

# Package ‘HMP16SData’

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**Type** Package

**Title** 16S rRNA Sequencing Data from the Human Microbiome Project

**Version** 1.6.0

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**Description** HMP16SData is a Bioconductor ExperimentData package of the Human Microbiome Project (HMP) 16S rRNA sequencing data for variable regions 1–3 and 3–5. Raw data files are provided in the package as downloaded from the HMP Data Analysis and Coordination Center. Processed data is provided as SummarizedExperiment class objects via ExperimentHub.

**License** Artistic-2.0

**Encoding** UTF-8

**LazyData** true

**Depends** R (>= 3.6.0), SummarizedExperiment

**Imports** AnnotationHub, assertthat, dplyr, ExperimentHub, kableExtra,  
knitr, magrittr, methods, readr, S4Vectors, tibble, utils

**Suggests** Biobase, BiocCheck, BiocManager, BiocStyle, circlize, covr,  
cowplot, curatedMetagenomicData, dendextend, devtools, ggplot2,  
gridExtra, haven, phyloseq, rmarkdown, roxygen2, stats,  
testthat

**biocViews** ExperimentData, ExperimentHub, Homo\_sapiens\_Data,  
MicrobiomeData, ReproducibleResearch, SequencingData

**VignetteBuilder** knitr

**URL** <https://github.com/waldronlab/HMP16SData>

**BugReports** <https://github.com/waldronlab/HMP16SData/issues>

**RoxygenNote** 6.1.1

**git\_url** <https://git.bioconductor.org/packages/HMP16SData>

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as_phyloseq	<i>Coerce a SummarizedExperiment object to a phyloseq object</i>
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### Description

The [phyloseq-package](#) provides a suite of methods for working with 16S rRNA sequencing and other microbiome data that may be of use to the users of [HMP16SData](#). The `as_phyloseq` method provides a means to easily coerce a [SummarizedExperiment-class](#) object to a [phyloseq-class](#) object.

### Usage

```
as_phyloseq(x)
```

### Arguments

`x` A [SummarizedExperiment-class](#) object from the [HMP16SData](#) package

### Value

A [phyloseq-class](#) object

### Examples

```
V13() %>%
  as_phyloseq()
```

---

attach_dbGaP	<i>Attach dbGaP metadata to a SummarizedExperiment object</i>
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### Description

The National Center for Biotechnology Information (NCBI) database of Genotypes and Phenotypes (dbGaP) has extensive metadata pertaining to the HMP study. Access to this metadata is controlled and its use requires authorization by the appropriate Data Access Committee – further information is available [here](#). Those with authorization will be able to download a dbGaP repository key and can use it to attach the controlled-access metadata to a `SummarizedExperiment-class` object with a single command, provided the NCBI SRA Toolkit is installed and on the user's PATH. See note below for further information.

### Usage

```
attach_dbGaP(x, dbGaP_repository_key = "")
```

### Arguments

x	A <code>SummarizedExperiment-class</code> object from the <code>HMP16SData</code> package
dbGaP_repository_key	A repository key downloaded from dbGaP; only required for the initial download and not needed thereafter

### Value

A `SummarizedExperiment-class` object with protected metadata from dbGaP attached

### Note

The NCBI SRA Toolkit is called internally and must be on the user's PATH or an error message will be displayed. The NCBI SRA Toolkit can readily be installed on multiple platforms following [these](#) instructions or by one of the following methods.

**Debian/Ubuntu:** Using the `apt` package manager:

```
apt install sra-toolkit
```

**macOS:** Using the `homebrew` package manager:

```
brew install sratoolkit
```

### See Also

[dictionary](#)

### Examples

```
## Not run:  
V13() %>%  
  attach_dbGaP(dbGaP_repository_key = "~/prj_12146.ngc")  
  
## End(Not run)
```

---

 dictionary

*A data dictionary describing dbGaP metadata variables*


---

### Description

A data dictionary containing descriptions of the metadata variables attached using the [attach\\_dbGaP](#) method, as translated from dbGaP XLM data dictionary files.

