

# GenomicFeatures

March 24, 2012

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DEFAULT\_CIRC\_SEQS *character vector: strings that are usually circular chromosomes*

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## Description

The DEFAULT\_CIRC\_SEQS character vector contains strings that are normally used by major repositories as the names of chromosomes that are typically circular, it is available as a convenience so that users can use it as a default value for `circ_seqs` arguments, and append to it as needed.

## Usage

```
DEFAULT_CIRC_SEQS
```

## See Also

[makeTranscriptDbFromUCSC](#), [makeTranscriptDbFromBiomart](#)

## Examples

```
DEFAULT_CIRC_SEQS
```

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TranscriptDb-class *TranscriptDb objects*

---

## Description

The TranscriptDb class is a container for storing transcript annotations. The FeatureDb class is a container for storing more generic GenomicFeature annotations.

See [?makeTranscriptDbFromUCSC](#) and [?makeTranscriptDbFromBiomart](#) for making a TranscriptDb object from the UCSC or BioMart sources.

See [?makeFeatureDbFromUCSC](#) for making a FeatureDb object from the UCSC or BioMart sources.

See [?saveDb](#) and [?loadDb](#) for saving and loading the database contents of a TranscriptDb or FeatureDb object.

`select`, `cols` and `keys` are used together to extract data from an TranscriptDb object.

## Methods

In the code snippets below, `x` is a `TranscriptDb` object. For the metadata and show methods, there is also support for `FeatureDb` objects.

`metadata(x)`: Returns `x`'s metadata in a data frame.

`seqinfo(x)`: Gets the information about the underlying sequences as a [Seqinfo](#) object.

`as.list(x)`: Dumps the entire db into a list of data frames `txdump` that can be used in `do.call(makeTranscriptDb, txdump)` to make the db again with no loss of information. Note that the transcripts are dumped in the same order in all the data frames.

`isActiveSeq(x)`: Returns the currently active sequences for this `txdb` object as a named logical vector. Only active sequences will be tapped when using the supplied accessor methods. Inactive sequences will be ignored. By default, all available sequences will be active.

`isActiveSeq(x) <-`: Allows the user to change which sequences will be actively accessed by the accessor methods by altering the contents of this named logical vector.

`keytypes(x)`: allows the user to discover which keytypes can be passed in to select or keys and the keytype argument.

`keys(x, keytype)`: returns keys for the database contained in the `TranscriptDb` object. By default it will return the "TXNAME" keys for the database, but if used with the `keytype` argument, it will return the keys from that keytype.

`cols(x)`: shows which kinds of data can be returned for the `TranscriptDb` object.

`select(x, keys, cols, keytype)`: When all the appropriate arguments are specified `select` will retrieve the matching data as a data.frame based on parameters for selected keys and cols and keytype arguments.

See [?transcripts](#), [?transcriptsByOverlaps](#), [?id2name](#) and [?transcriptsBy](#) for other useful operations on `TranscriptDb` objects.

## Author(s)

H. Pages, Marc Carlson

## See Also

[Seqinfo-class](#), [makeTranscriptDbFromUCSC](#), [makeTranscriptDbFromBiomart](#), [loadFeatures](#), [transcripts](#), [transcriptsByOverlaps](#), [id2name](#), [transcriptsBy](#)

## Examples

```
txdb_file <- system.file("extdata", "Biomart_Ensembl_sample.sqlite",
                        package="GenomicFeatures")
txdb <- loadFeatures(txdb_file)
txdb

## Use of seqinfo
seqinfo(txdb)
seqlevels(txdb) # shortcut for 'seqlevels(seqinfo(txdb))'
seqlengths(txdb) # shortcut for 'seqlengths(seqinfo(txdb))'
isCircular(txdb) # shortcut for 'isCircular(seqinfo(txdb))'
names(which(isCircular(txdb)))

## Examples on how to change which sequences are active
## Set chr1 and chr3 to be inactive:
```

```

isActiveSeq(txdb)[c("1", "3")] <- FALSE
## Set ALL of the chromsomed to be inactive
isActiveSeq(txdb)[seqlevels(txdb)] <- FALSE
## Now set only chr1 and chr5 to be active
isActiveSeq(txdb)[c("1", "4")] <- TRUE

## Use of as.list
txdump <- as.list(txdb)
txdump
txdb1 <- do.call(makeTranscriptDb, txdump)
stopifnot(identical(as.list(txdb1), txdump))

## Use of select and supporting methods
## find key types
keytypes(txdb)
## list IDs that can be used to filter
head(keys(txdb, "GENEID"))
head(keys(txdb, "TXID"))
head(keys(txdb, "TXNAME"))
## list columns that can be returned by select
cols(txdb)
## call select
res = select(txdb, head(keys(txdb, "GENEID")),
             cols = c("GENEID", "TXNAME"),
             keytype="GENEID")
head(res)

```

---

```
extractTranscriptsFromGenome
```

*Tools for extracting transcript sequences*

---

## Description

`extractTranscriptsFromGenome` extracts the transcript sequences from a BSgenome data package using the transcript information (exon boundaries) stored in a [TranscriptDb](#) or [GRangesList](#) object.

`extractTranscripts` extracts a set of transcripts from a single DNA sequence.

Related utilities:

`transcriptWidths` to get the lengths of the transcripts (called the "widths" in this context) based on the boundaries of their exons.

`transcriptLocs2refLocs` converts transcript-based locations into reference-based (aka chromosome-based or genomic) locations.

