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Rfam 15: RNA families database in 2025

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Abstract

The Rfam database, a widely-used repository of non-coding RNA (ncRNA) families, has undergone significant updates in release 15.0. This paper introduces major improvements, including the expansion of Rfamseq to 26,106 genomes, a 76% increase, incorporating the latest UniProt reference proteomes and additional viral genomes. Sixty-five RNA families were enhanced using experimentally determined 3D structures, improving the accuracy of consensus secondary structures and annotations. R-scape covariation analysis was used to refine structural predictions in 26 families. Gene Ontology and Sequence Ontology annotations were comprehensively updated, increasing GO term coverage to 75% of families. The release adds 14 new Hepatitis C Virus RNA families and completes microRNA family synchronisation with miRBase, resulting in 1,603 microRNA families. New data types, including FULL alignments, have been implemented. Integration with APICURON for improved curator attribution and multiple website enhancements further improve user experience. These updates significantly expand Rfam's coverage and improve annotation quality, reinforcing its critical role in RNA research, genome annotation, and the development of machine learning models. Rfam is freely available at https://rfam.org.

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Introduction

The Rfam database was established in 2002 (1) in order to provide a central repository of non-coding RNA (ncRNA) families for genomic annotations. Each family is represented by three key components: (i) a multiple sequence alignment called the SEED alignment that contains aligned sequences of homologous RNA sequences that share a consensus secondary structure, (ii) a covariance model (CM) built using the Infernal software (2) that was trained on the SEED alignment, and (ii) a set of matches that were found using the covariance model, called the set of FULL hits. The families are built manually by Rfam curators using scientific literature or alignments submitted by the community.

For each model the curators search for homologs in a sequence database, Rfamseq, and select a bit score threshold, called the gathering threshold, that separates homologous sequences from unrelated or more distantly related sequences, taking into account phylogenetic distribution of hits. The cutoff can be used by Infernal to report only sequences that score higher than this threshold when annotating genomes or searching in sequence databases.

Each major release of the Rfam database, such as 14.0 or 15.0, corresponds to a new version of Rfamseq. Prior to Rfam 13.0, Rfamseq was based on a set of sequences from the ENA database (3). However, due to the explosive growth in ENA, in Rfam 13.0 Rfamseq transitioned to a representative and reduced redundancy set of genomes produced by the UniProt team (4) for the Reference Proteomes dataset (5). The representative proteomes from UniProt are mapped to their corresponding genomes and the genomic sequence is analysed by Rfam (5). This provides users with a representative collection of genomes which have comprehensive ncRNA and protein annotations.

Rfam has been widely adopted by various scientific communities, with uses ranging from the annotation of small non-coding RNAs (ncRNAs) in genomic resources like Ensembl (6), to serving as a dataset for training machine learning models such as AlphaFold 3 (7). Additionally, Rfam is frequently used as a key reference for known non-coding RNAs. To ensure it remains current and valuable to the scientific community, we continuously review, update, and enhance the Rfam families.

In release 15.0 we have updated and expanded Rfamseq, improved families using 3D structures and R-scape (8), improved Gene Ontology (9) and Sequence Ontology (10) annotations and completed the synchronisation of miRBase (11) microRNAs into Rfam.

New Rfamseq database

Rfam 15 is based on the 2024_03 release of UniProt reference proteomes that includes 23,158 genomes (see Figure 1 showing the taxonomic distribution). We attempted to download all components of the genomes used to build the proteome set. In some cases, the specified genome was replaced by a newer version, which was used instead. In a very few cases, less than 50, all versions of the genome were either outdated or removed. In those cases we did not fetch any genome.

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In addition to the genomes in the UniProt set, we also fetched all viral genomes from the protein information resource (12) at 75% percent identity for an additional 2,985 viral genomes. This set was added because during our viral work, described below, we found that the UniProt reference proteome work under reports the diversity of viral genomes. This has led to some viral Rfam families having very few or no FULL hits. Rfam would prefer that all families have at least one match outside of the SEED sequences. While using an additional set of viral genomes leads to a large increase in the number of genomes, the total size of Rfamseq is dominated by cellular organisms as <1% of the nucleotides come from a viral genome. Table 1 shows the comparison of Rfamseq in the last major release Rfam 14.0 vs Rfam 15.0.

Table 1. The number of genomes in Rfamseq corresponding to release 14.0 and 15.0. The size on disk is the uncompressed size of all sequences in Rfamseq.

Kingdom	**Rfamseq v14**	**Rfamseq v15**
Total sequence length	3.68e11	1.46e12
Number of species	14,774	26,106
Eukaryotes	1,057	2,613
Archaea	418	370
Bacteria	7,808	9,601
Viruses	5,491	13,552
Number of Rfam hits	2,897,296	10,736,534
Size on disk	170 GB	772 GB

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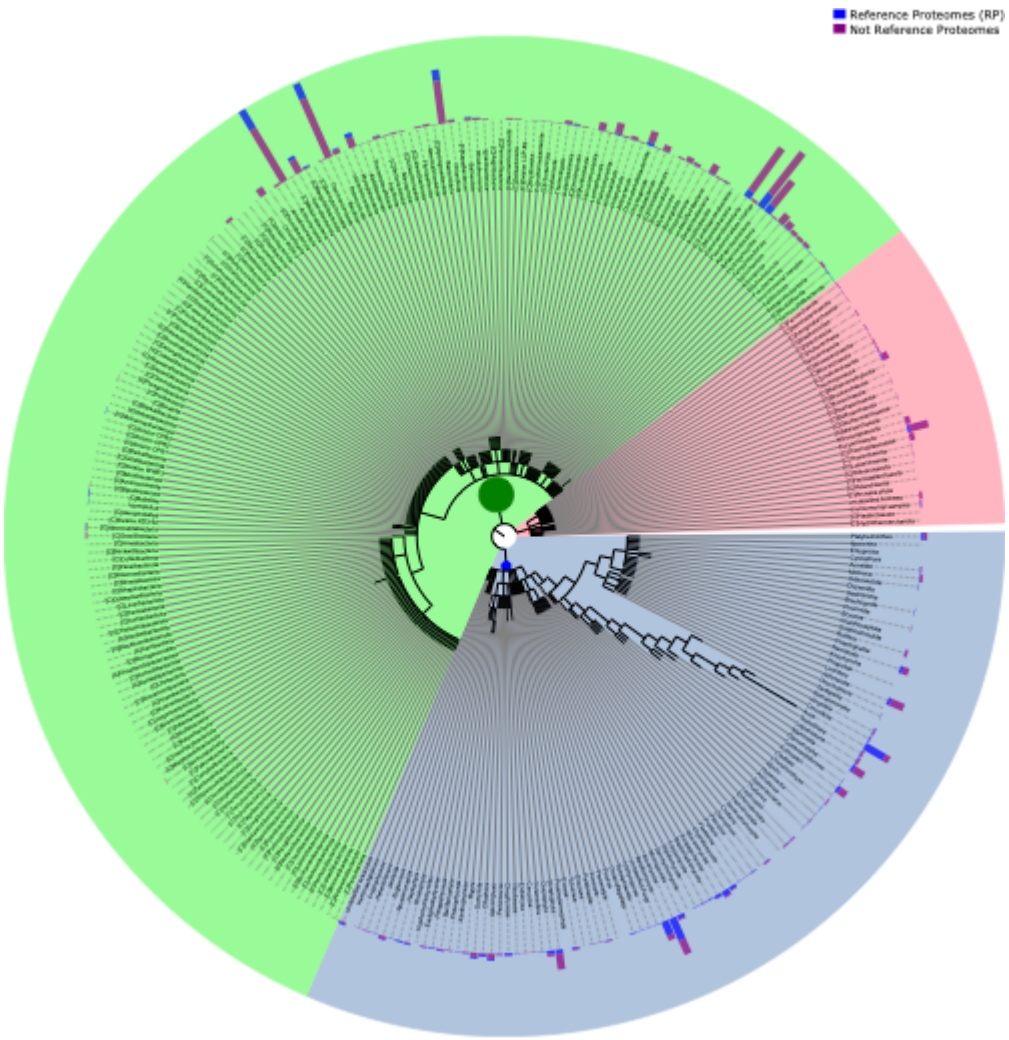

Figure 1. The taxonomic distribution of cellular organisms in Rfamseq 15 organised by the phylogenetic kingdom. Shown on the outside is the number of reference and non-reference proteomes in each lineage. Each coloured section indicates the kingdom with bacteria (green), archaea (pink) and eukaryotes (blue).

Once Rfamseq was updated all families were searched against the updated database and the matches were collected. Many older or larger families have not been rescanned in years due to technical pipeline limitations, for example, the 5S rRNA (RF00001) has not had its matches updated since 2014.

Once all families were updated, we compared the matches of families in 14.3, which was the last published version, and 15.0 to determine how Rfam has changed. Of the 3,431 families in common between 14.3 and 15.0, 98 had no FULL hits in 14.3 and when moving to 15.0, 23 of these families gained at least one hit while 21 lost all hits, leading to 96 families in 15.0 without FULL hits. Families without FULL hits occur because either the curator-selected gathering threshold of the family is too high, or if Rfamseq does not contain any similar sequences. Future work will look to see if these families require updating the threshold or if additional genomes need to be added to Rfamseq.

Of the 3,302 families with hits in both releases, the average family grew by 166%, with 2,335 gaining at least one hit, 547 losing hits and 420 with no change in the number of hits.

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Examining the families with an increase shows that there are 26 families with a greater than 10x growth. These families are primarily microRNA families matching to plant genomes. While, as described below, these families have been synchronised with miRBase, we are revisiting these families to see if they need additional future updates in the light of these additional hits, or if the genomes are poorly assembled and should be excluded from Rfamseq.

Overall the update to Rfamseq has led to a considerable change in all Rfam families. This will provide the community with a consistent and up-to-date dataset to reuse. Future updates to Rfamseq will seek to maximise the coverage of known organisms.

Improving existing Rfam families

Using RNA 3D structures to revise Rfam secondary structures

Rfam families are based on multiple sequence alignments annotated with consensus secondary structures that indicate base pairing. The accuracy and completeness of the consensus secondary structure is of critical importance as it guides the SEED alignment, informs the Infernal CM, and is used for training and benchmarking of software for RNA 2D and 3D structure prediction, including AlphaFold 3 (7) and R-scape (8).

Most of the Rfam families with known 3D structure were created prior to the 3D structure determination using less accurate, predicted secondary structures. For example, while the FMN riboswitch family (RF00050) correctly captured 5 helices of the FMN riboswitch, it did not include 1 helix, 2 pseudoknots, and several key base pairings (Figure 2B). As such, one major goal of this project was to include the pseudoknots which are observed in 3D structures into the Rfam families.

To aid the Rfam curators with updating Rfam alignments an automated pipeline was developed to map RNA sequences and secondary structures of experimentally determined RNA 3D structures to Rfam SEED alignments. Every week Rfam families are mapped to the latest set of RNA chains from PDB (13) using the Infernal *cmscan* program. For each Rfam family with one or more matching structures, the sequences and secondary structures are iteratively added to the alignment in the Stockholm format using Infernal's *cmalign* program. The base pairing information, as determined by FR3D (14), is also included in the alignment as an additional GR annotation line (one per 3D structure). The pipeline is automatically executed weekly and the Rfam curators receive notifications of newly mapped structures (Figure 2A).

The resulting alignments undergo manual review to determine whether the family consensus secondary structure is consistent with the base pair information from PDB structures. The structure and annotated based pairs are always kept in the alignment, even in cases where the structure is not used to update the consensus secondary structure, e.g. low resolution structure or non-canonical base pairs. Additional annotations are also included in the Stockholm files, such as RNA structural elements. For example P1, P2, and P3 domains are included in the Pistol ribozyme RF02679, while the SAM riboswitch (RF00162) now includes a kink-turn annotation.

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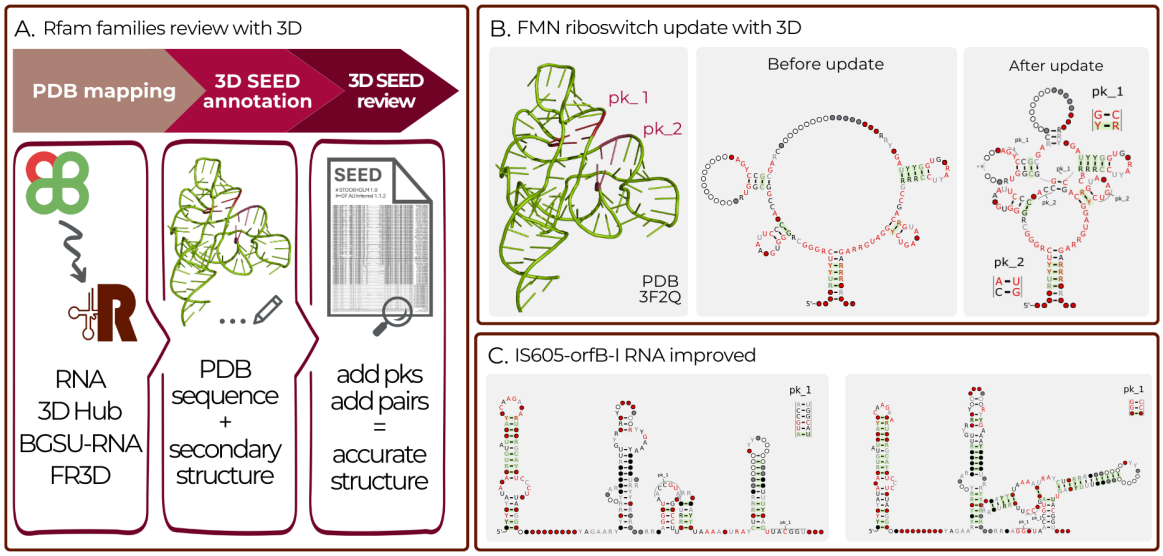

Figure 2. A) Pipeline for reviewing Rfam families using experimentally determined RNA 3D structures from PDB. B) Example of the FMN riboswitch (RF00050) before and after improvements with a 3D structure. Improvements included adding 2 pseudoknots and creating a missing helicees. C) A summary of how the IS605-orfB-I RNA (RF03065) family was reviewed and improved using R-scape.

Our pipeline detects 143 Rfam families which match at least one 3D structure. We began updating families with 3D structures in release 14.5 and since then Rfam has updated 65 families, with 298 chains from 3D structures. This includes well known families such as the SAM riboswitch (RF00162), the FMN riboswitch (RF00050) and microRNA 16 precursor (RF00254). The updates included the addition of pseudoknots (PK) in 42 of the 65 families, of which 6 had 2 PK, and 1 had 3. These features include ligand binding sites for riboswitches (28 annotations), locations of well known motifs such kink-turns (8 annotations), and structural regions such as helices and domains (60 annotations). A detailed table showing which families were updated with which 3D structures and can also be found online at https://rfam.org/3d. Rfam curators work to keep families as up-to-date with the latest structures as possible, which has led to 11 families being updated more than once since release 14.5.

The review of structures is part of the ongoing curation process, and additional families will be improved in future releases. The pipeline is implemented in Python and is available at https://github.com/Rfam/rfam-3d-seed-alignments and the weekly updates are found in the file pdb_full_region.txt.gz located in the preview section of the FTP archive (http://ftp.ebi.ac.uk/pub/databases/Rfam/.preview/).