### Usage

dictionary

### Format

A `data.frame` with 789 rows and 8 variables:

**VARIABLE** The name of the variable as it appears in `SummarizedExperiment colData`

**DESCRIPTION** A description of the variable

**TYPE** The type of variable, as specified by dbGaP

**UNITS** The units of the variable (e.g. days)

**MINIMUM** The smallest possible value of the variable

**MAXIMUM** The largest possible value of the variable

**CODED\_VALUES** The encoding of coded categorical variables, if needed

**COMMENT** Any comments from dbGaP, most pertain to gated fields

### Source

The following dbGaP XLM data dictionary files were used to construct the data dictionary.

Data dictionary for data table pht001185.v4.p1: <https://tinyurl.com/y7rgelao>. No description provided by dbGaP.

Data dictionary for data table pht001193.v3.p1: <https://tinyurl.com/y7at85tv>. The data table contains subject data with sample information for the Global Trace Screen (GTV). Variables include the specimen type (based on 18 specimens from 6 body sites), nucleic extraction method, and sample administrative information. The Global Trace dataset will be updated when additional visits or subjects have been added.

Data dictionary for data table pht002157.v1.p1: <https://tinyurl.com/y7af3arf>. The Targeted Physical Forms (DTP), Medical History Screening Forms (DHX), and the Visit Documentation Forms (DVD) have been combined into a single data table. The DTP variables include measurements collected for blood pressure, pulse, body weight, height, and BMI. Variables also include physical assessment of areas/systems and the specific details of the abnormalities. Areas/Systems consist of general appearance, HEENT, cardiovascular, pulmonary, abdomen, neurological, musculoskeletal, and extremities. The DHX variables include data that indicate whether the subject noted medical problems in various areas/systems and the indications and specifications of medical problems. Areas/Systems consist of HEENT, cardiovascular, pulmonary, GI, hepatobiliary, renal, neurologic, blood lymphatic, endocrine/metabolic, musculoskeletal, genital/reproductive, dermatologic, allergies, cancer, immunodeficiency, drug or alcohol dependence, and autoimmune disease. Data were also collected for relevant medical or surgical history, medical abnormality with ongoing treatment and presence of acute disease. The DVD variables include education level, insurance status, occupation status, tobacco usage, and visit-specific information. This visit-specific information

pertains to subject's oral temperature, pregnancy test results, education level, insurance status, occupation, and if blood and GI specimens were collected. DTP, DHX and DVD data will be collected at each visit though not every variable was collected.

Data dictionary for data table pht001187.v3.p1: <https://tinyurl.com/y4w4wyw1>. The data table contains data that were collected from the Concomitant Medications Form (DCM). Variables include medication number and code, indication, if the medication is ongoing, and the duration of the medication.

Data dictionary for data table pht001184.v3.p1: <https://tinyurl.com/y9hwfn9e>. The data table contains the subject and consent group information.

Data dictionary for data table pht002158.v1.p1: <https://tinyurl.com/y7jtghxv>. The Demographics Form (DEM) and the Eligibility Checklist (ENR) have been combined into a single data table. The DEM variables include sociodemographic measurements such as gender, ethnicity, race, and place of birth, while the ENR variables include the enrollment/first sampling time of subjects (n=1 variable) and administrative variables (n=4 variables). Both the Medical History and Targeted Physical exams must be completed prior to the completion of the Exclusion Criteria found in the ENR form. Data derived from the Medical History (DHX) and Targeted Physical (DTP) exams can be found in EMMES\_HMP\_DTP\_DHX\_DVD dataset.

Data dictionary for data table pht002156.v1.p1: <https://tinyurl.com/y7znjmak>. The data table contains data that were collected from the Supplemental Questions Form (DSU) upon the completion of HMP study enrollment. Variables include additional health history such as dietary habits, breastfeeding, birthing history, delivery method, and if the subject failed any initial screenings prior to enrollment.

### See Also

[attach\\_dbGaP](#)

### Examples

```
head(dictionary)
```

---

HMP16SData

*16S rRNA sequencing data from the Human Microbiome Project*

---

### Description

HMP16SData is a Bioconductor ExperimentData package of the Human Microbiome Project (HMP) 16S rRNA sequencing data for variable regions 1–3 and 3–5. Raw data files are provided in the package as downloaded from the HMP Data Analysis and Coordination Center. Processed data is provided as `SummarizedExperiment-class` objects via [ExperimentHub](#).