## Usage

```

extractTranscriptsFromGenome(genome, txdb, use.names=TRUE)

extractTranscripts(x,
                  exonStarts=list(), exonEnds=list(), strand=character(0),
                  reorder.exons.on.minus.strand=FALSE)

## Related utilities:

```

```
transcriptWidths(exonStarts=list(), exonEnds=list())

transcriptLocs2refLocs(tlocs,
                       exonStarts=list(), exonEnds=list(), strand=character(0),
                       reorder.exons.on.minus.strand=FALSE)
```

### Arguments

genome	A <a href="#">BSgenome</a> object. See the <a href="#">available.genomes</a> function in the <a href="#">BSgenome</a> package for how to install a genome.
txdb	A <a href="#">TranscriptDb</a> object or a <a href="#">GRangesList</a> object.
use.names	TRUE or FALSE. Ignored if <code>txdb</code> is not a <a href="#">TranscriptDb</a> object. If TRUE (the default), the returned sequences are named with the transcript names. If FALSE, they are named with the transcript internal ids. Note that, unlike the transcript internal ids, the transcript names are not guaranteed to be unique or even defined (they could be all NAs). A warning is issued when this happens.
x	A <a href="#">DNAString</a> or <a href="#">MaskedDNAString</a> object.
exonStarts, exonEnds	The starts and ends of the exons, respectively. Each argument can be a list of integer vectors, an <a href="#">IntegerList</a> object, or a character vector where each element is a comma-separated list of integers. In addition, the lists represented by <code>exonStarts</code> and <code>exonEnds</code> must have the same shape i.e. have the same lengths and have elements of the same lengths. The length of <code>exonStarts</code> and <code>exonEnds</code> is the number of transcripts.
strand	A character vector of the same length as <code>exonStarts</code> and <code>exonEnds</code> specifying the strand ("+" or "-") from which the transcript is coming.
reorder.exons.on.minus.strand	TRUE or FALSE. Should the order of exons for transcripts coming from the minus strand be reversed?
tlocs	A list of integer vectors of the same length as <code>exonStarts</code> and <code>exonEnds</code> . Each element in <code>tlocs</code> must contain transcript-based locations.

### Value

For `extractTranscriptsFromGenome`: A named [DNAStringSet](#) object with one element per transcript. When `txdb` is a [GRangesList](#) object, elements in the output align with elements in the input (`txdb`), and they have the same names.

For `extractTranscripts`: A [DNAStringSet](#) object with one element per transcript.

For `transcriptWidths`: An integer vector with one element per transcript.

For `transcriptLocs2refLocs`: A list of integer vectors of the same shape as `tlocs`.

### Author(s)

H. Pages

### See Also

[available.genomes](#), [TranscriptDb-class](#), [GRangesList-class](#), [DNAStringSet-class](#)

**Examples**

```

library(BSgenome.Hsapiens.UCSC.hg18) # load the genome

## -----
## A. USING extractTranscriptsFromGenome() WITH A TranscriptDb OBJECT
## -----
txdb_file <- system.file("extdata", "UCSC_knownGene_sample.sqlite",
                        package="GenomicFeatures")
txdb <- loadFeatures(txdb_file)
txseqs <- extractTranscriptsFromGenome(Hsapiens, txdb)
txseqs

## -----
## B. USING extractTranscriptsFromGenome() WITH A GRangesList OBJECT
## -----

## A GRangesList object containing exons grouped by transcripts gives
## the same result as above:
exbytx <- exonsBy(txdb, by="tx", use.names=TRUE)
txseqs2 <- extractTranscriptsFromGenome(Hsapiens, exbytx)
## A sanity check:
stopifnot(identical(unname(sapply(width(exbytx), sum)), width(txseqs2)))

## CDSs grouped by transcripts (this extracts only the translated parts
## of the transcripts):
cds <- extractTranscriptsFromGenome(Hsapiens, cdsBy(txdb))

## -----
## C. GOING FROM TRANSCRIPT-BASED TO REFERENCE-BASED LOCATIONS
## -----
## Get the reference-based locations of the first 4 (5' end)
## and last 4 (3' end) nucleotides in each transcript:
tlocs <- lapply(width(txseqs2), function(w) c(1:4, (w-3):w))
tx_strand <- sapply(strand(exbytx), runValue)
## Note that, because of how we made them, 'tlocs', 'start(exbytx)',
## 'end(exbytx)' and 'tx_strand' have the same length, and, for any
## valid positional index, elements at this position are corresponding
## to each other. This is how transcriptLocs2refLocs() expects them
## to be!
rlocs <- transcriptLocs2refLocs(tlocs, start(exbytx), end(exbytx),
                              tx_strand, reorder.exons.on.minus.strand=TRUE)

## -----
## D. EXTRACTING WORM TRANSCRIPTS ZC101.3 AND F37B1.1
## -----

## Transcript ZC101.3 (is on + strand):
## Exons starts/ends relative to transcript:
rstarts1 <- c(1, 488, 654, 996, 1365, 1712, 2163, 2453)
rends1 <- c(137, 578, 889, 1277, 1662, 1870, 2410, 2561)
## Exons starts/ends relative to chromosome:
starts1 <- 14678410 + rstarts1
ends1 <- 14678410 + rends1

## Transcript F37B1.1 (is on - strand):
## Exons starts/ends relative to transcript:

```

```

rstarts2 <- c(1, 325)
rends2 <- c(139, 815)
## Exons starts/ends relative to chromosome:
starts2 <- 13611188 - rends2
ends2 <- 13611188 - rstarts2

exon_starts <- list(as.integer(starts1), as.integer(starts2))
exon_ends <- list(as.integer(ends1), as.integer(ends2))

library(BSgenome.Celegans.UCSC.ce2)
## Both transcripts are on chrII:
chrII <- Celegans$chrII
transcripts <- extractTranscripts(chrII,
                                  exonStarts=exon_starts,
                                  exonEnds=exon_ends,
                                  strand=c("+", "-"))

## Same as 'width(transcripts)':
transcriptWidths(exonStarts=exon_starts, exonEnds=exon_ends)

transcriptLocs2refLocs(list(c(1:6, 135:140, 1555:1560),
                             c(1:6, 137:142, 625:630)),
                       exonStarts=exon_starts,
                       exonEnds=exon_ends,
                       strand=c("+", "-"))

## A sanity check:
ref_locs <- transcriptLocs2refLocs(list(1:1560, 1:630),
                                   exonStarts=exon_starts,
                                   exonEnds=exon_ends,
                                   strand=c("+", "-"))
stopifnot(chrII[ref_locs[[1]]] == transcripts[[1]])
stopifnot(complement(chrII)[ref_locs[[2]]] == transcripts[[2]])

```

---

features

*Extract simple features from a FeatureDb object*

---

## Description

Generic function to extract genomic features from a FeatureDb object.