Using R-scape to improve Rfam consensus secondary structures

Since version 13.0 (5) the Rfam website included the results of the R-scape analysis (8) to help users evaluate consensus secondary structures for each Rfam family, as well as alternative secondary structures generated using the R-scape CaCoFold algorithm. CaCoFold evaluates all possible consensus secondary structures that are consistent with multiple

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sequence alignment and can propose a structure maximising the number of base pairs with statistically significant covariation (15).

In release 14.9, the R-scape software was used to systematically review all Rfam families and identify those that could be enhanced using R-scape CaCoFold structures. We examined all families with an increased number of covarying base pairs and selected 26 families for updates. These families are listed in Table 2. Shown in Figure 2C is an example of a family, IS605-orfB-I, before and after improvement.

Table 2: Summary of the R-scape based improvements. This shows the families which were improved by using R-scape CaCoFold structures.

Family	**Additional Covarying Basepairs**
RF02033 (HEARO)	24
RF03065 (IS605-orfB-I)	14
RF03068 (RT-3)	8
RF03072 (raiA)	5
RF02969 (DUF3800-I)	4
RF01688 (Actino-pnp)	3
RF02004 (group-II-D1D4-5)	3
RF02005 (group-II-D1D4-6)	3
RF02913 (pemK)	3
RF03077 (RT-2)	3
RF03135 (L4-Archaeoglobi)	3
RF03144 (eL15-Euryarchaeota)	3
RF00062 (HgcC)	2
RF01731 (TwoAYGGAY)	2
RF01794 (sok)	2
RF02221 (sRNA-Xcc1)	2
RF02947 (cow-rumen-2)	2
RF03000 (LOOT)	2
RF03158 (L31-Actinobacteria)	2
RF01864 (plasmodium_snoR21)	1
RF01867 (CC2171)	1
RF02944 (c4-2)	1
RF02968 (DUF3800-IX)	1

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RF02987 (GA-cis)	1
RF03019 (RT-16)	1
RF03046 (Pseudomonadales-1)	1

Gene and Sequence Ontology annotations

Rfam is commonly used as a source of functional information for non-coding RNAs. This takes several forms, from users reading our curated descriptions and Wikipedia articles to understand the role of an ncRNA, to using the Gene Ontology (GO) and Sequence Ontology (SO) annotations that Rfam curators provide to understand the role of an ncRNA. Rfam is the largest source of GO annotations with over 10 million sequences having an Rfam based GO annotation. In addition to providing information to human users, Rfam is also used in training Large Language Models (LLM). LLMs such as ChatGPT and Claude have clearly been trained on Rfam data and are able to output entries in the formats, Stockholm and DESC, that Rfam uses. Thus providing a completely new way for scientists to access the information found in Rfam.

The Gene Ontology is a resource to classify and provide functional information for biomolecules using structured annotations and ontologies (9). Similarly the Sequence Ontology provides an ontology and structured annotations for the types of biomolecules (10). Both resources are continuously updated to better reflect scientific knowledge. For example, since the last publication of Rfam the SO gained several terms specific to the location of rRNA, e.g. cytosolic_rRNA (SO:0002343) and obsoleted the more generic rRNA terms.

Rfam provides GO and SO annotations for families, however, these annotations are not regularly reviewed to stay up-to-date with the latest changes in the ontologies. As an example, prior to 15.0 the rRNA families used obsoleted SO terms. For 15.0 we manually reviewed all annotations and updated them to better reflect changes in the GO and SO, as well as improved the specificity of annotations where possible.

We ensured that all families had at least one up-to-date SO term and the annotation was as specific as possible. For GO terms, we ensured the terms were up-to-date and added related terms where possible. A few examples of the changes we made were to 1) ensure all snoRNAs had a snoRNA specific SO term and included an RNA processing GO term; 2) add the sodium ion binding term to the NA+ riboswitch; and 3) updated families with the generic mature_transcript SO term to the more specific ncRNA SO term. Of the 3,431 common families between 14.3 and 15.0 2,084 had a GO term in 14.3 while 2,426 did in 15.0. For all families in 15.0 we now have at least one GO term for 3,157, which covers 75% of all families, an increase from 60% in 14.3. These changes increased the total number of GO terms from 3,752 to 4,446. As these updates propagate through the community, we expect these changes to lead to millions more sequences annotated with functional information.

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Viral RNAs

Starting with Rfam 14.3 we collaborated with the Marz group to develop a new workflow for viral RNA families (16). This workflow is based upon whole genome alignments of viruses and led to the creation of *Flaviviridae* and *Coronaviridae* families as described previously (16). Since the last publication we have continued to use this workflow and have added *Hepatitis C Virus* (HCV) (17) families. We included 14 new families and removed 4 outdated families. A schematic of the new families can be seen in Figure 3. These families include structures found in both the non-coding and coding regions of the viral alignments. All viral families organised by viral clade can be seen at https://rfam.org/viruses. We plan to continue to use the viral pipeline and improve the representation of viral families in Rfam and expect to focus on HDV and pestivirus families in the near future.

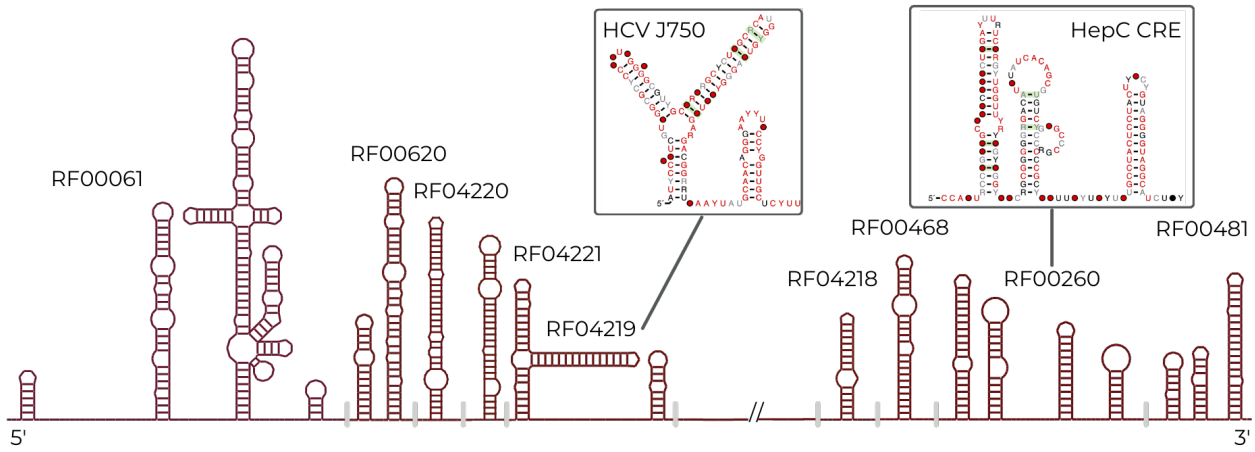

Figure 3: A schematic of the HCV viral families Rfam now contains. These families were built from whole genome alignments, as described in (17). The figure shows their relative locations in the HCV genomic alignment and shown in the inset are two of the new HCV families.

MicroRNAs

MicroRNAs are an important class of ncRNA that regulate gene expression in animals and plants, with many microRNAs being implicated in disease. For example, the mir-17~92 cluster (18) and mir-155 (19) are amongst a number of microRNAs which act as oncogenes. Understanding the evolutionary and family relationships of microRNAs across species allows the transfer of annotation, for example from model organisms to humans and vice versa.

Since early releases, Rfam has included microRNA families, e.g let-7 (20) was deposited in 2002 for Rfam 1.1. However, they were not subject to regular review and were not coordinated with miRBase (11), an authoritative resource for microRNA annotation that assigns identifiers for microRNA genes and sequences. As of Rfam 13.0, out of 1,983 microRNA families found in miRBase v21, only 28% matched one or more of the 529 Rfam microRNA families.

Starting in Rfam 14, we began systematically reviewing microRNA families with the goal to synchronise Rfam microRNA families with miRBase. To this end, we worked to ensure that

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the SEED alignments of all microRNA families in Rfam were built from microRNA sequences that are tracked in the miRBase database. Multiple sequence alignments of microRNA sequences were extracted from miRBase and mapped to Rfam accessions. Each sequence was assigned a RNAcentral Unique RNA Sequence (URS) (21) identifier to remove sequence redundancy and represent only distinct sequences for each species. For each alignment a covariance model was built using Infernal and used to search the Rfamseq database. Bit score thresholds for each model (known as gathering thresholds (16)) were manually curated. These thresholds enable automatic and accurate genome annotation using Rfam microRNA families with Infernal.

Pre-existing Rfam microRNA families were reviewed and replaced with miRBase-derived SEED alignments where possible. New families were created when Rfam did not already represent the microRNA sequences. MicroRNA families found in Rfam that did not match miRBase were reviewed and updated or deleted. In cases where the miRBase alignment matched several Rfam families we manually inspected the alignment and families and split and merged families and built clans of families as appropriate.

Rfam release 15.0 marks the completion of the synchronisation process, as we have processed all microRNA alignments from miRBase. For roughly 200 miRBase-derived alignments, we determined that the family was not suitable for inclusion into Rfam. In most cases this was because there was a single unique sequence in the miRBase alignment. A small fraction of the alignments which have not been added may be removed from miRBase in the future. Table 3 shows the summary of changes since release 14.3, and a list of all microRNA families is found in Supplementary information in Table S1. All miRBase microRNA sequences that are not represented in updated Rfam families will be periodically and systematically reviewed in a cycle of improvements and curation of both Rfam and miRBase. Rfam and miRBase will continue to synchronise our resources as new microRNAs and new microRNA alignments are available, with miRBase acting as the repository of microRNA sequences, and Rfam as the authority on the grouping of those sequences into families. Rfam microRNA family classifications will be available through both resources.

Table 3: A summary of the changes in Rfam microRNA families since last publication (16) with release 14.3.

	Changes for Rfam 15.0
Total number of microRNA families	1,603
New families	722
Updated families	881
Deleted families	8

New families

While the primary focus of Rfam has been to complete the microRNA project, and improve existing families with 3D structures, we have continued to create new families. Since Rfam 14.3 (16), Rfam has created 16 new non-microRNA or viral RNA families. The families cover

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a range of phylogenetic and functional types. A few examples include Bacteroidales small SRP (RF04183), the signal recognition particle RNA of Bacteroidetes (22), Hairpin-meta1, a virus-like ribozyme reported in RNA satellites of plant viruses (RF04190) (23), Hovlinc ribozyme (RF04188) (24), a newly discovered type of self-cleaving ribozymes found in human and other hominids and RF04222 PLRV xrRNA, a exoribonuclease-resistant RNA detected in Flavivirus Potato virus (25), RF04247 bZIP family which is a non canonical Hac1/Xbp1 intron found in *Metazoa* (26). Shown in Figure 4 are the secondary structures of selected families.

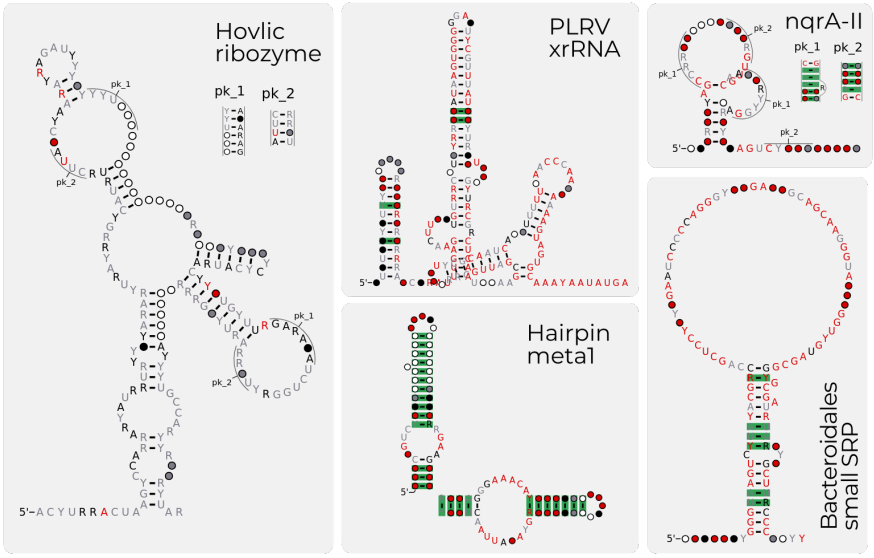

Figure 4: A selection of the new families for Rfam 15.0. The five families shown Hovlinc ribozyme (RF04188), the PLRV xrRNA (RF04222), the hairpin meta ribozyme (RF04190), nqrA-II ncRNA motif (RF04310) and Bacteriodales small SRP (RF04183) are several of the new families created for Rfam 15.0.

These families are curated through a combination of literature reviews and community submissions. We actively encourage groups with candidate RNAs to contribute their alignments and secondary structure data to Rfam. However, it is important to note that Rfam requires all sequences in SEED alignments to be traceable to public databases such as GenBank (27) or RNAcentral (21). With the increasing ease of sequencing, many laboratories maintain private sequence databases for constructing alignments. As a result, many of these new alignments cannot be incorporated into Rfam due to the lack of traceable public records. We strongly recommend that the scientific community submit their sequences to publicly accessible databases, ensuring they are available for reuse and analysis by the broader research community. Furthermore, when publishing alignments, using public accessions will facilitate faster and more efficient integration into resources like Rfam.

Other improvements

Updating FULL alignments

Rfam provides several data types for interested users to download from our FTP site. These include the SEED alignments, CMs and FULL sequences. Older versions of Rfam included

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FULL alignments, which are an alignment of all matching sequences to the CM. Previously, these were no longer produced because of technical limitations, however, with improvements to infernal and growth in available compute power it is now possible to create these alignments again. We now produce full alignments for all Rfam families. These are available for each model in the 'full_alignments' section on the FTP site (https://ftp.ebi.ac.uk/pub/databases/Rfam/CURRENT/full_alignments).

APICURON integration

APICURON (https://apicuron.org/) is a database to track and credit biocurators for the work they do (28). The database allows for databases to credit curators for each activity they perform and provides overall statistics for each database including Rfam. In Rfam, it is common for a curator to perform many small updates and fixes to families to produce a release. Currently, this work goes unacknowledged except during publication, which are generally separated by several years. By integrating with APICURON we are able to display all the changes curators perform as part of their duties on a more regular schedule. Additionally, APICURON updates ORCID records (https://orcid.org/) to help credit curators for their activities. We update our APICURON records with each release and our APICURON page is available at: https://apicuron.org/databases/rfam. APICURON requires that each resource track the activities of each curator, unfortunately some historical Rfam activity does not have the required specificity, leading to some older curators lacking attributions. This is being worked on and we hope to properly credit all curators for their contributions to Rfam.

Website improvements

The Rfam website (http://rfam.org) has undergone continuous development since our last publication. We have added several new features, such as dedicated landing pages for each project, e.g. viral families can easily be browsed at http://rfam.org/viruses. These pages make it simpler for users interested in a particular project, e.g. the 3D structure alignments, to see our progress and fetch all data related to the project.

