title** optimalFlowData

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**Description**

Data files used as examples and for testing of the software provided in the optimalFlow package.

**License** Artistic-2.0

**Encoding** UTF-8

**LazyData** true

**Depends** R (>= 4.0)

**Suggests** knitr, BiocStyle, rmarkdown, magick

**VignetteBuilder** knitr

**biocViews** ExperimentData, PackageTypeData, ImmunoOncologyData,  
FlowCytometryData

**RoxygenNote** 7.1.0

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---

buildDatabase	<i>buildDatabase</i>
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---

**Description**

Constructs a subset of the cell types and cytometries in `optimalFlowData` in order to be used as a database.

**Usage**

```
buildDatabase(dataset_names, population_ids)
```

**Arguments**

`dataset_names` A vector of strings with the names of the cytometries, ranging in `c("Cytometry1", ..., "Cytometry40")`.  
`population_ids` A vector of strings with the names of the cell types to be selected in each cytometry.

**Value**

A list where each element is a cytometry containing only the cell types given by `population_ids`.

**Examples**

```
database <- buildDatabase(
  dataset_names = paste0('Cytometry', c(2:5, 7:9, 12:17, 19, 21)),
  population_ids = c('Monocytes', 'CD4+CD8-', 'Mature SIg Kappa', 'TCRgd-'))
```

---

<code>cytometry.diagnosis</code>	<i>cytometry.diagnosis</i>
----------------------------------	----------------------------

---

**Description**

A list of abbreviations corresponding to the diagnosis for each cytometry in `optimalFlowData`. Diagnosis abbreviations correspond to: Healthy Diagnosis, Mantle Cell Lymphoma, Follicular Lymphoma, Lymphoplasmacytic Lymphoma, Chronic Lymphocytic Leukemia, Diffuse Large B-Cell Lymphoma and Hairy Cell Leukemia.

**Usage**

```
data("cytometry_diagnosis")
```

**Format**

A list of 40 diagnosis.

**Examples**

```
data(cytometry.diagnosis)
print(cytometry.diagnosis)
```

---

Cytometry1

*Cytometry1*


---

**Description**

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

**Usage**

```
data("Cytometry1")
```

**Format**

A data frame with 82810 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:PO-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) an vector of cell types (strings).

**Source**

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

**Examples**

```
data(Cytometry1)
head(Cytometry1)
```

---

Cytometry10

*Cytometry10*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry10")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:PO-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry10)  
head(Cytometry10)
```

---

Cytometry11

*Cytometry11*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry11")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry11)  
head(Cytometry11)
```

---

Cytometry12

*Cytometry12*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry12")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry12)  
head(Cytometry12)
```

---

Cytometry13

*Cytometry13*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry13")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry13)  
head(Cytometry13)
```



---

Cytometry14

*Cytometry14*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry14")
```

### Format

A data frame with 154882 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry14)
head(Cytometry14)
```

---

Cytometry15

*Cytometry15*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry15")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:PO-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry15)  
head(Cytometry15)
```

---

Cytometry16

*Cytometry16*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry16")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry16)  
head(Cytometry16)
```

---

Cytometry17

*Cytometry17*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry17")
```

### Format

A data frame with 252425 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry17)  
head(Cytometry17)
```

---

Cytometry18

*Cytometry18*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry18")
```

### Format

A data frame with 200675 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry18)  
head(Cytometry18)
```

---

Cytometry19

*Cytometry19*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry19")
```

### Format

A data frame with 100600 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry19)  
head(Cytometry19)
```

---

Cytometry2

*Cytometry2*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry2")
```

### Format

A data frame with 140753 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:PO-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry2)
head(Cytometry2)
```

---

Cytometry20

*Cytometry20*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry20")
```

### Format

A data frame with 200925 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry20)
head(Cytometry20)
```



---

Cytometry21

*Cytometry21*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry21")
```

### Format

A data frame with 254450 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry21)
head(Cytometry21)
```

---

Cytometry22

*Cytometry22*

---

### Description

A simulated flow cytometry dataset, as a data frame, of an individual with a Mantle Cell Lymphoma based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry22")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry22)
head(Cytometry22)
```

---

Cytometry23

*Cytometry23*

---

### Description

A flow cytometry dataset, as a data frame, of an individual with a Mantle Cell Lymphoma taken following Euroflow protocols.

### Usage

```
data("Cytometry23")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry23)  
head(Cytometry23)
```

---

Cytometry24

*Cytometry24*

---

### Description

A simulated flow cytometry dataset, as a data frame, of an individual with a Follicular Lymphoma based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry24")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry24)
head(Cytometry24)
```