## Usage

```

features(x)
## S4 method for signature 'FeatureDb'
features(x)

```

## Arguments

x [A FeatureDb object](#).

## Value

a GRanges object

**Author(s)**

M. Carlson

**See Also**

[FeatureDb](#)

**Examples**

```
fdb <- loadFeatures(system.file("extdata", "FeatureDb.sqlite",
                               package="GenomicFeatures"))
features(fdb)
```

---

id2name

*Map internal ids to external names for a given feature type*

---

**Description**

Utility function for retrieving the mapping from the internal ids to the external names of a given feature type.

**Usage**

```
id2name(txdb, feature.type=c("tx", "exon", "cds"))
```

**Arguments**

txdb           A [TranscriptDb](#) object.

feature.type   The feature type for which the mapping must be retrieved.

**Details**

Transcripts, exons and CDS in a [TranscriptDb](#) object are stored in separate tables where the primary key is an integer called *feature internal id*. This id is stored in the "tx\_id" column for transcripts, in the "exon\_id" column for exons, and in the "cds\_id" column for CDS. Unlike other commonly used ids like Entrez Gene IDs or Ensembl IDs, this internal id was generated at the time the [TranscriptDb](#) object was created and has no meaning outside the scope of this object.

The id2name function can be used to translate this internal id into a more informative id or name called *feature external name*. This name is stored in the "tx\_name" column for transcripts, in the "exon\_name" column for exons, and in the "cds\_name" column for CDS.

Note that, unlike the feature internal id, the feature external name is not guaranteed to be unique or even defined (the column can contain NAs).

**Value**

A named character vector where the names are the internal ids and the values the external names.

**Author(s)**

H. Pages

**See Also**

[TranscriptDb](#), [transcripts](#), [transcriptsBy](#)

**Examples**

```
txdb1_file <- system.file("extdata", "UCSC_knownGene_sample.sqlite",
                          package="GenomicFeatures")
txdb1 <- loadFeatures(txdb1_file)
id2name(txdb1, feature.type="tx") [1:4]
id2name(txdb1, feature.type="exon") [1:4]
id2name(txdb1, feature.type="cds") [1:4]

txdb2_file <- system.file("extdata", "Biomart_Ensembl_sample.sqlite",
                          package="GenomicFeatures")
txdb2 <- loadFeatures(txdb2_file)
id2name(txdb2, feature.type="tx") [1:4]
id2name(txdb2, feature.type="exon") [1:4]
id2name(txdb2, feature.type="cds") [1:4]
```

---

makeFeatureDbFromUCSC

*Making a FeatureDb object from annotations available at the UCSC  
Genome Browser*

---

**Description**

The `makeFeatureDbFromUCSC` function allows the user to make a [FeatureDb](#) object from simple annotation tracks at UCSC. The tracks in question must (at a minimum) have a start, end and a chromosome affiliation in order to be made into a [FeatureDb](#). This function requires a precise declaration of its first three arguments to indicate which genome, track and table wish to be imported. There are discovery functions provided to make this process go smoothly.

**Usage**

```
supportedUCSCFeatureDbTracks(genome)

supportedUCSCFeatureDbTables(genome, track)

UCSCFeatureDbTableSchema(genome,
                          track,
                          tablename)

makeFeatureDbFromUCSC(
  genome,
  track,
  tablename,
  columns = UCSCFeatureDbTableSchema(genome, track, tablename),
  url="http://genome.ucsc.edu/cgi-bin/",
  goldenPath_url="http://hgdownload.cse.ucsc.edu/goldenPath",
  chromCol,
  chromStartCol,
  chromEndCol)
```



**Arguments**

genome	genome abbreviation used by UCSC and obtained by <code>ucscGenomes()</code> [ , "db"]. For example: "hg18".
track	name of the UCSC track. Use <code>supportedUCSCFeatureDbTracks</code> to get the list of available tracks for a particular genome
tablename	name of the UCSC table containing the annotations to retrieve. Use the <code>supportedUCSCFeatureDbTables</code> utility function to get the list of supported tables for a track.
columns	a named character vector to list out the names and types of the other columns that the downloaded track should have. Use <code>UCSCFeatureDbTableSchema</code> to retrieve this information for a particular table.
url, goldenPath_url	use to specify the location of an alternate UCSC Genome Browser.
chromCol	If the schema comes back and the 'chrom' column has been labeled something other than 'chrom', use this argument to indicate what that column has been labeled as so we can properly designate it. This could happen (for example) with the knownGene track tables, which has no 'chromStart' or 'chromEnd' columns, but which DOES have columns that could reasonably substitute for these columns under particular circumstances. Therefore we allow these three columns to have arguments so that their definition can be re-specified
chromStartCol	Same thing as chromCol, but for renames of 'chromStart'
chromEndCol	Same thing as chromCol, but for renames of 'chromEnd'

**Details**

`makeFeatureDbFromUCSC` is a convenience function that builds a tiny database from one of the UCSC track tables. `supportedUCSCFeatureDbTracks` a convenience function that returns potential track names that could be used to make `FeatureDb` objects `supportedUCSCFeatureDbTables` a convenience function that returns potential table names for `FeatureDb` objects (table names go with a track name) `UCSCFeatureDbTableSchema` A convenience function that creates a named vector of types for all the fields that can potentially be supported for a given track. By default, this will be called on your specified tablename to include all of the fields in a track.