We have recently updated some terminology used for riboswitch families in Rfam. We have found that some users are confused that Rfam riboswitch families generally include just the aptamer domains. This is because aptamers align well, while it is difficult to build an alignment of a whole riboswitch. We have added a short note to the header of each Rfam riboswitch page to indicate that this family is only the aptamer domain and a short explanation of what that means. Additionally, the descriptions of families now include the term 'aptamer' to clarify this point. We have not updated the identifiers or accessions of any families.

Finally, we have integrated the RNAcentral LitScan widget from RNAcentral. RNAcentral has developed a pipeline, LitScan, which identifies and extracts mentions of any non-coding RNA in all open access literature (29). The result of this pipeline can be reused by embedding a simple HTML widget. The widget allows users to browse and search the related literature in a convenient way. We have embedded this widget on all Rfam family pages under the new 'Publications' tab. The results are updated with each RNAcentral release, roughly every 4 months. An example of the widget for the Glutamine riboswitch family page is shown in Figure 5.

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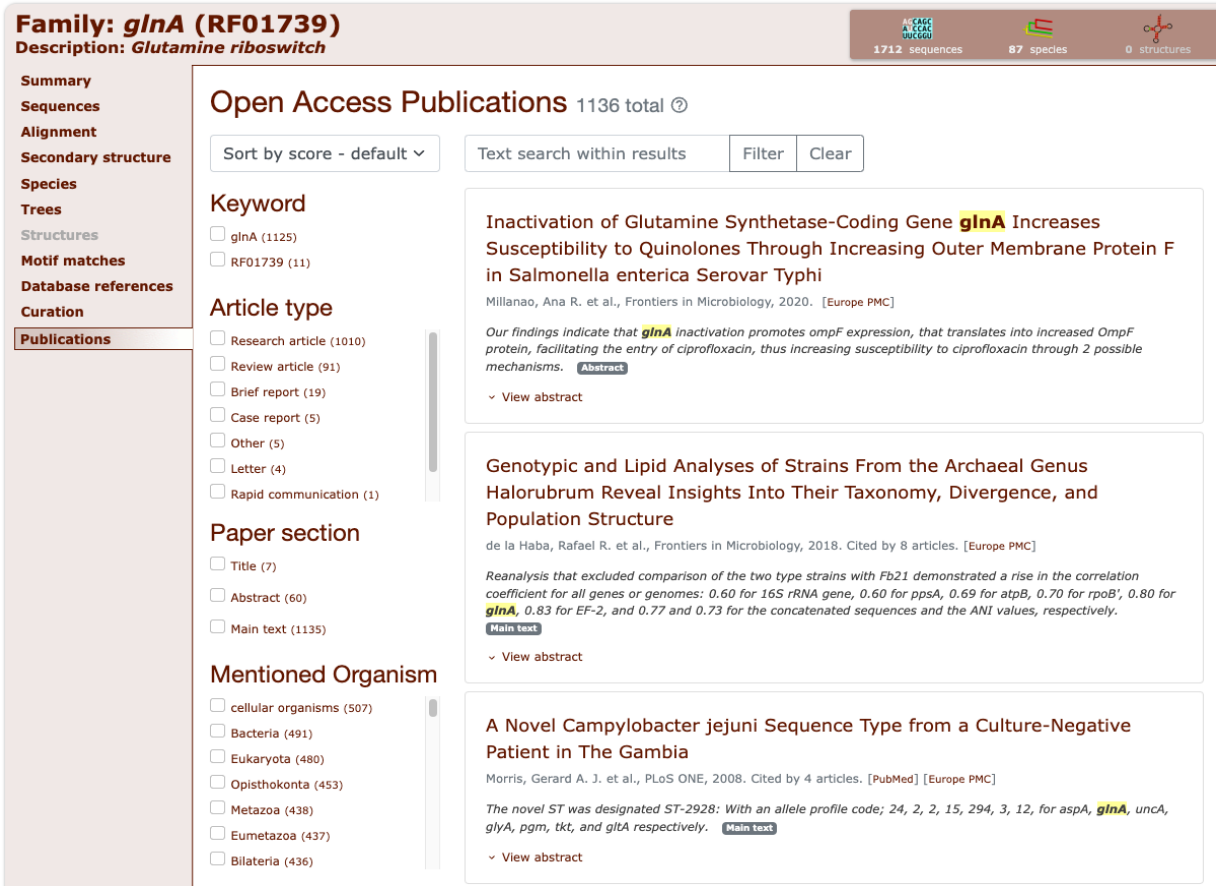

Figure 5: The LitScan widget embedded in the Glutamine riboswitch family page. This widget shows users which open access articles mention the family. Families are searched using their Rfam ID and Rfam accession in all open access literature. It allows users to search the matched articles by several types of metadata such as the article type (research, review, report, etc), the section of the paper which mentions the family and organisms mentioned in the paper. Additionally, users can perform a text search within the sentences which mention the Rfam family.

Conclusions

After more than 20 years of work (1), Rfam has grown to over 4,000 families and continues to be a key resource in RNA science. We continue to provide a large centralised collection of ncRNA families, which are used in many ways. Rfam was originally created to annotate genomes, but we have grown far beyond that use case. We would like to take this opportunity to thank everyone who has worked on or collaborated with Rfam over the past 20 years. Anyone interested in learning about the history and changes in Rfam since its inception are encouraged to visit https://rfam.org/rfam20 to find interviews with many former and current staff and users.

Since our last publication we have focused on completing our synchronisation with miRBase and improving existing families using R-scape and 3D structures. This has led to a large increase in the number and quality of families. Rfam plans to stay synchronised with miRBase and complete the 3D structure improvements by connecting each family to at least one

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structure where possible. Outside of those projects, we will continue to import viral RNAs and return to capturing more novel families discovered by the community. Finally, we will explore ways to expand Rfamseq to better improve our coverage of the phylogenetic space.

It is essential to note that there has been a major shift in bioinformatics with the publication of AlphaFold and its effect on protein structure prediction. We expect that as the field of RNA structure prediction matures, Rfam will continue to play a key role as a source of ground truth. In order to best serve this new use case, we will begin exploring ways to grow faster than before, while maintaining the high standards the community has come to expect of Rfam alignments. This will be essential to providing the test and training sets required for deep learning based approaches.

Finally, we encourage any interested community members to reach out for collaboration or to provide data. As discussed here, much of our major work is carried out with interested community members and can lead to new directions for the resource. We invite new data submissions and feedback at https://docs.rfam.org/page/contact-us.html.

Data availability

All Rfam data are released under the Creative Commons Zero (CC0) licence at https://rfam.org. The data can be accessed via an API, a public MySQL database, and the FTP archive. The Rfam documentation (https://docs.rfam.org) and (30) contain detailed instructions. All code is available on GitHub under the Apache 2.0 licence at https://github.com/Rfam.

Funding

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Conflict of interest

AB is a member of the Nucleic Acids Research Editorial Board.

Acknowledgements

The authors would like to thank the community for its excellent feedback and the organisers of the Benasque 2022 and 2024 meetings where several collaborations described in this paper were established. We would also like to thank the broader RNA community community for their contributions, including providing alignments and feedback for families. In particular we thank Lars Barquist, Fei Qi, Christina Weinberg, Zasha Weinberg and Quentin Vincens who kindly shared their data with us and worked with us in the creation of new families.

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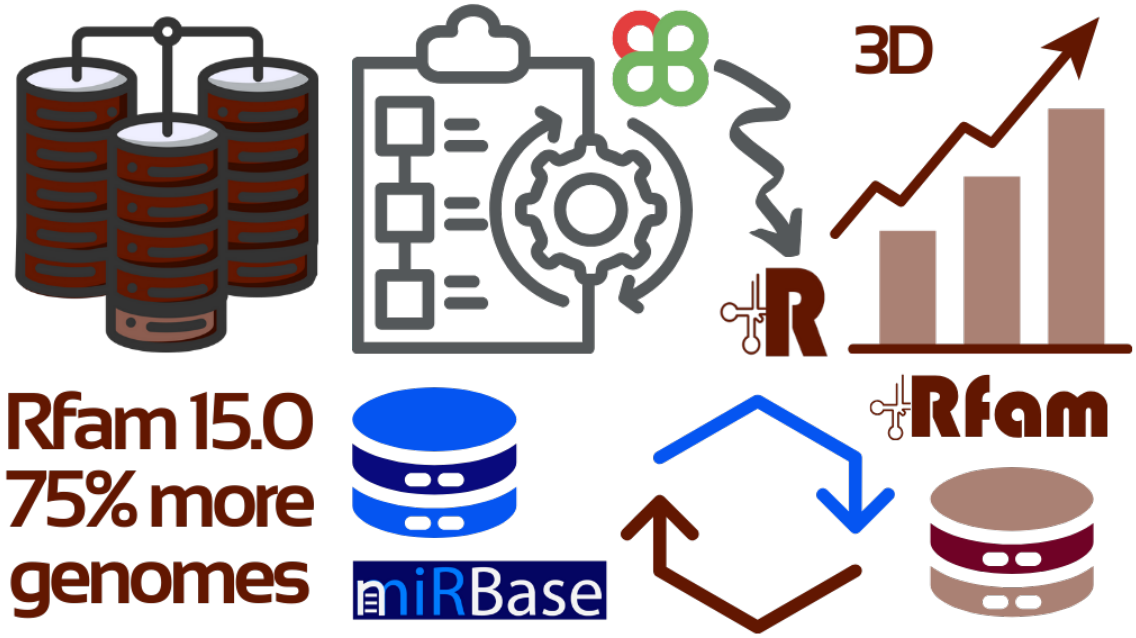
Graphical Abstract



Rfam has undergone a major update with the release of 15.0. We have increased the number of genomes in our sequence database Rfamseq by 75%, completed the synchronisation with miRBase and improved 65 families using 3D structures.

References

1. Griffiths-Jones,S., Bateman,A., Marshall,M., Khanna,A. and Eddy,S.R. (2003) Rfam: an RNA family database. *Nucleic Acids Res.*, **31**, 439–441.

2. Nawrocki,E.P. and Eddy,S.R. (2013) Infernal 1.1: 100-fold faster RNA homology searches. *Bioinformatics*, **29**, 2933–2935.

3. Nawrocki,E.P., Burge,S.W., Bateman,A., Daub,J., Eberhardt,R.Y., Eddy,S.R., Floden,E.W., Gardner,P.P., Jones,T.A., Tate,J., *et al.* (2015) Rfam 12.0: updates to the RNA families database. *Nucleic Acids Res.*, **43**, D130–7.

4. UniProt Consortium (2023) UniProt: the Universal Protein Knowledgebase in 2023. *Nucleic Acids Res.*, **51**, D523–D531.

5. Kalvari,I., Argasinska,J., Quinones-Olvera,N., Nawrocki,E.P., Rivas,E., Eddy,S.R., Bateman,A., Finn,R.D. and Petrov,A.I. (2018) Rfam 13.0: shifting to a genome-centric resource for non-coding RNA families. *Nucleic Acids Res.*, **46**, D335–D342.

6. Harrison,P.W., Amode,M.R., Austine-Orimoloye,O., Azov,A.G., Barba,M., Barnes,I., Becker,A., Bennett,R., Berry,A., Bhai,J., *et al.* (2024) Ensembl 2024. *Nucleic Acids Res.*, **52**, D891–D899.

7. Abramson,J., Adler,J., Dunger,J., Evans,R., Green,T., Pritzel,A., Ronneberger,O., Willmore,L., Ballard,A.J., Bambrick,J., *et al.* (2024) Accurate structure prediction of biomolecular interactions with AlphaFold 3. *Nature*, 10.1038/s41586-024-07487-w.

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8. Rivas,E., Clements,J. and Eddy,S.R. (2020) Estimating the power of sequence covariation for detecting conserved RNA structure. *Bioinformatics*, **36**, 3072–3076.

9. Gene Ontology Consortium, Aleksander,S.A., Balhoff,J., Carbon,S., Cherry,J.M., Drabkin,H.J., Ebert,D., Feuermann,M., Gaudet,P., Harris,N.L., *et al.* (2023) The Gene Ontology knowledgebase in 2023. *Genetics*, **224**.

10. Sant,D.W., Sinclair,M., Mungall,C.J., Schulz,S., Zerbino,D., Lovering,R.C., Logie,C. and Eilbeck,K. (2021) Sequence Ontology terminology for gene regulation. *Biochim. Biophys. Acta Gene Regul. Mech.*, **1864**, 194745.

11. Kozomara,A., Birgaoanu,M. and Griffiths-Jones,S. (2019) miRBase: from microRNA sequences to function. *Nucleic Acids Res.*, **47**, D155–D162.

12. Wu,C.H., Yeh,L.-S.L., Huang,H., Arminski,L., Castro-Alvear,J., Chen,Y., Hu,Z., Kourtesis,P., Ledley,R.S., Suzek,B.E., *et al.* (2003) The Protein Information Resource. *Nucleic Acids Res.*, **31**, 345–347.

13. Armstrong,D.R., Berrisford,J.M., Conroy,M.J., Gutmanas,A., Anyango,S., Choudhary,P., Clark,A.R., Dana,J.M., Deshpande,M., Dunlop,R., *et al.* (2020) PDBe: improved findability of macromolecular structure data in the PDB. *Nucleic Acids Res.*, **48**, D335–D343.

14. Sarver,M., Zirbel,C.L., Stombaugh,J., Mokdad,A. and Leontis,N.B. (2008) FR3D: finding local and composite recurrent structural motifs in RNA 3D structures. *J. Math. Biol.*, **56**, 215–252.

15. Rivas,E. (2020) RNA structure prediction using positive and negative evolutionary information. *PLoS Comput. Biol.*, **16**, e1008387.

16. Kalvari,I., Nawrocki,E.P., Ontiveros-Palacios,N., Argasinska,J., Lamkiewicz,K., Marz,M., Griffiths-Jones,S., Toffano-Nioche,C., Gautheret,D., Weinberg,Z., *et al.* (2021) Rfam 14: expanded coverage of metagenomic, viral and microRNA families. *Nucleic Acids Res.*, **49**, D192–D200.

17. Triebel,S., Lamkiewicz,K., Ontiveros,N., Sweeney,B., Stadler,P.F., Petrov,A.I., Niepmann,M. and Marz,M. (2024) Comprehensive survey of conserved RNA secondary structures in full-genome alignment of Hepatitis C virus. *Sci. Rep.*, **14**, 15145.

18. Zhao,W., Gupta,A., Krawczyk,J. and Gupta,S. (2022) The miR-17-92 cluster: Yin and Yang in human cancers. *Cancer Treat. Res. Commun.*, **33**, 100647.

19. Wang,F., Wang,J., Zhang,H., Fu,B., Zhang,Y., Jia,Q. and Wang,Y. (2024) Diagnostic value of circulating miR-155 for breast cancer: a meta-analysis. *Front. Oncol.*, **14**, 1374674.

20. Rougvie,A.E. (2001) Control of developmental timing in animals. *Nat. Rev. Genet.*, **2**, 690–701.

21. RNAcentral Consortium (2021) RNAcentral 2021: secondary structure integration, improved sequence search and new member databases. *Nucleic Acids Res.*, **49**, D212–D220.

22. Ryan,D., Jenniches,L., Reichardt,S., Barquist,L. and Westermann,A.J. (2020) A high-resolution transcriptome map identifies small RNA regulation of metabolism in the gut microbe Bacteroides thetaiotaomicron. *Nat. Commun.*, **11**, 3557.