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kable_one	<i>Produce a summary HTML table of key demographic variables</i>
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---

### Description

Sometimes it is desirable to produce a summary of key demographic variables for presentation. The `table_one` and `kable_one` methods are a quick way to do so – they not only summarize key demographic variables from `SummarizedExperiment-class` object(s) in the `HMP16SData` package but remove abbreviations and underscores in column and variable names that might otherwise be ambiguous. The `table_one` method returns a *tidy* (i.e. one sample observation per line) `data.frame` object or a named list of *tidy* `data.frame` objects. The `kable_one` method can then be used to produce a publication-ready HTML table that could, for example, be pasted into a word processor.

### Usage

```
kable_one(x, significant_figures = 2)
```

### Arguments

`x` A `data.frame` object or a named list of `data.frame` objects returned from the `table_one` method

`significant_figures` The number of significant figures to be used for decimals in the HTML table; if no value is specified, the default is 2

### Value

A summary HTML table of key demographic variables

### See Also

[table\\_one](#)

### Examples

```
V13() %>%
  table_one() %>%
  kable_one()
```

---

table_one	<i>Produce a summary data.frame of key demographic variables</i>
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---

### Description

Sometimes it is desirable to produce a summary of key demographic variables for presentation. The `table_one` and `kable_one` methods are a quick way to do so – they not only summarize key demographic variables from `SummarizedExperiment-class` object(s) in the `HMP16SData` package but remove abbreviations and underscores in column and variable names that might otherwise be ambiguous. The `table_one` method returns a *tidy* (i.e. one sample observation per line) `data.frame` object or a named list of *tidy* `data.frame` objects. The `kable_one` method can then be used to produce a publication-ready HTML table that could, for example, be pasted into a word processor.

**Usage**

```
table_one(x, VISITNO = TRUE, SEX = TRUE, RUN_CENTER = TRUE,
          HMP_BODY_SITE = TRUE, HMP_BODY_SUBSITE = TRUE)
```

**Arguments**

x	A <a href="#">SummarizedExperiment-class</a> object or a named list of <a href="#">SummarizedExperiment-class</a> objects from the <a href="#">HMP16SData</a> package
VISITNO	logical; if FALSE, the VISITNO column(s) of SummarizedExperiment colData will not be summarized
SEX	logical; if FALSE, the SEX column(s) of SummarizedExperiment colData will not be summarized
RUN_CENTER	logical; if FALSE, the RUN_CENTER column(s) of SummarizedExperiment colData will not be summarized
HMP_BODY_SITE	logical; if FALSE, the HMP_BODY_SITE column(s) of SummarizedExperiment colData will not be summarized
HMP_BODY_SUBSITE	logical; if FALSE, the HMP_BODY_SUBSITE column(s) of SummarizedExperiment colData will not be summarized

**Value**

A data.frame object or a named list of data.frame objects

**See Also**

[kable\\_one](#)

**Examples**

```
V13() %>%
  table_one()
```

---

V13

*HMP 16S rRNA sequencing data for variable regions 1–3*

---

**Description**

The NIH Human Microbiome Project (HMP) was a longitudinal study conducted from 2007 to 2012 across four institutions (Baylor College of Medicine, the Broad Institute, the J. Craig Venter Institute, and Washington University) of healthy adults aged 18 to 40 that produced a comprehensive reference for the composition, diversity, and variation of the healthy human microbiome. This [SummarizedExperiment-class](#) object represents 16S rRNA sequencing data for variable regions 1–3 that was performed on samples collected at five major body sites – available participant meta-data as well as phylogenetic trees are included.