**Value**

A `FeatureDb` object for `makeFeatureDbFromUCSC`. Or in the case of `supportedUCSCFeatureDbTracks` and `UCSCFeatureDbTableSchema` a named character vector

**Author(s)**

M. Carlson and H. Pages

**See Also**

[ucscGenomes](#),

**Examples**

```
## Display the list of genomes available at UCSC:
library(GenomicFeatures)
library(rtracklayer)
```

```

ucscGenomes() [ , "db"]

## Display the list of Tracks supported by makeFeatureDbFromUCSC():
supportedUCSCFeatureDbTracks("mm9")

## Display the list of tables supported by your track:
supportedUCSCFeatureDbTables(genome="mm9",
                             track="oreganno")

## Display fields that could be passed in to colnames:
UCSCFeatureDbTableSchema(genome="mm9",
                         track="oreganno",
                         tablename="oreganno")

## Retrieving a full transcript dataset for Yeast from UCSC:
fdb <- makeFeatureDbFromUCSC(genome="mm9",
                             track="oreganno",
                             tablename="oreganno")

fdb

```

---

makeTranscriptDb    *Making a TranscriptDb object from user supplied annotations*

---

## Description

makeTranscriptDb is a low-level constructor for making a [TranscriptDb](#) object from user supplied transcript annotations. See [?makeTranscriptDbFromUCSC](#) and [?makeTranscriptDbFromBiomart](#) for higher-level functions that feed data from the UCSC or BioMart sources to makeTranscriptDb.

## Usage

```

makeTranscriptDb(transcripts, splicings,
                 genes=NULL, chrominfo=NULL, metadata=NULL, ...)

```

## Arguments

transcripts	data frame containing the genomic locations of a set of transcripts
splicings	data frame containing the exon and cds locations of a set of transcripts
genes	data frame containing the genes associated to a set of transcripts
chrominfo	data frame containing information about the chromosomes hosting the set of transcripts
metadata	2-column data frame containing meta information about this set of transcripts like species, organism, genome, UCSC table, etc... The names of the columns must be "name" and "value" and their type must be character.
...	ignored for now

## Details

The `transcripts` (required), `splicings` (required) and `genes` (optional) arguments must be data frames that describe a set of transcripts and the genomic features related to them (exons, cds and genes at the moment). The `chrominfo` (optional) argument must be a data frame containing chromosome information like the length of each chromosome.

`transcripts` must have 1 row per transcript and the following columns:

- `tx_id`: Transcript ID. Integer vector. No NAs. No duplicates.
- `tx_name`: [optional] Transcript name. Character vector (or factor).
- `tx_chrom`: Transcript chromosome. Character vector (or factor) with no NAs.
- `tx_strand`: Transcript strand. Character vector (or factor) where each element is either "+" or "-".
- `tx_start`, `tx_end`: Transcript start and end. Integer vectors with no NAs.

Other columns, if any, are ignored (with a warning).

`splicings` must have N rows per transcript, where N is the nb of exons in the transcript. Each row describes an exon plus eventually the cds contained in this exon. Its columns must be:

- `tx_id`: Foreign key that links each row in the `splicings` data frame to a unique row in the `transcripts` data frame. Note that more than 1 row in `splicings` can be linked to the same row in `transcripts` (many-to-one relationship). Same type as `transcripts$tx_id` (integer vector). No NAs. All the values in this column must be present in `transcripts$tx_id`.
- `exon_rank`: The rank of the exon in the transcript. Integer vector with no NAs. (`tx_id`, `exon_rank`) pairs must be unique.
- `exon_id`: [optional] Exon ID. Integer vector with no NAs.
- `exon_name`: [optional] Exon name. Character vector (or factor).
- `exon_chrom`: [optional] Exon chromosome. Character vector (or factor) with no NAs. If missing then `transcripts$tx_chrom` is used. If present then `exon_strand` must be present too.
- `exon_strand`: [optional] Exon strand. Character vector (or factor) with no NAs. If missing then `transcripts$tx_strand` is used and `exon_chrom` must be missing too.
- `exon_start`, `exon_end`: Exon start and end. Integer vectors with no NAs.
- `cds_id`: [optional] cds ID. Integer vector. If present then `cds_start` and `cds_end` must be too. NAs are allowed and must match NAs in `cds_start` and `cds_end`.
- `cds_name`: [optional] cds name. Character vector (or factor). If present then `cds_start` and `cds_end` must be too. NAs are allowed and must match NAs in `cds_start` and `cds_end`.
- `cds_start`, `cds_end`: [optional] cds start and end. Integer vectors. If one of the 2 columns is missing then all `cds_*` columns must be missing. NAs are allowed and must occur at the same positions in `cds_start` and `cds_end`.

Other columns, if any, are ignored (with a warning).

`genes` must have N rows per transcript, where N is the nb of genes linked to the transcript (N will be 1 most of the time). Its columns must be:

- `tx_id`: [optional] `genes` must have either a `tx_id` or a `tx_name` column but not both. Like `splicings$tx_id`, this is a foreign key that links each row in the `genes` data frame to a unique row in the `transcripts` data frame.

- `tx_name`: [optional] Can be used as an alternative to the `genes$tx_id` foreign key.
- `gene_id`: Gene ID. Character vector (or factor). No NAs.

Other columns, if any, are ignored (with a warning).

`chrominfo` must have 1 row per chromosome and the following columns:

- `chrom`: Chromosome name. Character vector (or factor) with no NAs.
- `length`: Chromosome length. Either all NAs or an integer vector with no NAs.
- `is_circular`: [optional] Chromosome circularity flag. Either all NAs or a logical vector with no NAs.

Other columns, if any, are ignored (with a warning).

### Value

A [TranscriptDb](#) object.