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23. Weinberg,C.E., Olzog,V.J., Eckert,I. and Weinberg,Z. (2021) Identification of over 200-fold more hairpin ribozymes than previously known in diverse circular RNAs. *Nucleic Acids Res.*, **49**, 6375–6388.

24. Chen,Y., Qi,F., Gao,F., Cao,H., Xu,D., Salehi-Ashtiani,K. and Kapranov,P. (2021) Hovlinc is a recently evolved class of ribozyme found in human lncRNA. *Nat. Chem. Biol.*, **17**, 601–607.

25. Steckelberg,A.-L., Vicens,Q., Costantino,D.A., Nix,J.C. and Kieft,J.S. (2020) The crystal structure of a Polerovirus exoribonuclease-resistant RNA shows how diverse sequences are integrated into a conserved fold. *RNA*, **26**, 1767–1776.

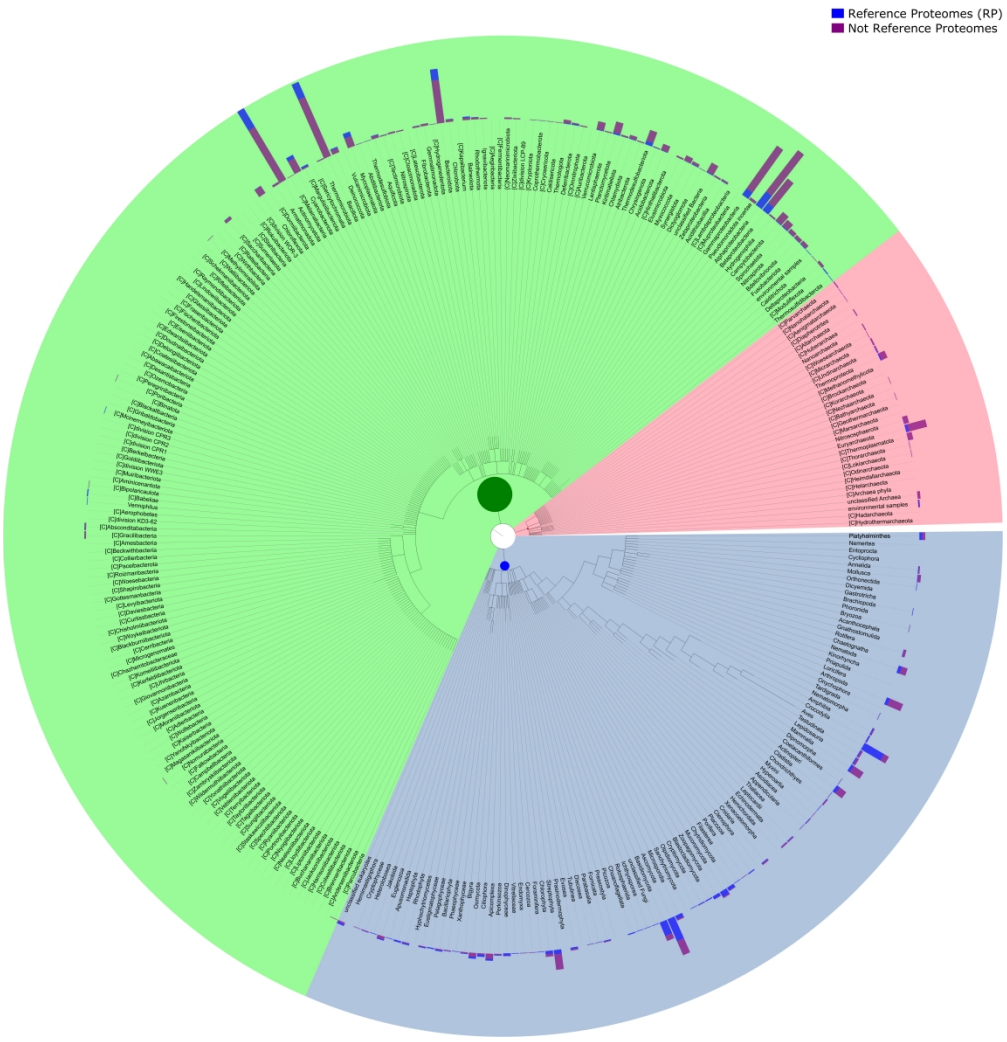
26. Hooks,K.B. and Griffiths-Jones,S. (2011) Conserved RNA structures in the non-canonical Hac1/Xbp1 intron. *RNA Biol.*, **8**, 552–556.

27. Benson,D.A., Cavanaugh,M., Clark,K., Karsch-Mizrachi,I., Lipman,D.J., Ostell,J. and Sayers,E.W. (2013) GenBank. *Nucleic Acids Res.*, **41**, D36–42.

28. Hatos,A., Quaglia,F., Piovesan,D. and Tosatto,S.C.E. (2021) APICURON: a database to credit and acknowledge the work of biocurators. *Database* , **2021**.

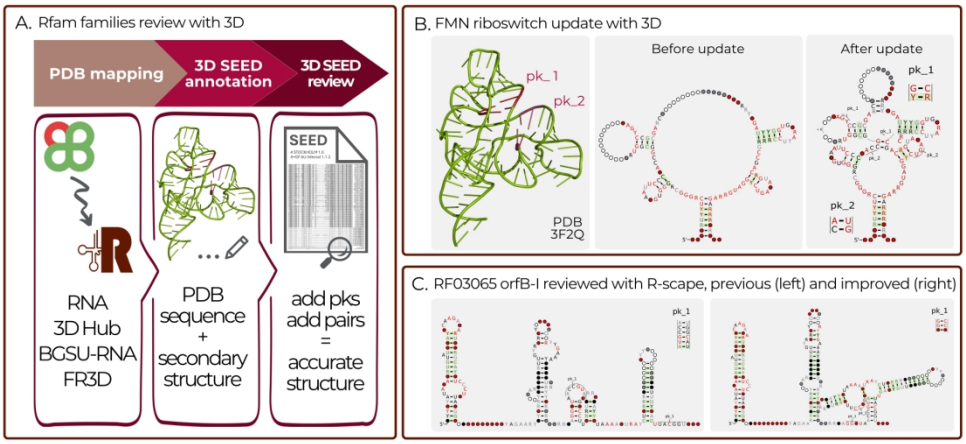
29. Green,A., Ribas,C., Ontiveros-Palacios,N., Griffiths-Jones,S., Petrov,A.I., Bateman,A. and Sweeney,B. (2023) LitSumm: Large language models for literature summarisation of non-coding RNAs. *arXiv [q-bio.GN]*.

30. Kalvari,I., Nawrocki,E.P., Argasinska,J., Quinones-Olvera,N., Finn,R.D., Bateman,A. and Petrov,A.I. (2018) Non-Coding RNA Analysis Using the Rfam Database. *Curr. Protoc. Bioinformatics*, **62**, e51.



The taxonomic distribution of cellular organisms in Rfamseq 15 organised by the phylogenetic kingdom. Shown on the outside is the number of reference and non-reference proteomes in each lineage. Each coloured section indicates the kingdom with bacteria (green), archaea (pink) and eukaryotes (blue).

1291x1329mm (118 x 118 DPI)



A) Pipeline for reviewing Rfam families using experimentally determined RNA 3D structures from PDB. B) Example of the FMN riboswitch (RF00050) before and after improvements with a 3D structure. Improvements included adding 2 pseudoknots and creating a missing helicees. C) A summary of how the IS605-orfB-I RNA (RF03065) family was reviewed and improved using R-scape.

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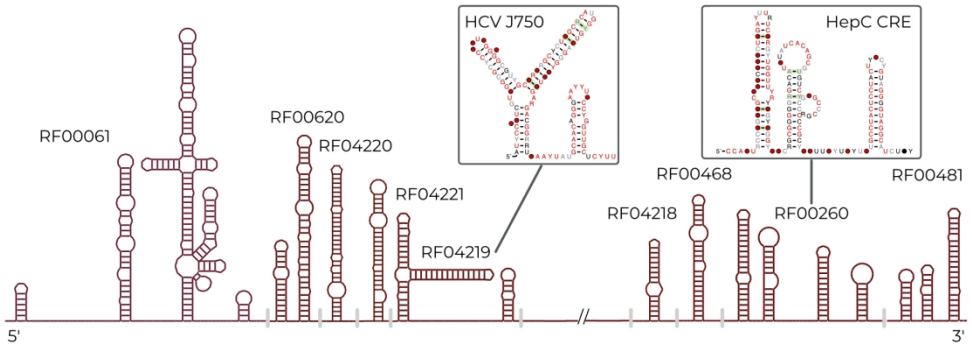
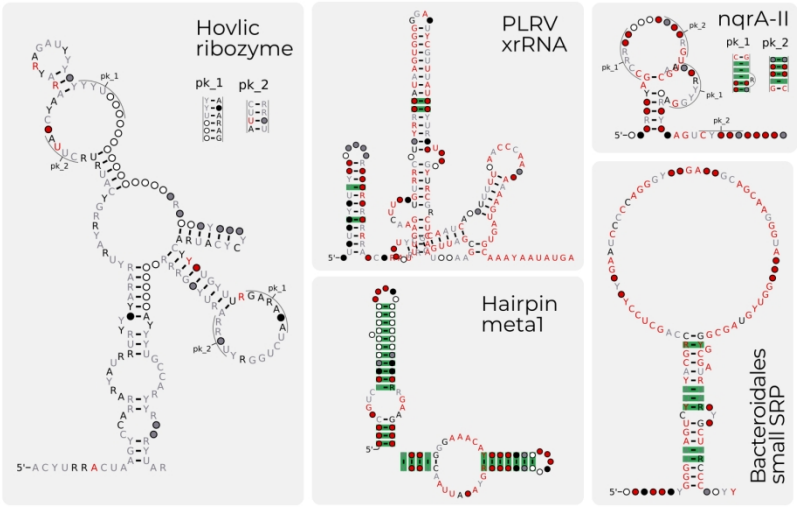


A schematic of the HCV viral families Rfam now contains. These families were built from whole genome alignments, as described in (17). The figure shows their relative locations in the HCV genomic alignment and shown in the inset are two of the new HCV families.

1283x721mm (38 x 38 DPI)



A selection of the new families for Rfam 15.0. The five families shown Hovlinc ribozyme (RF04188), the PLRV xrRNA (RF04222), the hairpin meta ribozyme (RF04190), nqrA-II ncRNA motif (RF04310) and Bacteriodales small SRP (RF04183) are several of the new families created for Rfam 15.0.

1283x721mm (38 x 38 DPI)

The LitScan widget embedded in the Glutamine riboswitch family page. This widget shows users which open access articles mention the family. Families are searched using their Rfam ID and Rfam accession in all open access literature. It allows users to search the matched articles by several types of metadata such as the article type (research, review, report, etc), the section of the paper which mentions the family and organisms mentioned in the paper. Additionally, users can perform a text search within the sentences which mention the Rfam family.

424x318mm (72 x 72 DPI)

Rfam has undergone a major update with the release of 15.0. We have increased the number of genomes in our sequence database Rfamseq by 75%, completed the synchronisation with miRBase and improved 65 families using 3D structures.

1283x721mm (38 x 38 DPI)

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Kingdom	Rfamseq v14	Rfamseq v15
Total sequence length	3.68e11	1.46e12
Number of species	14,774	26,106
Eukaryotes	1,057	2,613
Archaea	418	370
Bacteria	7,808	9,601
Viruses	5,491	13,552
Number of Rfam hits	2,897,296	10,736,534
Size on disk	170 GB	772 GB

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Family	Additional Covarying Basepairs
RF02033 (HEARO)	24
RF03065 (IS605-orfB-I)	14
RF03068 (RT-3)	8
RF03072 (raiA)	5
RF02969 (DUF3800-I)	4
RF01688 (Actino-pnp)	3
RF02004 (group-II-D1D4-5)	3
RF02005 (group-II-D1D4-6)	3
RF02913 (pemK)	3
RF03077 (RT-2)	3
RF03135 (L4-Archaeoglobi)	3
RF03144 (eL15-Euryarchaeota)	3
RF00062 (HgcC)	2
RF01731 (TwoAYGGAY)	2
RF01794 (sok)	2
RF02221 (sRNA-Xcc1)	2
RF02947 (cow-rumen-2)	2
RF03000 (LOOT)	2
RF03158 (L31-Actinobacteria)	2
RF01864 (plasmodium_snoR21)	1
RF01867 (CC2171)	1
RF02944 (c4-2)	1
RF02968 (DUF3800-IX)	1
RF02987 (GA-cis)	1
RF03019 (RT-16)	1
RF03046 (Pseudomonadales-1)	1

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	Changes for Rfam 15.0
Total number of microRNA families	1,603
New families	722
Updated families	881
Deleted families	8

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Rfam Accession	Rfam ID	miRBase Family Accession
RF00027	let-7	MIPF0000002
RF00047	mir-2	MIPF0000049
RF00051	mir-17	MIPF0000001
RF00052	lin-4	MIPF0000303
RF00053	mir-7	MIPF0000022
RF00073	mir-156	MIPF0000008
RF00074	mir-29	MIPF0000009
RF00075	mir-166	MIPF0000004
RF00076	mir-181	MIPF0000007
RF00103	mir-1	MIPF0000038
RF00104	mir-10	MIPF0000033
RF00104	mir-10	MIPF0000025
RF00104	mir-10	MIPF0000268
RF00104	mir-10	MIPF0000271
RF00129	mir-103	MIPF0000024
RF00130	mir-192	MIPF0000063
RF00131	mir-30	MIPF0000005
RF00143	mir-6	MIPF0000119
RF00144	mir-199	MIPF0000040
RF00237	mir-9	MIPF0000014
RF00239	mir-124	MIPF0000021
RF00241	mir-8	MIPF0000019
RF00244	mir-26	MIPF0000043
RF00245	mir-19	MIPF0000011
RF00246	mir-135	MIPF0000028
RF00247	mir-160	MIPF0000032
RF00251	mir-219	MIPF0000044
RF00253	mir-101	MIPF0000046
RF00254	mir-16	MIPF0000006
RF00255	mir-218	MIPF0000026
RF00256	mir-196	MIPF0000031

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RF00257	mir-194	MIPF0000055
RF00258	mir-130	MIPF0000034
RF00363	mir-BART1	MIPF0000325
RF00365	mir-BHRF1-1	MIPF0000331
RF00366	mir-BHRF1-2	MIPF0000332
RF00446	mir-133	MIPF0000029
RF00455	mir-15	MIPF0000006
RF00637	mir-276	MIPF0000124
RF00638	MIR159	MIPF0000010
RF00639	mir-515	MIPF0000020
RF00640	MIR167	MIPF0000023
RF00641	mir-154	MIPF0000018
RF00642	mir-23	MIPF0000027
RF00643	MIR171_1	MIPF0000030
RF00644	mir-27	MIPF0000036
RF00645	MIR169_2	MIPF0000037
RF00646	mir-204	MIPF0000042
RF00647	MIR164	MIPF0001794
RF00648	MIR396	MIPF0000047
RF00649	mir-128	MIPF0000048
RF00650	mir-153	MIPF0000050
RF00651	mir-221	MIPF0000051
RF00652	MIR478	MIPF0000052
RF00653	mir-22	MIPF0000053
RF00654	mir-216	MIPF0000054
RF00655	mir-28	MIPF0000057
RF00656	mir-205	MIPF0000058
RF00657	mir-184	MIPF0000059
RF00658	mir-21	MIPF0000060
RF00659	mir-365	MIPF0000061
RF00660	mir-214	MIPF0000062
RF00661	mir-31	MIPF0000064
RF00662	mir-132	MIPF0000065