**Usage**

```
V13(metadata = FALSE)
```

**Arguments**

`metadata` logical; if TRUE only the metadata is downloaded, rather than the entire resource

**Format**

A `SummarizedExperiment-class` object with 43,140 features and 2,898 samples:

**colData:**

**RSID** a random subject identifier

**VISITNO** visit number, between 1 and 3

**SEX** sex, female or male

**RUN\_CENTER** center where sample sequencing took place: Baylor College of Medicine (BCM), the Broad Institute (BI), the J. Craig Venter Institute (JCVI), or the Genome Sequencing Center at Washington University (WUGC)

**HMP\_BODY\_SITE** body site where the sample was collected

**HMP\_BODY\_SUBSITE** body subsite where the sample was collected

**SRS\_SAMPLE\_ID** a sample identifier to be used when comparing 16S rRNA samples to whole metagenome shotgun (WMS) samples

**rowData:**

**CONSENSUS\_LINEAGE** the most detailed lineage description shared by the sequences within an OTU

**SUPERKINGDOM** superkingdom taxonomy, assumed to be Bacteria

**PHYLUM** phylum taxonomy parsed from CONSENSUS\_LINEAGE

**CLASS** class taxonomy parsed from CONSENSUS\_LINEAGE

**ORDER** order taxonomy parsed from CONSENSUS\_LINEAGE

**FAMILY** family taxonomy parsed from CONSENSUS\_LINEAGE

**GENUS** genus taxonomy parsed from CONSENSUS\_LINEAGE

**Value**

A `SummarizedExperiment-class` object

**Note**

The "PSN" identifiers were used as the colnames of the `SummarizedExperiment-class` object, see source for additional information.

**Source**

The following source information is derived from the HMP Data Analysis and Coordination Center: Following a July 2010 16S data freeze, data was downloaded from NCBI SRA projects SRP002395: Human Microbiome Project 16S rRNA Clinical Production Phase I, and SRP002012: Human Microbiome Project 454 Clinical Production Pilot. This dataset corresponds to over 5,700 samples and over 10,000 sequence preps. 16S variable region 3–5 (V35) was sequenced for the entire set of samples, and variable region 1–3 (V13) for a subset of samples.

The QIIME (Quantitative Insights Into Microbial Ecology) software package was used to process HMP 16S data using an OTU-binning strategy to which taxonomic classification is added.

Raw 16S sequence and metadata, available through <https://tinyurl.com/y7ev836z>, were demultiplexed using QIIME. OTU picking was performed for the V1–3 and V3–5 region sequences



using OTUPipe, which includes error correction, chimera checking through UCHIME, and clustering via UCLUST, and postprocessing by picking the optimal representative sequence centroid. Taxonomy was assigned using the RDP classifier version 2.2.

The resulting OTU tables were checked for mislabeling and contamination, as described in the SOP available through <https://tinyurl.com/y7ev836z>. Alpha and beta diversity for each sample and Procrustes analysis were established using QIIME with default parameters.

All QIIME output files are available through <https://tinyurl.com/y7ev836z>, for both the V1–3 and V3–5 variable regions, as well as Procrustes summary data. SOPs and custom scripts are also available through <https://tinyurl.com/y7ev836z>.

If you're interested in joint analysis of 16S and shotgun metagenomic datasets from the HMP, pairing up data from the same microbiome samples can initially seem tricky. The HMP Sample Flow Schematic indicates how these sample IDs are related experimentally, and provides tables joining 16S dataset "SN" and "PSN" identifiers with metagenomic dataset "SRS" identifiers.

Four files were used to construct this `SummarizedExperiment-class` object.

OTU table file with PSN identifiers: <https://tinyurl.com/y74gqpho>

Subject metadata files with PSN identifiers: <https://tinyurl.com/y8adlfso>

Subject metadata files with SRS identifiers: <https://tinyurl.com/ybmn7q8m>

Representative sequence phylogenetic trees: <https://tinyurl.com/ybp8mzgj>

## See Also

[V35](#)

## Examples

V13()

---

V35

*HMP 16S rRNA sequencing data for variable regions 3–5*

---

## Description

The NIH Human Microbiome Project (HMP) was a longitudinal study conducted from 2007 to 2012 across four institutions (Baylor College of Medicine, the Broad Institute, the J. Craig Venter Institute, and Washington University) of healthy adults aged 18 to 40 that produced a comprehensive reference for the composition, diversity, and variation of the healthy human microbiome. This `SummarizedExperiment-class` object represents 16S rRNA sequencing data for variable regions 3–5 that was performed on samples collected at five major body sites – available participant metadata as well as phylogenetic trees are included.