### Author(s)

H. Pages

### See Also

[TranscriptDb](#), [makeTranscriptDbFromUCSC](#), [makeTranscriptDbFromBiomart](#)

### Examples

```
transcripts <- data.frame(
  tx_id=1:3,
  tx_chrom="chr1",
  tx_strand=c("-", "+", "+"),
  tx_start=c(1, 2001, 2001),
  tx_end=c(999, 2199, 2199))
splittings <- data.frame(
  tx_id=c(1L, 2L, 2L, 2L, 3L, 3L),
  exon_rank=c(1, 1, 2, 3, 1, 2),
  exon_start=c(1, 2001, 2101, 2131, 2001, 2131),
  exon_end=c(999, 2085, 2144, 2199, 2085, 2199),
  cds_start=c(1, 2022, 2101, 2131, NA, NA),
  cds_end=c(999, 2085, 2144, 2193, NA, NA))

txdb <- makeTranscriptDb(transcripts, splittings)
```

---

`makeTranscriptDbFromBiomart`

*Making a TranscriptDb object from annotations available on a BioMart database*

---

### Description

The `makeTranscriptDbFromBiomart` function allows the user to make a [TranscriptDb](#) object from transcript annotations available on a BioMart database.

**Usage**

```
getChromInfoFromBiomart (biomart="ensembl",
                        dataset="hsapiens_gene_ensembl")

makeTranscriptDbFromBiomart (biomart="ensembl",
                            dataset="hsapiens_gene_ensembl",
                            transcript_ids=NULL,
                            circ_seqs=DEFAULT_CIRC_SEQS)
```

**Arguments**

biomart	which BioMart database to use. Get the list of all available BioMart databases with the <code>listMarts</code> function from the <code>biomaRt</code> package. See the details section below for a list of BioMart databases with compatible transcript annotations.
dataset	which dataset from BioMart. For example: "hsapiens_gene_ensembl", "mmusculus_gene_ensembl", "dmelanogaster_gene_ensembl", "celegans_gene_ensembl", "scerevisiae_gene_ensembl", etc in the ensembl database. See the examples section below for how to discover which datasets are available in a given BioMart database.
transcript_ids	optionally, only retrieve transcript annotation data for the specified set of transcript ids. If this is used, then the meta information displayed for the resulting <code>TranscriptDb</code> object will say 'Full dataset: no'. Otherwise it will say 'Full dataset: yes'.
circ_seqs	a character vector to list out which chromosomes should be marked as circular.

**Details**

`makeTranscriptDbFromBiomart` is a convenience function that feeds data from a BioMart database to the lower level `makeTranscriptDb` function. See `?makeTranscriptDbFromUCSC` for a similar function that feeds data from the UCSC source.

BioMart databases that are known to have compatible transcript annotations are:

- the most recent ensembl: ENSEMBL GENES (SANGER UK)
- the most recent bacterial\_mart: ENSEMBL BACTERIA (EBI UK)
- the most recent fungal\_mart: ENSEMBL FUNGAL (EBI UK)
- the most recent metazoa\_mart: ENSEMBL METAZOA (EBI UK)
- the most recent plant\_mart: ENSEMBL PLANT (EBI UK)
- the most recent protist\_mart: ENSEMBL PROTISTS (EBI UK)
- the most recent ensembl\_expressionmart: EURATMART (EBI UK)

Not all annotations will have CDS information.

**Value**

A `TranscriptDb` object.

**Author(s)**

M. Carlson and H. Pages

**See Also**

[listMarts](#), [useMart](#), [listDatasets](#), [DEFAULT\\_CIRC\\_SEQS](#), [makeTranscriptDbFromUCSC](#), [makeTranscriptDb](#)

**Examples**

```
## Discover which datasets are available in the "ensembl" BioMart
## database:
library(biomaRt)
listDatasets(useMart("ensembl"))

## Retrieving an incomplete transcript dataset for Human from the
## "ensembl" BioMart database:
transcript_ids <- c(
  "ENST00000268655",
  "ENST00000313243",
  "ENST00000341724",
  "ENST00000400839",
  "ENST00000435657",
  "ENST00000478783"
)
txdb <- makeTranscriptDbFromBiomart(transcript_ids=transcript_ids)
txdb # note that these annotations match the GRCh37 genome assembly
```

---

```
makeTranscriptDbFromUCSC
```

*Making a TranscriptDb object from annotations available at the UCSC Genome Browser*

---

**Description**

The `makeTranscriptDbFromUCSC` function allows the user to make a [TranscriptDb](#) object from transcript annotations available at the UCSC Genome Browser.

**Usage**

```
supportedUCSCTables()

getChromInfoFromUCSC(
  genome,
  goldenPath_url="http://hgdownload.cse.ucsc.edu/goldenPath")

makeTranscriptDbFromUCSC(
  genome="hg18",
  tablename="knownGene",
  transcript_ids=NULL,
  circ_seqs=DEFAULT_CIRC_SEQS,
  url="http://genome.ucsc.edu/cgi-bin/",
  goldenPath_url="http://hgdownload.cse.ucsc.edu/goldenPath")
```

**Arguments**

genome	genome abbreviation used by UCSC and obtained by <code>ucscGenomes()</code> [ , "db"]. For example: "hg18".
tablename	name of the UCSC table containing the transcript annotations to retrieve. Use the <code>supportedUCSCTables</code> utility function to get the list of supported tables. Note that not all tables are available for all genomes.
transcript_ids	optionally, only retrieve transcript annotation data for the specified set of transcript ids. If this is used, then the meta information displayed for the resulting <code>TranscriptDb</code> object will say 'Full dataset: no'. Otherwise it will say 'Full dataset: yes'.
circ_seqs	a character vector to list out which chromosomes should be marked as circular.
url, goldenPath_url	use to specify the location of an alternate UCSC Genome Browser.

**Details**

`makeTranscriptDbFromUCSC` is a convenience function that feeds data from the UCSC source to the lower level `makeTranscriptDb` function. See `?makeTranscriptDbFromBiomart` for a similar function that feeds data from a BioMart database.

**Value**

A `TranscriptDb` object.