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RF00663	mir-183	MIPF0000066
RF00664	mir-223	MIPF0000067
RF00665	mir-290	MIPF0000068
RF00666	mir-32	MIPF0000069
RF00667	mir-33	MIPF0000070
RF00668	mir-302	MIPF0000071
RF00669	mir-96	MIPF0000072
RF00670	mir-105	MIPF0000074
RF00671	mir-138	MIPF0000075
RF00672	mir-190	MIPF0000076
RF00673	mir-217	MIPF0000077
RF00674	mir-187	MIPF0000078
RF00675	mir-145	MIPF0000079
RF00676	mir-127	MIPF0000080
RF00677	MIR168	MIPF0000081
RF00678	mir-140	MIPF0000085
RF00679	mir-210	MIPF0000086
RF00680	mir-224	MIPF0000088
RF00681	mir-198	MIPF0000090
RF00682	mir-144	MIPF0000093
RF00683	mir-143	MIPF0000094
RF00684	mir-122	MIPF0000095
RF00685	mir-36	MIPF0000096
RF00686	mir-338	MIPF0000097
RF00687	mir-136	MIPF0000099
RF00688	MIR394	MIPF0000100
RF00689	MIR390	MIPF0000101
RF00690	MIR408	MIPF0000102
RF00691	mir-146	MIPF0000103
RF00692	MIR171_2	MIPF0000104
RF00693	mir-147	MIPF0000105
RF00694	mir-137	MIPF0000106
RF00695	MIR398	MIPF0000107

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RF00696	mir-203	MIPF0000108
RF00697	mir-186	MIPF0000109
RF00698	mir-489	MIPF0000111
RF00699	mir-134	MIPF0000112
RF00700	mir-375	MIPF0000114
RF00701	mir-126	MIPF0000115
RF00702	mir-182	MIPF0000116
RF00703	mir-139	MIPF0000117
RF00704	MIR397	MIPF0000120
RF00705	mir-202	MIPF0000121
RF00706	mir-263	MIPF0000122
RF00707	mir-197	MIPF0000123
RF00708	mir-450	MIPF0000128
RF00709	mir-455	MIPF0000129
RF00710	mir-44	MIPF0000132
RF00711	mir-449	MIPF0000133
RF00712	mir-460	MIPF0000134
RF00713	mir-239	MIPF0000135
RF00714	MIR535	MIPF0000136
RF00715	mir-383	MIPF0000137
RF00716	mir-3	MIPF0000140
RF00717	mir-315	MIPF0000141
RF00718	mir-431	MIPF0000142
RF00719	mir-326	MIPF0000143
RF00720	mir-317	MIPF0000144
RF00721	MIR475	MIPF0000145
RF00722	mir-451	MIPF0000148
RF00723	mir-448	MIPF0000149
RF00724	mir-282	MIPF0000150
RF00725	mir-iab-4	MIPF0000151
RF00726	mir-87	MIPF0000152
RF00727	bantam	MIPF0000153
RF00728	mir-81	MIPF0000154

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RF00729	mir-278	MIPF0000155
RF00730	mir-277	MIPF0000156
RF00731	mir-155	MIPF0000157
RF00732	mir-305	MIPF0000158
RF00733	mir-296	MIPF0000159
RF00734	mir-52	MIPF0000160
RF00735	mir-367	MIPF0000162
RF00736	mir-320	MIPF0000163
RF00737	mir-322	MIPF0000164
RF00739	MIR476	MIPF0000166
RF00740	mir-370	MIPF0000167
RF00741	mir-378	MIPF0000168
RF00742	MIR162_1	MIPF0000127
RF00743	mir-308	MIPF0000171
RF00744	mir-361	MIPF0000172
RF00745	mir-499	MIPF0000173
RF00746	mir-454	MIPF0000174
RF00747	mir-283	MIPF0000175
RF00748	mir-433	MIPF0000177
RF00749	mir-208	MIPF0000178
RF00750	mir-458	MIPF0000179
RF00751	mir-12	MIPF0000181
RF00752	mir-14	MIPF0000182
RF00753	mir-503	MIPF0000183
RF00754	mir-279	MIPF0000184
RF00755	mir-542	MIPF0000185
RF00756	mir-299	MIPF0000186
RF00757	mir-275	MIPF0000187
RF00758	mir-346	MIPF0000188
RF00760	mir-342	MIPF0000190
RF00761	mir-340	MIPF0000191
RF00762	mir-412	MIPF0000192
RF00763	mir-339	MIPF0000193

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RF00764	mir-191	MIPF0000194
RF00765	mir-337	MIPF0000195
RF00766	mir-335	MIPF0000196
RF00767	mir-150	MIPF0000197
RF00768	MIR405	MIPF0000198
RF00769	mir-331	MIPF0000199
RF00770	mir-330	MIPF0000200
RF00771	mir-185	MIPF0000202
RF00772	mir-328	MIPF0000203
RF00773	mir-298	MIPF0000206
RF00774	mir-360	MIPF0000210
RF00775	mir-432	MIPF0000211
RF00776	mir-540	MIPF0000212
RF00777	mir-541	MIPF0000213
RF00778	MIR473	MIPF0000214
RF00779	MIR474	MIPF0000215
RF00780	MIR477	MIPF0000216
RF00781	mir-505	MIPF0000217
RF00782	MIR480	MIPF0000218
RF00783	mir-484	MIPF0000219
RF00784	mir-486	MIPF0000220
RF00785	mir-90	MIPF0000221
RF00786	mir-289	MIPF0000222
RF00787	mir-288	MIPF0000223
RF00788	mir-287	MIPF0000224
RF00789	mir-286	MIPF0000225
RF00790	mir-358	MIPF0000226
RF00791	mir-357	MIPF0000227
RF00792	mir-490	MIPF0000229
RF00793	mir-497	MIPF0000231
RF00794	mir-42	MIPF0000233
RF00795	mir-43	MIPF0000234
RF00796	mir-48	MIPF0000235

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RF00797	mir-355	MIPF0000236
RF00798	mir-49	MIPF0000237
RF00799	mir-354	MIPF0000238
RF00801	mir-280	MIPF0000240
RF00802	mir-207	MIPF0000241
RF00803	mir-425	MIPF0000242
RF00804	mir-240	MIPF0000243
RF00805	mir-351	MIPF0000244
RF00806	mir-350	MIPF0000245
RF00807	mir-314	MIPF0000246
RF00808	mir-86	MIPF0000247
RF00809	mir-241	MIPF0000248
RF00810	mir-85	MIPF0000249
RF00811	mir-84	MIPF0000250
RF00812	mir-83	MIPF0000251
RF00813	mir-11	MIPF0000252
RF00814	mir-316	MIPF0000254
RF00815	mir-244	MIPF0000256
RF00816	mir-245	MIPF0000257
RF00817	mir-80	MIPF0000258
RF00818	mir-318	MIPF0000259
RF00819	mir-246	MIPF0000260
RF00820	mir-248	MIPF0000262
RF00821	mir-249	MIPF0000263
RF00822	mir-274	MIPF0000264
RF00823	lsy-6	MIPF0000265
RF00824	mir-50	MIPF0000266
RF00825	mir-344	MIPF0000267
RF00826	mir-55	MIPF0000270
RF00827	mir-77	MIPF0000272
RF00828	mir-75	MIPF0000273
RF00829	mir-149	MIPF0000274
RF00830	mir-74	MIPF0000275

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RF00831	mir-73	MIPF0000276
RF00832	mir-71	MIPF0000278
RF00833	mir-70	MIPF0000279
RF00834	mir-268	MIPF0000280
RF00835	mir-58	MIPF0000282
RF00836	mir-250	MIPF0000283
RF00837	mir-251	MIPF0000284
RF00838	mir-252	MIPF0000285
RF00839	mir-452	MIPF0000287
RF00840	mir-374	MIPF0000288
RF00841	mir-384	MIPF0000289
RF00842	MIR403	MIPF0000290
RF00843	mir-228	MIPF0000292
RF00844	mir-67	MIPF0000293
RF00845	MIR158	MIPF0000294
RF00846	mir-64	MIPF0000295
RF00847	mir-62	MIPF0000296
RF00848	mir-61	MIPF0000297
RF00849	mir-60	MIPF0000298
RF00850	mir-259	MIPF0000299
RF00851	mir-230	MIPF0000306
RF00852	mir-231	MIPF0000307
RF00853	mir-304	MIPF0000308
RF00854	mir-5	MIPF0000309
RF00855	mir-254	MIPF0000310
RF00856	mir-232	MIPF0000311
RF00857	mir-233	MIPF0000312
RF00858	mir-306	MIPF0000313
RF00859	mir-234	MIPF0000315
RF00861	mir-488	MIPF0000318
RF00862	mir-491	MIPF0000319
RF00863	mir-BART17	MIPF0000321
RF00864	mir-BART20	MIPF0000322

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RF00865	MIR169_5	MIPF0000323
RF00866	mir-BART3	MIPF0000324
RF00867	mir-BART5	MIPF0000326
RF00868	mir-BART15	MIPF0000327
RF00869	mir-BART7	MIPF0000328
RF00870	mir-423	MIPF0000329
RF00872	mir-652	MIPF0000333
RF00873	mir-550	MIPF0000334
RF00874	mir-BART12	MIPF0000335
RF00875	mir-692	MIPF0000336
RF00876	mir-684	MIPF0000337
RF00877	mir-592	MIPF0000340
RF00878	mir-456	MIPF0000341
RF00879	mir-615	MIPF0000342
RF00883	MIR820	MIPF0000348
RF00884	MIR815	MIPF0000349
RF00885	MIR821	MIPF0000350
RF00886	MIR807	MIPF0000352
RF00887	mir-802	MIPF0000353
RF00888	mir-770	MIPF0000355
RF00890	mir-668	MIPF0000357
RF00891	mir-671	MIPF0000358
RF00892	mir-551	MIPF0000360
RF00893	MIR854	MIPF0000361
RF00894	mir-790	MIPF0000362
RF00895	mir-786	MIPF0000363
RF00896	mir-787	MIPF0000364
RF00897	mir-675	MIPF0000365
RF00898	mir-242	MIPF0000366
RF00899	mir-235	MIPF0000367
RF00900	mir-255	MIPF0000368
RF00901	MIR845_1	MIPF0000369
RF00902	mir-791	MIPF0000370

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RF00903	mir-359	MIPF0000371
RF00904	mir-392	MIPF0000372
RF00905	mir-789	MIPF0000373
RF00906	MIR1122	MIPF0000382
RF00907	mir-941	MIPF0000387
RF00908	MIR529	MIPF0000388
RF00909	mir-883	MIPF0000389
RF00910	mir-873	MIPF0000390
RF00911	mir-672	MIPF0000391
RF00912	mir-877	MIPF0000392
RF00914	mir-674	MIPF0000394
RF00915	mir-760	MIPF0000395
RF00917	mir-708	MIPF0000397
RF00918	mir-872	MIPF0000399
RF00919	mir-874	MIPF0000401
RF00920	MIR444	MIPF0000402
RF00921	mir-665	MIPF0000404
RF00922	mir-673	MIPF0000405
RF00925	MIR1027	MIPF0000414
RF00926	MIR1151	MIPF0000415
RF00927	mir-582	MIPF0000417
RF00928	mir-590	MIPF0000418
RF00929	mir-574	MIPF0000419
RF00931	mir-879	MIPF0000421
RF00932	mir-471	MIPF0000423
RF00933	mir-875	MIPF0000424
RF00934	mir-463	MIPF0000425
RF00935	mir-876	MIPF0000430
RF00936	mir-744	MIPF0000431
RF00937	mir-653	MIPF0000435
RF00939	mir-504	MIPF0000437
RF00940	mir-327	MIPF0000438
RF00941	mir-434	MIPF0000439

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RF00942	mir-1224	MIPF0000440
RF00943	MIR824	MIPF0000442
RF00945	mir-1226	MIPF0000444
RF00946	mir-1225	MIPF0000445
RF00947	mir-929	MIPF0000447
RF00948	mir-996	MIPF0000449
RF00949	mir-983	MIPF0000450
RF00950	mir-927	MIPF0000452
RF00951	mir-1302	MIPF0000456
RF00952	mir-650	MIPF0000457
RF00953	mir-1497	MIPF0000458
RF00954	MIR1446	MIPF0000459
RF00955	mir-1829	MIPF0000460
RF00956	MIR1444	MIPF0000461
RF00957	mir-663	MIPF0000462
RF00958	mir-498	MIPF0000463
RF00959	mir-612	MIPF0000464
RF00960	mir-661	MIPF0000465
RF00961	mir-581	MIPF0000466
RF00962	mir-586	MIPF0000467
RF00963	mir-642	MIPF0000468
RF00964	mir-938	MIPF0000469
RF00965	mir-549	MIPF0000470
RF00966	mir-676	MIPF0000471
RF00967	mir-281	MIPF0000472
RF00968	mir-626	MIPF0000474
RF00969	mir-556	MIPF0000475
RF00970	mir-648	MIPF0000476
RF00971	mir-578	MIPF0000477
RF00972	mir-651	MIPF0000478
RF00973	mir-597	MIPF0000479
RF00974	mir-607	MIPF0000480
RF00975	MIR845_2	MIPF0000481

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RF00976	mir-583	MIPF0000482
RF00977	mir-600	MIPF0000484
RF00978	mir-638	MIPF0000486
RF00979	mir-553	MIPF0000487
RF00980	mir-643	MIPF0000488
RF00981	mir-939	MIPF0000490
RF00983	mir-662	MIPF0000492
RF00984	mir-576	MIPF0000493
RF00985	mir-640	MIPF0000494
RF00986	mir-920	MIPF0000495
RF00987	mir-589	MIPF0000496
RF00988	mir-657	MIPF0000498
RF00989	mir-492	MIPF0000499
RF00990	mir-552	MIPF0000501
RF00991	mir-599	MIPF0000502
RF00992	mir-593	MIPF0000503
RF00993	mir-1473	MIPF0000504
RF00994	mir-1255	MIPF0000506
RF00995	mir-616	MIPF0000507
RF00996	mir-631	MIPF0000508
RF00997	mir-942	MIPF0000511
RF00998	mir-562	MIPF0000512
RF00999	mir-924	MIPF0000513
RF01000	mir-580	MIPF0000515
RF01001	mir-609	MIPF0000516
RF01002	mir-936	MIPF0000517
RF01003	mir-563	MIPF0000519
RF01004	mir-557	MIPF0000520
RF01005	MIR530	MIPF0000521
RF01006	mir-601	MIPF0000522
RF01007	mir-624	MIPF0000523
RF01008	mir-636	MIPF0000524
RF01009	mir-M7	MIPF0000526