---

Cytometry25

*Cytometry25*

---

### Description

A simulated flow cytometry dataset, as a data frame, of an individual with a Mantle Cell Lymphoma based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry25")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry25)  
head(Cytometry25)
```

---

Cytometry26

*Cytometry26*

---

### Description

A simulated flow cytometry dataset, as a data frame, of an individual with a Lymphoplasmacytic Lymphoma based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry26")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry26)
head(Cytometry26)
```

---

Cytometry27

*Cytometry27*

---

### Description

A simulated flow cytometry dataset, as a data frame, of an individual with a Chronic Lymphocytic Leukemia based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry27")
```

### Format

A data frame with 300000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry27)
head(Cytometry27)
```

---

Cytometry28

*Cytometry28*

---

### Description

A simulated flow cytometry dataset, as a data frame, of an individual with a Chronic Lymphocytic Leukemia based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry28")
```

### Format

A data frame with 300000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry28)
head(Cytometry28)
```



---

Cytometry29

*Cytometry29*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry29")
```

### Format

A data frame with 300000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry29)
head(Cytometry29)
```

---

Cytometry3

*Cytometry3*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry3")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry3)
head(Cytometry3)
```

---

Cytometry30

*Cytometry30*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry30")
```

### Format

A data frame with 236886 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry30)
head(Cytometry30)
```

---

Cytometry31

*Cytometry31*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry31")
```

### Format

A data frame with 229216 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry31)
head(Cytometry31)
```

---

Cytometry32

*Cytometry32*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry32")
```

### Format

A data frame with 260598 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry32)
head(Cytometry32)
```

---

Cytometry33

*Cytometry33*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry33")
```

### Format

A data frame with 135798 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry33)  
head(Cytometry33)
```

---

Cytometry34

*Cytometry34*

---

### Description

A simulated flow cytometry dataset, as a data frame, of an individual with Diffuse Large B-Cell Lymphoma based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry34")
```

### Format

A data frame with 300000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry34)
head(Cytometry34)
```

---

Cytometry35

*Cytometry35*

---

### Description

A simulated flow cytometry dataset, as a data frame, of an individual with a Hairy Cell Leukemia based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry35")
```

### Format

A data frame with 213720 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry35)  
head(Cytometry35)
```



---

Cytometry36

*Cytometry36*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry36")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry36)
head(Cytometry36)
```

---

Cytometry37

*Cytometry37*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry37")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry37)  
head(Cytometry37)
```

---

Cytometry38

*Cytometry38*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry38")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry38)
head(Cytometry38)
```

---

Cytometry39

*Cytometry39*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry39")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry39)
head(Cytometry39)
```

---

Cytometry4

*Cytometry4*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry4")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry4)  
head(Cytometry4)
```

---

Cytometry40

*Cytometry40*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry40")
```

### Format

A data frame with 145075 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry40)
head(Cytometry40)
```

---

Cytometry5

*Cytometry5*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry5")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry5)
head(Cytometry5)
```

---

Cytometry6

*Cytometry6*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry6")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry6)
head(Cytometry6)
```



---

Cytometry7

*Cytometry7*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry7")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry7)
head(Cytometry7)
```

---

Cytometry8

*Cytometry8*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry8")
```

### Format

A data frame with 50000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry8)
head(Cytometry8)
```

---

Cytometry9

*Cytometry9*

---

### Description

A simulated flow cytometry dataset, as a data frame, of a healthy individual based on data taken following Euroflow protocols.

### Usage

```
data("Cytometry9")
```

### Format

A data frame with 100000 observations on the following 11 variables.

CD19/TCRgd:PE Cy7-A LOGICAL an integer vector.

CD38:APC H7-A LOGICAL an integer vector.

CD3:APC-A LOGICAL an integer vector.

CD4+CD20:PB-A LOGICAL an integer vector.

CD45:P0-A LOGICAL an integer vector.

CD56+IgK:PE-A LOGICAL an integer vector.

CD5:PerCP Cy5-5-A LOGICAL an integer vector.

CD8+IgL:FITC-A LOGICAL an integer vector.

FSC-A LINEAR an integer vector.

SSC-A Exp-SSC Low an integer vector.

Population ID (name) a vector of cell types (strings)

### Source

E del Barrio, H Inouzhe, JM Loubes, C Matran and A Mayo-Isacar. (2019) optimalFlow: Optimal-transport approach to flow cytometry gating and population matching. arXiv:1907.08006

### Examples

```
data(Cytometry9)
head(Cytometry9)
```

---

`noise.types`*noise.types*

---

**Description**

A list of cells that can be considered as noise (Debris and Doublets).

**Usage**

```
data("noise_types")
```

**Format**

A list 38 cell types that can be viewed as noise.

**Examples**

```
data(noise.types)
print(noise.types)
```

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