**Author(s)**

M. Carlson and H. Pages

**See Also**

`ucscGenomes`, `DEFAULT_CIRC_SEQS`, `makeTranscriptDbFromBiomart`, `makeTranscriptDb`

**Examples**

```
## Display the list of genomes available at UCSC:
library(rtracklayer)
ucscGenomes()[ , "db"]

## Display the list of tables supported by makeTranscriptDbFromUCSC():
supportedUCSCTables()

## Not run:
## Retrieving a full transcript dataset for Yeast from UCSC:
txdb1 <- makeTranscriptDbFromUCSC(genome="sacCer2", tablename="ensGene")

## End(Not run)

## Retrieving an incomplete transcript dataset for Mouse from UCSC
## (only transcripts linked to Entrez Gene ID 22290):
transcript_ids <- c(
  "uc009uzf.1",
  "uc009uzg.1",
  "uc009uzh.1",
```

```

    "uc009uzi.1",
    "uc009uzj.1"
  )

txdb2 <- makeTranscriptDbFromUCSC(genome="mm9", tablename="knownGene",
                                transcript_ids=transcript_ids)

txdb2

```

---

makeTxDbPackage     *Making a TranscriptDb packages from annotations available at the UCSC Genome Browser, biomaRt or from another source.*

---

## Description

The `makeTxDbPackageFromUCSC` function allows the user to make a [TranscriptDb](#) object from transcript annotations available at the UCSC Genome Browser. The `makeTxDbPackageFromBiomart` function allows the user to do the same thing as `makeTxDbPackageFromUCSC` except that the annotations originate from biomaRt. Finally, the `makeTxDbPackage` function allows the user to make a [TranscriptDb](#) object from transcript annotations that are in a custom transcript Database, such as could be produced using `makeTranscriptDb`.

## Usage

```

makeTxDbPackageFromUCSC (
  version=,
  maintainer,
  author,
  destDir=".",
  license="Artistic-2.0",
  genome="hg19",
  tablename="knownGene",
  transcript_ids=NULL,
  circ_seqs=DEFAULT_CIRC_SEQS,
  url="http://genome.ucsc.edu/cgi-bin/",
  goldenPath_url="http://hgdownload.cse.ucsc.edu/goldenPath")

makeTxDbPackageFromBiomart (
  version,
  maintainer,
  author,
  destDir=".",
  license="Artistic-2.0",
  biomart="ensembl",
  dataset="hsapiens_gene_ensembl",
  transcript_ids=NULL,
  circ_seqs=DEFAULT_CIRC_SEQS)

makeTxDbPackage (txdb,
                 version,
                 maintainer,

```



```

    author,
    destDir=".",
    license="Artistic-2.0")

```

### Arguments

version	What is the version number for this package?
maintainer	Who is the package maintainer? (must include email to be valid)
author	Who is the creator of this package?
destDir	A path where the package source should be assembled.
license	What is the license (and it's version)
biomart	which BioMart database to use. Get the list of all available BioMart databases with the <a href="#">listMarts</a> function from the <a href="#">biomaRt</a> package. See the details section below for a list of BioMart databases with compatible transcript annotations.
dataset	which dataset from BioMart. For example: "hsapiens_gene_ensembl", "mmusculus_gene_ensembl", "dmelanogaster_gene_ensembl", "celegans_gene_ensembl", "scerevisiae_gene_ensembl", etc in the ensembl database. See the examples section below for how to discover which datasets are available in a given BioMart database.
genome	genome abbreviation used by UCSC and obtained by <a href="#">ucscGenomes()</a> [ , "db" ]. For example: "hg18".
tablename	name of the UCSC table containing the transcript annotations to retrieve. Use the <a href="#">supportedUCSCTables</a> utility function to get the list of supported tables. Note that not all tables are available for all genomes.
transcript_ids	optionally, only retrieve transcript annotation data for the specified set of transcript ids. If this is used, then the meta information displayed for the resulting <a href="#">TranscriptDb</a> object will say 'Full dataset: no'. Otherwise it will say 'Full dataset: yes'.
circ_seqs	a character vector to list out which chromosomes should be marked as circular.
url, goldenPath_url	use to specify the location of an alternate UCSC Genome Browser.
txdb	A <a href="#">TranscriptDb</a> object that represents a handle to a transcript database. This object type is what is returned by <a href="#">makeTranscriptDbFromUCSC</a> , <a href="#">makeTranscriptDbFromUC</a> or <a href="#">makeTranscriptDb</a>

### Details

[makeTxDbPackageFromUCSC](#) is a convenience function that calls both the [makeTranscriptDbFromUCSC](#) and the [makeTxDbPackage](#) functions. The [makeTxDbPackageFromBiomart](#) follows a similar pattern and calls the [makeTranscriptDbFromBiomart](#) and [makeTxDbPackage](#) functions.

### Value

A [TranscriptDb](#) object.

### Author(s)

M. Carlson

**See Also**

[ucscGenomes](#), [DEFAULT\\_CIRC\\_SEQS](#), [makeTranscriptDbFromUCSC](#), [makeTranscriptDbFromBioma](#)  
[makeTranscriptDb](#)

**Examples**

```
## Display the list of tables supported by makeTxDbPackageFromUCSC():
supportedUCSCTables()

## Not run:
## Makes a transcript package for Yeast from the ensGene table at UCSC:
makeTxDbPackageFromUCSC(version="0.01",
                        maintainer="Some One <so@someplace.org>",
                        author="Some One <so@someplace.com>",
                        genome="sacCer2",
                        tablename="ensGene")

## Makes a transcript package from Human by using biomaRt and limited to a
## small subset of the transcripts.
transcript_ids <- c(
  "ENST00000400839",
  "ENST00000400840",
  "ENST00000478783",
  "ENST00000435657",
  "ENST00000268655",
  "ENST00000313243",
  "ENST00000341724")

makeTxDbPackageFromBiomart(version="0.01",
                          maintainer="Some One <so@someplace.org>",
                          author="Some One <so@someplace.com>",
                          transcript_ids=transcript_ids)

## End(Not run)
```

---

regions

*Functions that compute genomic regions of interest.*

---

**Description**

Functions that compute genomic regions of interest such as promotor, upstream regions etc, from the genomic locations provided in a UCSC-style data frame.