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RF01010	mir-632	MIPF0000527
RF01011	mir-605	MIPF0000528
RF01012	mir-628	MIPF0000529
RF01013	mir-577	MIPF0000530
RF01014	mir-1306	MIPF0000531
RF01015	mir-885	MIPF0000532
RF01016	mir-584	MIPF0000533
RF01018	mir-569	MIPF0000535
RF01019	mir-922	MIPF0000536
RF01020	mir-572	MIPF0000537
RF01021	mir-558	MIPF0000538
RF01022	mir-611	MIPF0000539
RF01023	mir-940	MIPF0000540
RF01024	mir-944	MIPF0000541
RF01025	mir-934	MIPF0000542
RF01026	MIR828	MIPF0000544
RF01027	mir-765	MIPF0000545
RF01028	mir-633	MIPF0000546
RF01029	mir-649	MIPF0000547
RF01030	mir-422	MIPF0000548
RF01031	mir-639	MIPF0000549
RF01032	mir-554	MIPF0000551
RF01033	mir-767	MIPF0000552
RF01034	mir-618	MIPF0000553
RF01035	mir-887	MIPF0000554
RF01036	mir-567	MIPF0000555
RF01037	mir-644	MIPF0000556
RF01038	mir-1307	MIPF0000558
RF01039	mir-937	MIPF0000560
RF01040	mir-573	MIPF0000561
RF01041	mir-604	MIPF0000562
RF01042	mir-891	MIPF0000420
RF01043	MIR1023	MIPF0000396

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RF01044	mir-345	MIPF0000189
RF01045	mir-544	MIPF0000436
RF01059	mir-598	MIPF0000393
RF01061	mir-548	MIPF0000317
RF01064	mir-253	MIPF0000286
RF01117	ciona-mir-92	MIPF0000509
RF01314	mir-1227	MIPF0000454
RF01413	miR-430	MIPF0000003
RF01895	mir-193	MIPF0000082
RF01896	mir-142	MIPF0000084
RF01897	mir-188	MIPF0000113
RF01898	mir-363	MIPF0000138
RF01899	mir-2241	MIPF0000821
RF01900	mir-2024	MIPF0000697
RF01901	mir-284	MIPF0000228
RF01902	MIR439	MIPF0000092
RF01903	mir-500	MIPF0000139
RF01910	mir-511	MIPF0000130
RF01911	MIR2118	MIPF0000745
RF01912	mir-2807	MIPF0000826
RF01913	mir-2778	MIPF0000827
RF01914	mir-932	MIPF0000588
RF01915	mir-2238	MIPF0000822
RF01916	mir-988	MIPF0000724
RF01917	MIR2587	MIPF0000835
RF01918	mir-1249	MIPF0000667
RF01919	mir-1419	MIPF0000570
RF01920	mir-764	MIPF0000707
RF01921	mir-1296	MIPF0000649
RF01922	mir-654	MIPF0000409
RF01923	mir-711	MIPF0000748
RF01924	mir-2774	MIPF0000829
RF01925	MIR1428	MIPF0000575

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RF01926	mir-981	MIPF0000710
RF01927	MIR1222	MIPF0000410
RF01936	mir-63	MIPF0000823
RF01937	mir-2780	MIPF0000828
RF01938	mir-1251	MIPF0000621
RF01939	mir-761	MIPF0000709
RF01940	hvt-mir-H	MIPF0000783
RF01941	MIR1223	MIPF0000383
RF01943	mir-999	MIPF0000852
RF01944	mir-2518	MIPF0000858
RF01945	mir-1388	MIPF0000805
RF01996	mir-995	MIPF0000895
RF01997	mir-969	MIPF0000879
RF02000	MIR1846	MIPF0000577
RF02006	mir-1253	MIPF0000611
RF02007	mir-1237	MIPF0000585
RF02008	mir-621	MIPF0000631
RF02009	mir-987	MIPF0000859
RF02010	mir-3180	MIPF0000894
RF02011	mir-575	MIPF0000586
RF02014	mir-1178	MIPF0000601
RF02015	mir-1287	MIPF0000725
RF02016	mir-1183	MIPF0000668
RF02017	mir-1912	MIPF0000768
RF02018	mir-1207	MIPF0000596
RF02019	mir-1265	MIPF0000688
RF02020	mir-25	MIPF0000013
RF02021	mir-3179	MIPF0000900
RF02022	mir-1275	MIPF0000674
RF02023	mir-1208	MIPF0000628
RF02024	mir-1180	MIPF0000789
RF02025	mir-3017	MIPF0001107
RF02026	mir-2833	MIPF0000886

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RF02027	MIR2907	MIPF0000861
RF02028	mir-1827	MIPF0000646
RF02092	mir-2970	MIPF0001328
RF02095	mir-2985	MIPF0001067
RF02516	mir-393	MIPF0000083
RF02518	mir-2494	MIPF0000975
RF02520	mir-965	MIPF0000708
RF03171	mir-1012	MIPF0001046
RF03172	mir-6012	MIPF0001496
RF03173	mir-4504	MIPF0001508
RF03174	mir-4803	MIPF0001511
RF03175	MIR3454	MIPF0001097
RF03176	MIR7729	MIPF0001721
RF03177	mir-2067	MIPF0001854
RF03178	mir-4515	MIPF0001512
RF03179	mir-1182	MIPF0000673
RF03180	mir-3126	MIPF0001525
RF03181	mir-2755	MIPF0001452
RF03182	MIR6032	MIPF0002003
RF03183	MIR5516	MIPF0001595
RF03184	mir-1250	MIPF0000696
RF03185	mir-3193	MIPF0001401
RF03186	mir-3689	MIPF0001144
RF03187	MIR1512	MIPF0001291
RF03188	mir-2843	MIPF0001044
RF03189	mir-1175	MIPF0000715
RF03190	mir-4857	MIPF0001842
RF03191	mir-1913	MIPF0001015
RF03192	mir-6794	MIPF0001726
RF03193	mir-2941	MIPF0000842
RF03194	mir-1272	MIPF0000645
RF03195	mir-3934	MIPF0001584
RF03196	mir-6790	MIPF0001811

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RF03197	mir-4887	MIPF0001841
RF03198	mir-7385	MIPF0001688
RF03199	MIR5271	MIPF0001281
RF03200	mir-BART13	MIPF0001051
RF03201	mir-617	MIPF0000672
RF03202	mir-555	MIPF0000583
RF03203	mir-3070	MIPF0001172
RF03204	mir-4510	MIPF0001467
RF03205	mir-1898	MIPF0000786
RF03206	mir-3102	MIPF0001469
RF03207	mir-3960	MIPF0001271
RF03208	mir-1781	MIPF0001583
RF03209	MIR9657	MIPF0001955
RF03210	mir-7359	MIPF0001650
RF03211	mir-666	MIPF0000782
RF03212	mir-2788	MIPF0001204
RF03213	mir-5885	MIPF0001404
RF03214	mir-769	MIPF0000727
RF03215	mir-5360	MIPF0001723
RF03216	mir-BART10	MIPF0000850
RF03217	mir-3167	MIPF0001823
RF03218	mir-3015	MIPF0001111
RF03219	mir-602	MIPF0000767
RF03220	mir-2582	MIPF0000870
RF03221	mir-6715	MIPF0001708
RF03222	mir-4900	MIPF0001224
RF03223	mir-2209	MIPF0000787
RF03224	MIR9560	MIPF0002116
RF03225	mir-2763	MIPF0001437
RF03226	mir-8196	MIPF0002057
RF03227	mir-2528	MIPF0001059
RF03228	mir-1471	MIPF0001069
RF03229	mir-1297	MIPF0000584

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RF03230	mir-967	MIPF0001096
RF03231	mir-4523	MIPF0002104
RF03232	mir-6526	MIPF0001431
RF03233	hvt-mir-H16	MIPF0000773
RF03234	mir-2813	MIPF0001043
RF03235	mir-2543	MIPF0000856
RF03236	mir-1206	MIPF0000634
RF03237	MIR6425	MIPF0001386
RF03238	mir-1542	MIPF0000485
RF03239	mir-963	MIPF0001035
RF03240	MIR5534	MIPF0001324
RF03241	mir-1789	MIPF0001636
RF03242	mir-1397	MIPF0000642
RF03243	mir-2731	MIPF0000795
RF03244	mir-4798	MIPF0001574
RF03246	MIR1515	MIPF0001591
RF03247	mir-1324	MIPF0000589
RF03248	MIR9772	MIPF0001934
RF03249	mir-2114	MIPF0001464
RF03251	mir-4446	MIPF0001385
RF03252	mir-678	MIPF0000774
RF03253	mir-4654	MIPF0001507
RF03254	mir-9460	MIPF0001910
RF03255	mir-2188	MIPF0000812
RF03256	mir-1286	MIPF0000682
RF03257	mir-4427	MIPF0001640
RF03258	mir-4	MIPF0000305
RF03259	MIR1514	MIPF0000694
RF03260	mir-8229	MIPF0001992
RF03261	mir-1759	MIPF0001565
RF03262	mir-1181	MIPF0000665
RF03263	MIR861	MIPF0001190
RF03264	MIR1024	MIPF0000406

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RF03265	mir-1460	MIPF0001502
RF03266	mir-2943	MIPF0001056
RF03267	mir-645	MIPF0000657
RF03268	mir-1911	MIPF0001787
RF03269	mir-5697	MIPF0001748
RF03270	MIR3712	MIPF0001625
RF03271	mir-1247	MIPF0000669
RF03272	mir-2187	MIPF0001770
RF03274	mir-1238	MIPF0000941
RF03275	mir-2542	MIPF0000889
RF03276	mir-2232	MIPF0001054
RF03277	mir-5886	MIPF0001638
RF03278	mir-980	MIPF0000890
RF03279	mir-1193	MIPF0000714
RF03280	mir-7583	MIPF0001676
RF03281	mir-596	MIPF0000808
RF03283	mir-1010	MIPF0000866
RF03284	mir-4637	MIPF0001586
RF03285	mir-564	MIPF0000612
RF03286	MIR6146	MIPF0001562
RF03287	mir-5904	MIPF0001444
RF03288	mir-3085	MIPF0001193
RF03289	mir-1205	MIPF0000609
RF03290	mir-9428	MIPF0001958
RF03291	mir-591	MIPF0000641
RF03292	mir-1301	MIPF0000742
RF03293	mir-4672	MIPF0001551
RF03294	mir-H3	MIPF0000717
RF03295	mir-7594	MIPF0001674
RF03296	MIR8788	MIPF0001903
RF03297	MIR1033	MIPF0000385
RF03298	mir-4488	MIPF0001623
RF03299	mir-1000	MIPF0000701

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RF03300	mir-3617	MIPF0001477
RF03301	mir-3154	MIPF0001387
RF03302	mir-6133	MIPF0001415
RF03303	mir-973	MIPF0001970
RF03304	mir-1744	MIPF0001589
RF03305	mir-3338	MIPF0001449
RF03306	mir-3923	MIPF0001527
RF03307	mir-1825	MIPF0000670
RF03308	MIR848	MIPF0001140
RF03309	mir-4791	MIPF0001529
RF03310	mir-1544	MIPF0001645
RF03311	MIR169	MIPF0000832
RF03312	mir-880	MIPF0000433
RF03313	mir-1468	MIPF0000777
RF03314	mir-1908	MIPF0001021
RF03315	mir-723	MIPF0001831
RF03316	mir-1263	MIPF0000687
RF03317	mir-4874	MIPF0001843
RF03318	mir-2208	MIPF0000772
RF03319	mir-989	MIPF0000885
RF03320	mir-1743	MIPF0001544
RF03321	mir-1006	MIPF0000873
RF03322	mir-1641	MIPF0001533
RF03323	mir-3613	MIPF0001411
RF03324	mir-1288	MIPF0000660
RF03325	mir-4872	MIPF0001205
RF03326	mir-312	MIPF0000573
RF03327	mir-1266	MIPF0000615
RF03328	mir-606	MIPF0000780
RF03329	mir-4743	MIPF0001384
RF03330	mir-750	MIPF0000796
RF03331	mir-247	MIPF0001019
RF03332	mir-2237	MIPF0000883

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RF03333	mir-2820	MIPF0001034
RF03334	MIR391	MIPF0001151
RF03335	MIR2950	MIPF0001121
RF03336	mir-1322	MIPF0000663
RF03337	mir-6505	MIPF0001805
RF03338	MIR4416	MIPF0001389
RF03339	mir-3047	MIPF0001196
RF03340	mir-6511	MIPF0001382
RF03341	mir-943	MIPF0000690
RF03342	mir-1467	MIPF0001416
RF03343	mir-3347	MIPF0001022
RF03344	mir-5365	MIPF0001363
RF03345	MIR3444	MIPF0001177
RF03346	mir-881	MIPF0000429
RF03347	mir-2816	MIPF0000884
RF03348	mir-667	MIPF0000794
RF03349	mir-3151	MIPF0001394
RF03350	mir-3851	MIPF0001201
RF03351	MIR6020	MIPF0001610
RF03352	mir-4869	MIPF0001829
RF03353	MIR5291	MIPF0001293
RF03354	mir-459	MIPF0001322
RF03355	mir-2008	MIPF0000729
RF03356	mir-4782	MIPF0001546
RF03357	mir-1842	MIPF0000788
RF03358	mir-634	MIPF0000600
RF03359	mir-1729	MIPF0000816
RF03360	mir-3156	MIPF0000891
RF03361	mir-3136	MIPF0001575
RF03362	mir-9436	MIPF0002111
RF03363	mir-6129	MIPF0001423
RF03364	mir-427	MIPF0000441
RF03365	mir-1236	MIPF0000689

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RF03366	mir-3122	MIPF0001549
RF03367	mir-975	MIPF0001038
RF03368	mir-1822	MIPF0001009
RF03369	mir-2217	MIPF0001912
RF03370	mir-2566	MIPF0000880
RF03371	mir-4788	MIPF0001573
RF03372	mir-5918	MIPF0001395
RF03373	mir-3170	MIPF0001637
RF03374	mir-2001	MIPF0000711
RF03375	MIR1094	MIPF0000400
RF03376	mir-3075	MIPF0001489
RF03377	mir-960	MIPF0000897
RF03378	mir-7398	MIPF0001643
RF03379	mir-4667	MIPF0001390
RF03380	mir-9441	MIPF0002092
RF03381	mir-2796	MIPF0001057
RF03382	mir-635	MIPF0000662
RF03383	mir-1976	MIPF0001633
RF03384	mir-7180	MIPF0002036
RF03385	mir-614	MIPF0000647
RF03386	mir-1994	MIPF0000743
RF03387	mir-1902	MIPF0000791
RF03388	mir-9418	MIPF0002040
RF03389	mir-4738	MIPF0001521
RF03390	mir-2450	MIPF0000758
RF03391	mir-588	MIPF0000681
RF03392	mir-3943	MIPF0001400
RF03393	mir-2849	MIPF0000876
RF03394	mir-2574	MIPF0001029
RF03395	mir-718	MIPF0000721
RF03396	mir-2814	MIPF0001070
RF03397	mir-1234	MIPF0000593
RF03398	mir-3552	MIPF0002093