## Usage

```
V35(metadata = FALSE)
```

## Arguments

`metadata` logical; if TRUE only the metadata is downloaded, rather than the entire resource

**Format**

A [SummarizedExperiment](#) with 45,383 features and 4,743 samples:

**colData:**

**RSID** a random subject identifier

**VISITNO** visit number, between 1 and 3

**SEX** sex, female or male

**RUN\_CENTER** center where sample sequencing took place: Baylor College of Medicine (BCM), the Broad Institute (BI), the J. Craig Venter Institute (JCVI), or the Genome Sequencing Center at Washington University (WUGC)

**HMP\_BODY\_SITE** body site where the sample was collected

**HMP\_BODY\_SUBSITE** body subsite where the sample was collected

**SRS\_SAMPLE\_ID** a sample identifier to be used when comparing 16S rRNA samples to whole metagenome shotgun (WMS) samples

**rowData:**

**CONSENSUS\_LINEAGE** the most detailed lineage description shared by the sequences within an OTU

**SUPERKINGDOM** superkingdom taxonomy, assumed to be Bacteria

**PHYLUM** phylum taxonomy parsed from CONSENSUS\_LINEAGE

**CLASS** class taxonomy parsed from CONSENSUS\_LINEAGE

**ORDER** order taxonomy parsed from CONSENSUS\_LINEAGE

**FAMILY** family taxonomy parsed from CONSENSUS\_LINEAGE

**GENUS** genus taxonomy parsed from CONSENSUS\_LINEAGE

**Value**

A [SummarizedExperiment](#) object

**Note**

The "PSN" identifiers were used as the colnames of the [SummarizedExperiment](#) object, see source for additional information.

**Source**

The following source information is derived from the HMP Data Analysis and Coordination Center: Following a July 2010 16S data freeze, data was downloaded from NCBI SRA projects SRP002395: Human Microbiome Project 16S rRNA Clinical Production Phase I, and SRP002012: Human Microbiome Project 454 Clinical Production Pilot. This dataset corresponds to over 5,700 samples and over 10,000 sequence preps. 16S variable region 3–5 (V35) was sequenced for the entire set of samples, and variable region 1–3 (V13) for a subset of samples.

The QIIME (Quantitative Insights Into Microbial Ecology) software package was used to process HMP 16S data using an OTU-binning strategy to which taxonomic classification is added.

Raw 16S sequence and metadata, available through <https://tinyurl.com/y7ev836z>, were demultiplexed using QIIME. OTU picking was performed for the V1–3 and V3–5 region sequences using OTUPipe, which includes error correction, chimera checking through UCHIME, and clustering via UCLUST, and postprocessing by picking the optimal representative sequence centroid. Taxonomy was assigned using the RDP classifier version 2.2.

The resulting OTU tables were checked for mislabeling and contamination, as described in the SOP available through <https://tinyurl.com/y7ev836z>. Alpha and beta diversity for each sample and Procrustes analysis were established using QIIME with default parameters.

All QIIME output files are available through <https://tinyurl.com/y7ev836z>, for both the V1–3 and V3–5 variable regions, as well as Procrustes summary data. SOPs and custom scripts are also available through <https://tinyurl.com/y7ev836z>.

If you're interested in joint analysis of 16S and shotgun metagenomic datasets from the HMP, pairing up data from the same microbiome samples can initially seem tricky. The HMP Sample Flow Schematic indicates how these sample IDs are related experimentally, and provides tables joining 16S dataset "SN" and "PSN" identifiers with metagenomic dataset "SRS" identifiers.

Four files were used to construct this `SummarizedExperiment-class` object.

OTU table file with PSN identifiers: <https://tinyurl.com/y9rbpj17>

Subject metadata files with PSN identifiers: <https://tinyurl.com/yaz35f22>

Subject metadata files with SRS identifiers: <https://tinyurl.com/y9xjqm29>

Representative sequence phylogenetic trees: <https://tinyurl.com/y9exxlgr>

### See Also

[V13](#)

### Examples

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