**WARNING:** All the functions described in this man page are deprecated. Please use [transcripts](#), [exons](#) or [intronsByTranscript](#) on a [TranscriptDb](#) object instead.

**Usage**

```
transcripts_deprecated(genes, proximal = 500, distal = 10000)
exons_deprecated(genes)
introns_deprecated(genes)
```

**Arguments**

genes	A UCSC-style data frame i.e. a data frame with 1 row per transcript and at least the following columns: "name", "chrom", "strand", "txStart", "txEnd", "exonCount", "exonStarts", "exonEnds", "intronStarts" and "intronEnds". A value in any of the last 4 columns must be a comma-separated list of integers. Note that unlike what UCSC does the start values here must be 1-based, not 0-based.
proximal	The number of bases on either side of TSS and 3'-end for the promoter and end region, respectively.
distal	The number of bases on either side for upstream/downstream, i.e. enhancer/silencer regions.

**Details**

The assumption made for introns is that there must be more than one exon, and that the introns are between the end of one exon and before the start of the next exon.

**Value**

All of these functions return a [RangedData](#) object with a `gene` column with the UCSC ID of the gene. For `transcripts_deprecated`, each element corresponds to a transcript, and there are columns for each type of region (promoter, threeprime, upstream, and downstream). For `exons_deprecated`, each element corresponds to an exon. For `introns_deprecated`, each element corresponds to an intron.

**Author(s)**

M. Lawrence.

**See Also**

[transcripts](#), [exons](#), [intronsByTranscript](#), [TranscriptDb-class](#)

---

saveFeatures	<i>Methods to save and load the database contents for a Transcript Object.</i>
--------------	--

---

**Description**

These methods provide a way to dump a TranscriptDb object to an SQLite file, and to recreate that object the saved file.

**Usage**

```
saveFeatures(x, file)
loadFeatures(file)
```

**Arguments**

x	a transcripts object, which contains a connection to a DB.
file	A SQLite Database filename.

**Value**

For `loadFeatures` only, a [TranscriptDb](#) object is returned.

**Author(s)**

M. Carlson

**See Also**

[TranscriptDb](#)

**Examples**

```
txdb <-
  loadFeatures(system.file("extdata", "UCSC_knownGene_sample.sqlite",
                           package = "GenomicFeatures"))
txdb
```

---

transcripts

*Extract genomic features from an object*

---

**Description**

Generic functions to extract genomic features from an object. This page documents the methods for [TranscriptDb](#) objects only.

**Usage**

```
transcripts(x, ...)
## S4 method for signature 'TranscriptDb'
transcripts(x, vals=NULL, columns=c("tx_id", "tx_name"))

exons(x, ...)
## S4 method for signature 'TranscriptDb'
exons(x, vals=NULL, columns="exon_id")

cds(x, ...)
## S4 method for signature 'TranscriptDb'
cds(x, vals=NULL, columns="cds_id")
```

**Arguments**

<code>x</code>	A <a href="#">TranscriptDb</a> object.
<code>...</code>	Arguments to be passed to or from methods.
<code>vals</code>	Either <code>NULL</code> or a named list of vectors to be used to restrict the output. Valid names for this list are: "gene_id", "tx_id", "tx_name", "tx_chrom", "tx_strand", "exon_id", "exon_name", "exon_chrom", "exon_strand", "cds_id", "cds_name", "cds_chrom", "cds_strand" and "exon_rank".
<code>columns</code>	Columns to include in the output. Must be <code>NULL</code> or a character vector with values in the above list of valid names. With the following restrictions:

- "tx\_chrom" and "tx\_strand" are not allowed for transcripts.
- "exon\_chrom" and "exon\_strand" are not allowed for exons.
- "cds\_chrom" and "cds\_strand" are not allowed for cds.

## Details

These are the main functions for extracting transcript information from a [TranscriptDb](#) object. They can restrict the output based on categorical information. To restrict the output based on interval information, use the [transcriptsByOverlaps](#), [exonsByOverlaps](#), and [cdsByOverlaps](#) functions.

## Value

a GRanges object

## Author(s)

M. Carlson, P. Aboyoun and H. Pages

## See Also

[TranscriptDb](#), [id2name](#), [transcriptsBy](#), [transcriptsByOverlaps](#)

## Examples

```
txdb <- loadFeatures(system.file("extdata", "UCSC_knownGene_sample.sqlite",
                               package="GenomicFeatures"))
vals <- list(tx_chrom = c("chr3", "chr5"), tx_strand = "+")
transcripts(txdb, vals)
exons(txdb, vals=list(exon_id=1), columns=c("exon_id", "tx_name"))
exons(txdb, vals=list(tx_name="uc009vip.1"), columns=c("exon_id", "tx_name"))
```

---

transcriptsBy

*Extract and group genomic features of a given type*

---

## Description

Generic functions to extract genomic features of a given type grouped based on another type of genomic feature. This page documents the methods for [TranscriptDb](#) objects only.

## Usage

```
transcriptsBy(x, by=c("gene", "exon", "cds"), ...)
## S4 method for signature 'TranscriptDb'
transcriptsBy(x, by=c("gene", "exon", "cds"), use.names=FALSE)

exonsBy(x, by=c("tx", "gene"), ...)
## S4 method for signature 'TranscriptDb'
exonsBy(x, by=c("tx", "gene"), use.names=FALSE)

cdsBy(x, by=c("tx", "gene"), ...)
## S4 method for signature 'TranscriptDb'
```

```

cdsBy(x, by=c("tx", "gene"), use.names=FALSE)

intronsByTranscript(x, ...)
## S4 method for signature 'TranscriptDb'
intronsByTranscript(x, use.names=FALSE)

fiveUTRsByTranscript(x, ...)
## S4 method for signature 'TranscriptDb'
fiveUTRsByTranscript(x, use.names=FALSE)

threeUTRsByTranscript(x, ...)
## S4 method for signature 'TranscriptDb'
threeUTRsByTranscript(x, use.names=FALSE)