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RF03399	mir-986	MIPF0000860
RF03400	mir-728	MIPF0001670
RF03401	mir-1323	MIPF0000617
RF03402	mir-957	MIPF0000723
RF03403	mir-5366	MIPF0001738
RF03404	mir-1298	MIPF0000598
RF03405	mir-3200	MIPF0001441
RF03406	mir-3099	MIPF0001559
RF03407	MIR531	MIPF0000607
RF03408	mir-5890	MIPF0001378
RF03409	mir-646	MIPF0000605
RF03410	mir-1891	MIPF0000857
RF03411	mir-2856	MIPF0001071
RF03412	mir-1915	MIPF0001037
RF03413	MIR904	MIPF0000379
RF03414	mir-670	MIPF0000734
RF03416	mir-7383	MIPF0001662
RF03417	mir-343	MIPF0000411
RF03418	mir-3198	MIPF0001216
RF03419	mir-998	MIPF0000952
RF03420	mir-1200	MIPF0001036
RF03421	mir-2558	MIPF0000817
RF03422	mir-637	MIPF0000597
RF03423	mir-962	MIPF0001011
RF03424	mir-4856	MIPF0001847
RF03425	mir-1292	MIPF0000675
RF03426	mir-1294	MIPF0000603
RF03427	mir-1005	MIPF0000943
RF03428	mir-6134	MIPF0001445
RF03429	mir-4451	MIPF0001582
RF03430	MIR5294	MIPF0001303
RF03431	mir-4657	MIPF0002009
RF03432	mir-7331	MIPF0001736

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RF03433	mir-2576	MIPF0001066
RF03434	mir-1246	MIPF0000627
RF03435	mir-726	MIPF0001344
RF03436	mir-759	MIPF0000706
RF03437	mir-2392	MIPF0001614
RF03438	mir-1956	MIPF0001470
RF03439	mir-1791	MIPF0001396
RF03440	MIR4414	MIPF0001299
RF03441	mir-613	MIPF0000590
RF03442	mir-4003	MIPF0000840
RF03443	mir-2131	MIPF0001631
RF03444	MIR5635	MIPF0001283
RF03445	mir-7552	MIPF0001916
RF03446	mir-2954	MIPF0001032
RF03447	mir-1231	MIPF0001309
RF03448	mir-6131	MIPF0001412
RF03449	mir-6827	MIPF0001747
RF03450	MIR1513	MIPF0001360
RF03451	mir-3188	MIPF0001488
RF03452	mir-3121	MIPF0001417
RF03453	mir-1276	MIPF0000652
RF03454	mir-1267	MIPF0000640
RF03455	mir-9847	MIPF0002065
RF03456	mir-724	MIPF0001616
RF03457	MIR173	MIPF0001175
RF03458	mir-766	MIPF0000677
RF03459	mir-1890	MIPF0000848
RF03460	mir-561	MIPF0000623
RF03461	MIR842	MIPF0001158
RF03462	mir-4677	MIPF0001848
RF03463	mir-3036	MIPF0001098
RF03464	mir-465	MIPF0000384
RF03465	MIR9666	MIPF0001930

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RF03466	mir-1184	MIPF0000592
RF03467	mir-2851	MIPF0001014
RF03468	mir-2830	MIPF0001052
RF03469	mir-1179	MIPF0000632
RF03470	mir-571	MIPF0000757
RF03471	mir-745	MIPF0001267
RF03472	mir-623	MIPF0000798
RF03473	mir-8813	MIPF0002069
RF03474	mir-4766	MIPF0001764
RF03475	mir-2387	MIPF0001986
RF03476	mir-7360	MIPF0001649
RF03477	MIR862_2	MIPF0001295
RF03478	mir-630	MIPF0000653
RF03479	mir-324	MIPF0000165
RF03480	mir-1284	MIPF0000604
RF03481	mir-9014	MIPF0002031
RF03482	mir-4774	MIPF0001578
RF03483	MIR319	MIPF0001104
RF03484	mir-K12-10	MIPF0000261
RF03485	mir-4000	MIPF0000867
RF03486	mir-3940	MIPF0001599
RF03487	mir-4423	MIPF0001587
RF03488	mir-2366	MIPF0001403
RF03489	mir-4796	MIPF0001402
RF03490	mir-1426	MIPF0000692
RF03491	mir-3146	MIPF0001626
RF03492	mir-878	MIPF0000434
RF03493	mir-1281	MIPF0000695
RF03494	mir-4680	MIPF0001988
RF03495	mir-968	MIPF0000865
RF03496	MIR2086	MIPF0001302
RF03497	MIR5038	MIPF0001368
RF03498	mir-3145	MIPF0001427

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RF03499	mir-702	MIPF0001163
RF03500	mir-1262	MIPF0000595
RF03501	mir-3140	MIPF0001615
RF03502	mir-1914	MIPF0001040
RF03503	mir-547	MIPF0000779
RF03504	mir-9461	MIPF0002000
RF03505	mir-9128	MIPF0002044
RF03506	mir-587	MIPF0000563
RF03507	mir-4429	MIPF0001474
RF03508	mir-970	MIPF0000700
RF03509	mir-4660	MIPF0001460
RF03510	mir-3660	MIPF0001397
RF03511	mir-5444	MIPF0001358
RF03512	mir-3479	MIPF0001629
RF03514	mir-6128	MIPF0001442
RF03516	MIR5229	MIPF0001323
RF03517	MIR5225	MIPF0001388
RF03518	mir-1893	MIPF0001812
RF03519	mir-238	MIPF0000862
RF03520	mir-3059	MIPF0001766
RF03521	mir-23c	MIPF0001429
RF03522	mir-4850	MIPF0002086
RF03523	mir-4703	MIPF0001759
RF03524	mir-3174	MIPF0001569
RF03525	mir-1343	MIPF0001206
RF03526	mir-7177	MIPF0002020
RF03527	mir-3072	MIPF0001410
RF03528	mir-1264	MIPF0000098
RF03548	mir-302_2	MIPF0000658
RF03549	mir-15_2	MIPF0001828
RF03550	mir-31_2	MIPF0001803
RF03552	mir-43_2	MIPF0001285
RF03553	mir-190_2	MIPF0001853

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RF03554	mir-92_2	MIPF0001099
RF03555	mir-2_2	MIPF0001838
RF03556	mir-559	MIPF0000656
RF03557	MIR6019	MIPF0001486
RF03558	mir-629	MIPF0001555
RF03559	mir-8303	MIPF0002121
RF03560	mir-3926	MIPF0001118
RF03561	mir-3533	MIPF0002063
RF03562	mir-2004	MIPF0002042
RF03563	mir-BART16	MIPF0000991
RF03564	mir-9416	MIPF0002105
RF03565	mir-1282	MIPF0000587
RF03566	mir-4875	MIPF0001222
RF03567	MIR8024	MIPF0001789
RF03568	mir-3204	MIPF0000908
RF03569	mir-7973	MIPF0001693
RF03570	mir-8286	MIPF0001964
RF03571	mir-734	MIPF0001543
RF03572	MIR2109	MIPF0001000
RF03573	mir-1954	MIPF0001275
RF03574	mir-4847	MIPF0002100
RF03575	mir-rL1-14	MIPF0000993
RF03576	mir-4435	MIPF0001220
RF03577	mir-9193	MIPF0002089
RF03578	mir-3910	MIPF0001148
RF03579	mir-2058	MIPF0001793
RF03580	mir-928	MIPF0000950
RF03581	mir-4878	MIPF0001827
RF03582	mir-m22-1	MIPF0000451
RF03583	MIR781	MIPF0001137
RF03584	mir-2290	MIPF0001973
RF03585	mir-3938	MIPF0001520
RF03586	mir-5132	MIPF0002061

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RF03587	mir-1202	MIPF0000613
RF03588	mir-2319	MIPF0000790
RF03589	mir-5583	MIPF0001356
RF03590	mir-2009	MIPF0001923
RF03591	mir-3117	MIPF0001506
RF03592	mir-2567	MIPF0000934
RF03593	mir-2331	MIPF0001951
RF03594	mir-3817	MIPF0001217
RF03595	mir-3569	MIPF0001797
RF03596	mir-5880	MIPF0001483
RF03597	MIR6438	MIPF0001538
RF03598	MIR6024	MIPF0001459
RF03599	MIR1883	MIPF0000683
RF03600	MIR3627	MIPF0001471
RF03601	MIR7993	MIPF0001663
RF03602	mir-8250	MIPF0002067
RF03603	mir-4899	MIPF0001837
RF03604	mir-5728	MIPF0001558
RF03605	MIR4221	MIPF0001128
RF03606	mir-2071	MIPF0001681
RF03607	mir-9447	MIPF0001994
RF03608	mir-9440	MIPF0001915
RF03609	mir-5470	MIPF0001967
RF03610	mir-H7	MIPF0000929
RF03611	mir-7147	MIPF0001705
RF03612	mir-608	MIPF0000972
RF03613	MIR6234	MIPF0001642
RF03614	mir-3431	MIPF0002046
RF03615	mir-4877	MIPF0001814
RF03616	MIR1888	MIPF0001333
RF03617	MIR8757	MIPF0002074
RF03618	mir-5592	MIPF0001366
RF03619	mir-5729	MIPF0001473

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RF03620	mir-1233	MIPF0000578
RF03621	MIR4245	MIPF0001495
RF03622	mir-731	MIPF0001354
RF03623	mir-1252	MIPF0000968
RF03624	mir-5345	MIPF0001357
RF03625	MIR6152	MIPF0001607
RF03626	mir-9791	MIPF0002118
RF03627	mir-9168	MIPF0002095
RF03628	mir-2355	MIPF0000938
RF03629	mir-641	MIPF0000679
RF03630	mir-2818	MIPF0001003
RF03631	MIR3440	MIPF0001127
RF03632	MIR1882	MIPF0000571
RF03633	mir-5882	MIPF0001418
RF03634	mir-3524	MIPF0001215
RF03635	mir-2066	MIPF0001819
RF03636	MIR4376	MIPF0001809
RF03637	mir-5879	MIPF0001472
RF03638	mir-1537	MIPF0000917
RF03639	mir-619	MIPF0000557
RF03640	mir-3747	MIPF0001223
RF03641	mir-991	MIPF0000957
RF03642	MIR5743	MIPF0001572
RF03643	mir-2056	MIPF0001734
RF03644	mir-2064	MIPF0001727
RF03645	mir-9080	MIPF0001982
RF03646	MIR9776	MIPF0001990
RF03647	mir-7640	MIPF0001783
RF03648	mir-9413	MIPF0002079
RF03649	MIR5643	MIPF0001348
RF03650	mir-1290	MIPF0000610
RF03651	mir-2070	MIPF0001796
RF03652	mir-2329	MIPF0000785

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RF03653	mir-971	MIPF0000995
RF03654	MIR4239	MIPF0001164
RF03655	MIR1887	MIPF0001125
RF03656	mir-2432	MIPF0002055
RF03657	MIR6145	MIPF0001620
RF03658	mir-2300	MIPF0000770
RF03659	MIR2871	MIPF0000986
RF03660	mir-4018	MIPF0001259
RF03661	mir-933	MIPF0000505
RF03662	mir-2060	MIPF0001654
RF03663	mir-5911	MIPF0001407
RF03664	MIR6288	MIPF0001696
RF03665	MIR4359	MIPF0001181
RF03666	MIR7724	MIPF0001802
RF03667	MIR1031	MIPF0000416
RF03668	mir-1788	MIPF0000792
RF03669	mir-2767	MIPF0001446
RF03670	MIR3932	MIPF0001159
RF03671	MIR3522	MIPF0000936
RF03672	MIR840	MIPF0001129
RF03673	mir-2822	MIPF0000970
RF03674	MIR5387	MIPF0001305
RF03675	mir-1001	MIPF0001048
RF03676	MIR5148	MIPF0001298
RF03677	mir-1304	MIPF0001064
RF03678	mir-3956	MIPF0001577
RF03679	MIR2084	MIPF0000809
RF03680	mir-9465	MIPF0002107
RF03681	mir-1295	MIPF0000676
RF03682	mir-3912	MIPF0001601
RF03683	mir-462	MIPF0001755
RF03684	mir-1990	MIPF0000718
RF03685	MIR9677	MIPF0001925

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RF03686	mir-9424	MIPF0002037
RF03687	mir-2011	MIPF0000739
RF03688	mir-3045	MIPF0001120
RF03689	mir-5892	MIPF0001539
RF03690	mir-9058	MIPF0002028
RF03691	mir-2765	MIPF0001008
RF03692	MIR827	MIPF0000726
RF03693	MIR1919	MIPF0000582
RF03694	mir-266	MIPF0000281
RF03695	MIR6151	MIPF0001374
RF03696	mir-4904	MIPF0001786
RF03697	mir-722	MIPF0001612
RF03698	mir-2861	MIPF0000963
RF03699	mir-729	MIPF0001307
RF03700	mir-1923	MIPF0000930
RF03701	mir-4041	MIPF0001266
RF03702	MIR851	MIPF0001168
RF03703	mir-3622	MIPF0001179
RF03704	MIR4380	MIPF0001117
RF03705	mir-1278	MIPF0000591
RF03706	mir-2253	MIPF0000915
RF03707	mir-1892	MIPF0000799
RF03709	MIR1878	MIPF0001218
RF03710	mir-1451	MIPF0001049
RF03711	mir-784	MIPF0000999
RF03712	MIR6450	MIPF0001528
RF03713	mir-1756	MIPF0000639
RF03714	MIR774	MIPF0001101
RF03715	mir-977	MIPF0000931
RF03716	mir-7131	MIPF0001675
RF03717	mir-3119	MIPF0000971
RF03718	mir-2804	MIPF0000851
RF03719	mir-3914	MIPF0001169

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RF03720	MIR4228	MIPF0001185
RF03721	mir-3478	MIPF0002075
RF03722	MIR4378	MIPF0001192
RF03723	MIR7125	MIPF0001851
RF03724	mir-1013	MIPF0000985
RF03725	mir-7094	MIPF0001704
RF03726	mir-m21-1	MIPF0000453
RF03727	mir-3477	MIPF0001227
RF03728	MIR1511	MIPF0001743
RF03729	mir-2363	MIPF0000806
RF03730	mir-7615	MIPF0001729
RF03731	mir-7371	MIPF0001652
RF03732	mir-2057	MIPF0001745
RF03733	mir-BART14	MIPF0000959
RF03734	mir-4773	MIPF0001250
RF03735	mir-1502	MIPF0001213
RF03736	mir-3130	MIPF0000845
RF03737	mir-8315	MIPF0002039
RF03738	mir-2320	MIPF0001253
RF03739	mir-4529	MIPF0001451
RF03740	mir-921	MIPF0000982
RF03741	mir-325	MIPF0000147
RF03742	mir-2162	MIPF0001950
RF03743	MIR7696	MIPF0001669
RF03744	MIR3704	MIPF0001425
RF03745	mir-2063	MIPF0001752
RF03746	mir-2318	MIPF0001968
RF03747	mir-4536	MIPF0001319
RF03748	mir-2772	MIPF0000906
RF03749	MIR2617	MIPF0000907
RF03750	mir-2489	MIPF0000953
RF03751	mir-7445	MIPF0001857
RF03752	MIR5292	MIPF0001329