```

## Arguments

<code>x</code>	A <a href="#">TranscriptDb</a> object.
<code>...</code>	Arguments to be passed to or from methods.
<code>by</code>	One of "gene", "exon", "cds" or "tx". Determines the grouping.
<code>use.names</code>	Controls how to set the names of the returned <a href="#">GRangesList</a> object. These functions return all the features of a given type (e.g. all the exons) grouped by another feature type (e.g. grouped by transcript) in a <a href="#">GRangesList</a> object. By default (i.e. if <code>use.names</code> is <code>FALSE</code> ), the names of this <a href="#">GRangesList</a> object (aka the group names) are the internal ids of the features used for grouping (aka the grouping features), which are guaranteed to be unique. If <code>use.names</code> is <code>TRUE</code> , then the names of the grouping features are used instead of their internal ids. For example, when grouping by transcript ( <code>by="tx"</code> ), the default group names are the transcript internal ids ( <code>"tx_id"</code> ). But, if <code>use.names=TRUE</code> , the group names are the transcript names ( <code>"tx_name"</code> ). Note that, unlike the feature ids, the feature names are not guaranteed to be unique or even defined (they could be all <code>NA</code> s). A warning is issued when this happens. See <a href="#">?id2name</a> for more information about feature internal ids and feature external names and how to map the formers to the latters. Finally, <code>use.names=TRUE</code> cannot be used when grouping by gene <code>by="gene"</code> . This is because, unlike for the other features, the gene ids are external ids (e.g. Entrez Gene or Ensembl ids) so the db doesn't have a <code>"gene_name"</code> column for storing alternate gene names.

## Details

These functions return a [GRangesList](#) object where the ranges within each of the elements are ordered according to the following rule:

When using `exonsBy` and `cdsBy` with `by = "tx"`, the ranges are returned in the order they appear in the transcript, i.e. order by the `splicing.exon_rank` field in `x`'s internal database. In all other cases, the ranges will be ordered by chromosome, strand, start, and end values.

## Value

A [GRangesList](#) object.

## Author(s)

M. Carlson, P. Aboyoun and H. Pages

**See Also**

[TranscriptDb](#), [transcripts](#), [id2name](#), [transcriptsByOverlaps](#)

**Examples**

```
txdb_file <- system.file("extdata", "UCSC_knownGene_sample.sqlite",
                        package="GenomicFeatures")
txdb <- loadFeatures(txdb_file)

## Get the transcripts grouped by gene:
transcriptsBy(txdb, "gene")

## Get the exons grouped by gene:
exonsBy(txdb, "gene")

## Get the cds grouped by transcript:
cds_by_tx0 <- cdsBy(txdb, "tx")
## With more informative group names:
cds_by_tx1 <- cdsBy(txdb, "tx", use.names=TRUE)
## Note that 'cds_by_tx1' can also be obtained with:
names(cds_by_tx0) <- id2name(txdb, feature.type="tx")[names(cds_by_tx0)]
stopifnot(identical(cds_by_tx0, cds_by_tx1))

## Get the introns grouped by transcript:
intronsByTranscript(txdb)

## Get the 5' UTRs grouped by transcript:
fiveUTRsByTranscript(txdb)
fiveUTRsByTranscript(txdb, use.names=TRUE) # more informative group names
```

---

transcriptsByOverlaps

*Extract genomic features from an object based on their by genomic location*

---

**Description**

Generic functions to extract genomic features for specified genomic locations. This page documents the methods for [TranscriptDb](#) objects only.

**Usage**

```
transcriptsByOverlaps(x, ranges,
                     maxgap = 0L, minoverlap = 1L,
                     type = c("any", "start", "end"), ...)
## S4 method for signature 'TranscriptDb'
transcriptsByOverlaps(x, ranges,
                     maxgap = 0L, minoverlap = 1L,
                     type = c("any", "start", "end"),
                     columns = c("tx_id", "tx_name"))

exonsByOverlaps(x, ranges,
               maxgap = 0L, minoverlap = 1L,
```

```

        type = c("any", "start", "end"), ...)
## S4 method for signature 'TranscriptDb'
exonsByOverlaps(x, ranges,
               maxgap = 0L, minoverlap = 1L,
               type = c("any", "start", "end"),
               columns = "exon_id")

cdsByOverlaps(x, ranges,
             maxgap = 0L, minoverlap = 1L,
             type = c("any", "start", "end"), ...)
## S4 method for signature 'TranscriptDb'
cdsByOverlaps(x, ranges,
             maxgap = 0L, minoverlap = 1L,
             type = c("any", "start", "end"),
             columns = "cds_id")

```

### Arguments

x	A <a href="#">TranscriptDb</a> object.
...	Arguments to be passed to or from methods.
ranges	A <a href="#">GRanges</a> object to restrict the output.
type	How to perform the interval overlap operations of the <a href="#">ranges</a> . See the <a href="#">findOverlaps</a> manual page in the <a href="#">GRanges</a> package for more information.
maxgap	A non-negative integer representing the maximum distance between a query interval and a subject interval.
minoverlap	Ignored.
columns	Columns to include in the output. See <code>?transcripts</code> for the possible values.

### Details

These functions subset the results of [transcripts](#), [exons](#), and [cds](#) function calls with using the results of [findOverlaps](#) calls based on the specified ranges.

### Value

a [GRanges](#) object

### Author(s)

P. Aboyoun

### See Also

[TranscriptDb](#), [transcripts](#)

### Examples

```

txdb <- loadFeatures(system.file("extdata", "UCSC_knownGene_sample.sqlite",
                               package="GenomicFeatures"))
gr <- GRanges(seqnames = rep("chr1",2),
             ranges = IRanges(start=c(500,10500), end=c(10000,30000)),
             strand = strand(rep("-",2)))
transcriptsByOverlaps(txdb, gr)

```



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