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RF03753	mir-1986	MIPF0000741
RF03754	mir-3116	MIPF0001002
RF03755	mir-4005	MIPF0001007
RF03756	mir-4891	MIPF0001856
RF03757	mir-6536	MIPF0001479
RF03758	mir-2756	MIPF0001391
RF03759	MIR8703	MIPF0001959
RF03760	mir-2041	MIPF0001913
RF03761	mir-5897	MIPF0001517
RF03762	MIR859	MIPF0001191
RF03763	mir-2568	MIPF0001004
RF03764	mir-647	MIPF0000939
RF03765	mir-2059	MIPF0001683
RF03766	mir-3155	MIPF0001242
RF03767	mir-3432	MIPF0001187
RF03768	mir-1329	MIPF0000635
RF03769	mir-3913	MIPF0001134
RF03770	mir-125	MIPF0000733
RF03771	mir-341	MIPF0000269
RF03772	mir-4867	MIPF0001707
RF03773	mir-978	MIPF0000926
RF03774	mir-2110	MIPF0001399
RF03775	mir-7578	MIPF0001810
RF03776	mir-2068	MIPF0001700
RF03777	MIR533	MIPF0000356
RF03778	mir-483	MIPF0000180
RF03779	mir-1805	MIPF0000947
RF03780	mir-3389	MIPF0001581
RF03781	mir-4524	MIPF0001330
RF03782	mir-3661	MIPF0001530
RF03783	mir-4854	MIPF0001908
RF03784	mir-2240	MIPF0000838
RF03785	mir-974	MIPF0002083

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RF03786	mir-9449	MIPF0001976
RF03787	mir-2010	MIPF0002019
RF03788	MIR5304	MIPF0001713
RF03789	MIR5269	MIPF0001370
RF03790	MIR8008	MIPF0001836
RF03791	mir-4526	MIPF0001545
RF03792	MIR6462	MIPF0001393
RF03793	MIR810	MIPF0000497
RF03794	MIR5298	MIPF0001286
RF03795	MIR6201	MIPF0001960
RF03796	mir-5984	MIPF0001468
RF03797	mir-9235	MIPF0001906
RF03798	MIR4227	MIPF0001115
RF03799	mir-3202	MIPF0000846
RF03800	mir-4477	MIPF0001274
RF03801	mir-7143	MIPF0002024
RF03802	MIR5649	MIPF0001369
RF03803	MIR1886	MIPF0001647
RF03804	mir-4989	MIPF0001239
RF03805	bpcv-mir-B1	MIPF0001235
RF03806	mir-2007	MIPF0002094
RF03807	mir-4890	MIPF0001703
RF03808	mir-3957	MIPF0001605
RF03809	mir-1203	MIPF0000633
RF03810	mir-8932	MIPF0002071
RF03811	mir-1896	MIPF0001981
RF03812	mir-BART19	MIPF0000983
RF03813	MIR8041	MIPF0001773
RF03814	mir-2797	MIPF0000911
RF03815	mir-3051	MIPF0001114
RF03816	MIR6297	MIPF0001754
RF03817	mir-3836	MIPF0001231
RF03818	MIR7994	MIPF0001763

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RF03819	mir-Ro6-3	MIPF0001628
RF03820	mir-5429	MIPF0001315
RF03821	mir-2002	MIPF0001989
RF03822	mir-3931	MIPF0001585
RF03823	mir-1814	MIPF0002102
RF03824	MIR5285	MIPF0001292
RF03825	mir-2335	MIPF0001971
RF03826	MIR825	MIPF0001178
RF03827	mir-2229	MIPF0001694
RF03828	MIR831	MIPF0001132
RF03829	mir-1257	MIPF0000998
RF03830	mir-1003	MIPF0000923
RF03831	mir-627	MIPF0000550
RF03832	mir-H4	MIPF0001247
RF03833	mir-5928	MIPF0001443
RF03834	mir-3173	MIPF0001383
RF03835	mir-955	MIPF0000989
RF03836	mir-3547	MIPF0001788
RF03837	mir-3138	MIPF0001428
RF03838	MIR8032	MIPF0001653
RF03839	MIR2599	MIPF0000913
RF03840	mir-3064	MIPF0001238
RF03841	mir-8941	MIPF0001932
RF03842	MIR2680	MIPF0000841
RF03843	MIR2600	MIPF0001284
RF03844	mir-3190	MIPF0001251
RF03845	mir-3327	MIPF0001547
RF03846	mir-4861	MIPF0001822
RF03847	mir-1538	MIPF0000903
RF03848	mir-1549	MIPF0001345
RF03849	MIR1219	MIPF0000346
RF03850	mir-961	MIPF0001006
RF03851	mir-1002	MIPF0000909

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RF03852	mir-610	MIPF0000661
RF03853	mir-2013	MIPF0001777
RF03854	mir-1949	MIPF0001139
RF03855	MIR5241	MIPF0001290
RF03856	mir-1188	MIPF0001188
RF03857	mir-3129	MIPF0001458
RF03858	mir-1991	MIPF0000732
RF03859	mir-6132	MIPF0001438
RF03860	MIR1520	MIPF0000581
RF03861	mir-4484	MIPF0001440
RF03862	MIR5274	MIPF0001311
RF03863	mir-1258	MIPF0000684
RF03864	mir-BART9	MIPF0000955
RF03865	mir-7637	MIPF0001774
RF03866	mir-1889	MIPF0000954
RF03867	mir-4081	MIPF0001241
RF03868	mir-H2	MIPF0001214
RF03869	mir-2834	MIPF0001047
RF03870	mir-2040	MIPF0000713
RF03871	mir-5681	MIPF0001343
RF03872	MIR6426	MIPF0001561
RF03873	mir-3192	MIPF0001597
RF03874	mir-8834	MIPF0002099
RF03875	MIR5272	MIPF0001278
RF03876	mir-7132	MIPF0002098
RF03877	mir-3937	MIPF0001500
RF03878	mir-B6	MIPF0001260
RF03879	mir-2831	MIPF0000978
RF03880	mir-1684	MIPF0001537
RF03881	mir-59	MIPF0000940
RF03882	mir-4889	MIPF0001686
RF03883	mir-9256	MIPF0001895
RF03884	mir-725	MIPF0001355

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RF03885	mir-4178	MIPF0000928
RF03886	mir-1993	MIPF0000716
RF03887	mir-2511	MIPF0000977
RF03888	mir-3160	MIPF0001028
RF03889	mir-4776	MIPF0001210
RF03890	mir-B8	MIPF0002021
RF03891	mir-2545	MIPF0000994
RF03892	mir-4860	MIPF0001765
RF03893	mir-4879	MIPF0001780
RF03894	mir-5736	MIPF0001480
RF03895	MIR2679	MIPF0000892
RF03896	MIR2275	MIPF0000797
RF03897	mir-4077	MIPF0000905
RF03898	mir-7616	MIPF0001718
RF03899	mir-5912	MIPF0001497
RF03900	mir-9242	MIPF0002032
RF03901	mir-BART18	MIPF0000948
RF03902	MIR7784	MIPF0001728
RF03903	mir-679	MIPF0001564
RF03904	MIR7991	MIPF0001701
RF03905	MIR6149	MIPF0001580
RF03906	mir-3199	MIPF0001026
RF03907	mir-4428	MIPF0001630
RF03908	MIR6459	MIPF0001730
RF03909	mir-3804	MIPF0001255
RF03910	mir-H5	MIPF0000966
RF03911	mir-1910	MIPF0000987
RF03912	mir-4659	MIPF0001256
RF03913	mir-992	MIPF0000914
RF03914	mir-BART21	MIPF0000961
RF03915	MIR5286	MIPF0001342
RF03916	MIR400	MIPF0001157
RF03917	mir-4449	MIPF0002103

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RF03918	mir-4922	MIPF0001229
RF03919	mir-1540	MIPF0001772
RF03920	mir-237	MIPF0000904
RF03921	MIR860	MIPF0001176
RF03922	MIR2119	MIPF0000762
RF03923	mir-964	MIPF0000949
RF03924	mir-1228	MIPF0000924
RF03925	mir-1011	MIPF0000969
RF03926	MIR1435	MIPF0000760
RF03927	MIR538	MIPF0000161
RF03929	mir-6579	MIPF0001492
RF03930	mir-1909	MIPF0000973
RF03931	mir-2061	MIPF0001790
RF03932	mir-1597	MIPF0000764
RF03933	MIR6445	MIPF0001621
RF03934	mir-m107-1	MIPF0000446
RF03935	mir-763	MIPF0000722
RF03936	mir-4079	MIPF0001273
RF03937	mir-9456	MIPF0001974
RF03938	mir-4662	MIPF0001245
RF03939	mir-4868	MIPF0001233
RF03940	MIR9563	MIPF0001941
RF03941	mir-3158	MIPF0001065
RF03942	mir-5727	MIPF0001627
RF03943	mir-1824	MIPF0001717
RF03944	mir-935	MIPF0000606
RF03945	mir-4876	MIPF0001776
RF03946	mir-3132	MIPF0001509
RF03947	mir-658	MIPF0000643
RF03948	mir-5045	MIPF0001341
RF03949	mir-8830	MIPF0001924
RF03950	mir-4928	MIPF0001818
RF03951	MIR7725	MIPF0001792

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RF03952	mir-3718	MIPF0001225
RF03953	mir-5350	MIPF0001367
RF03954	mir-8993	MIPF0002018
RF03955	MIR2934	MIPF0001269
RF03956	mir-737	MIPF0001689
RF03957	mir-5856	MIPF0001503
RF03958	mir-959	MIPF0000910
RF03959	mir-303	MIPF0001013
RF03960	mir-6644	MIPF0001504
RF03961	mir-9033	MIPF0002087
RF03962	mir-958	MIPF0000912
RF03963	mir-2996	MIPF0001023
RF03964	mir-H1	MIPF0000738
RF03965	mir-8927	MIPF0001979
RF03966	mir-76	MIPF0000902
RF03967	mir-1270	MIPF0000877
RF03968	mir-8934	MIPF0002010
RF03969	mir-622	MIPF0000619
RF03970	mir-2766	MIPF0001608
RF03971	mir-3572	MIPF0001244
RF03972	mir-3150	MIPF0001102
RF03973	mir-5615	MIPF0001318
RF03974	MIR838	MIPF0001184
RF03975	mir-5881	MIPF0001420
RF03976	MIR898	MIPF0000378
RF03977	mir-976	MIPF0000916
RF03978	mir-1269	MIPF0000984
RF03979	mir-2006	MIPF0001936
RF03980	mir-2012	MIPF0000720
RF03981	mir-8799	MIPF0001881
RF03982	mir-4865	MIPF0001750
RF03983	MIR5284	MIPF0001277
RF03984	MIR2933	MIPF0001072

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RF03985	mir-9250	MIPF0002073
RF03986	mir-6095	MIPF0001433
RF03987	MIR6136	MIPF0001741
RF03988	mir-6301	MIPF0001556
RF03989	mir-7950	MIPF0001678
RF03990	mir-4888	MIPF0001724
RF03991	mir-9209	MIPF0001927
RF03992	mir-6302	MIPF0001398
RF03993	mir-8536	MIPF0002030
RF03994	mir-7558	MIPF0001716
RF03995	mir-7957	MIPF0001668
RF03996	mir-3012	MIPF0001018
RF03997	mir-8510	MIPF0001886
RF03998	mir-2160	MIPF0000769
RF03999	mir-7883	MIPF0001849
RF04000	MIR8139	MIPF0001665
RF04001	mir-7918	MIPF0001655
RF04002	MIR6143	MIPF0001685
RF04003	mir-4841	MIPF0001264
RF04004	mir-7940	MIPF0001719
RF04005	mir-4599	MIPF0001252
RF04006	mir-9338	MIPF0001921
RF04007	mir-8489	MIPF0002034
RF04008	mir-4880	MIPF0001833
RF04009	mir-754	MIPF0000749
RF04010	mir-3003	MIPF0000818
RF04011	mir-8515	MIPF0002064
RF04012	MIR7532	MIPF0001820
RF04013	mir-4818	MIPF0001211
RF04014	mir-8338	MIPF0002060
RF04015	MIR946	MIPF0000427
RF04016	mir-4873	MIPF0001806
RF04017	mir-4864	MIPF0001702

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RF04018	mir-5316	MIPF0001364
RF04019	MIR950	MIPF0000407
RF04020	mir-4859	MIPF0001784
RF04021	mir-3492	MIPF0001622
RF04022	mir-4863	MIPF0001778
RF04023	MIR1314	MIPF0001609
RF04024	mir-9571	MIPF0002068
RF04025	mir-7964	MIPF0001749
RF04026	mir-8499	MIPF0002029
RF04027	mir-1422	MIPF0000565
RF04028	mir-7948	MIPF0001695
RF04029	mir-8521	MIPF0001871
RF04030	mir-6096	MIPF0001436
RF04031	mir-2686	MIPF0000927
RF04032	MIR2912	MIPF0000778
RF04033	mir-8512	MIPF0002076
RF04035	mir-7910	MIPF0001840
RF04036	mir-2076	MIPF0001795
RF04037	mir-7911	MIPF0001858
RF04038	mir-5985	MIPF0001491
RF04039	mir-2242	MIPF0000945
RF04040	mir-4866	MIPF0001756
RF04041	MIR6154	MIPF0001560
RF04042	mir-7961	MIPF0001832
RF04043	mir-2062	MIPF0001753
RF04044	mir-7939	MIPF0001646
RF04045	mir-2147	MIPF0000751
RF04046	mir-2154	MIPF0000781
RF04047	mir-9228	MIPF0001876
RF04048	mir-7927	MIPF0001660
RF04049	MIR7127	MIPF0001408
RF04050	mir-2072	MIPF0001697
RF04051	mir-8517	MIPF0002077

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RF04052	mir-466	MIPF0000208
RF04053	mir-95	MIPF0000098
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RF04055	mir-1261	MIPF0000802
RF04056	mir-982	MIPF0000843
RF04057	MIR1432	MIPF0001063
RF04059	MIR5020	MIPF0001226
RF04060	mir-703	MIPF0000761
RF04061	mir-1420	MIPF0000574
RF04062	MIR949	MIPF0001455
RF04063	MIR2629	MIPF0000824
RF04064	MIR5267	MIPF0001276
RF04065	mir-7563	MIPF0001709
RF04066	mir-1256	MIPF0000594
RF04067	mir-4520	MIPF0001272
RF04068	mir-3927	MIPF0001462
RF04069	MIR6135	MIPF0001644
RF04070	MIR6440	MIPF0001406
RF04071	MIR2863	MIPF0000925
RF04072	mir-7386	MIPF0001658
RF04073	mir-727	MIPF0001371
RF04074	mir-1199	MIPF0001659
RF04075	mir-1545	MIPF0001711
RF04076	mir-H11	MIPF0000833
RF04077	mir-1245	MIPF0000620
RF04078	mir-1905	MIPF0000753
RF04079	MIR161	MIPF0000455
RF04080	mir-762	MIPF0000624
RF04081	mir-1992	MIPF0000705
RF04082	mir-54	MIPF0000874
RF04083	MIR528	MIPF0000868
RF04084	mir-595	MIPF0000651
RF04085	mir-1271	MIPF0000483

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RF04087	MIR5565	MIPF0001279
RF04088	MIR812	MIPF0000345
RF04089	mir-753	MIPF0000752
RF04090	mir-6529	MIPF0001771
RF04091	mir-72	MIPF0000277
RF04092	MIR1508	MIPF0000719
RF04093	mir-1784	MIPF0001873
RF04094	MIR537	MIPF0000207
RF04095	MIR9746	MIPF0001884
RF04096	mir-4433	MIPF0001826
RF04097	MIR2630	MIPF0000814
RF04098	MIR9471	MIPF0002045
RF04099	MIR837	MIPF0001155
RF04100	mir-493	MIPF0000230
RF04101	mir-8864	MIPF0001919
RF04102	MIR6457	MIPF0001534
RF04103	mir-8356	MIPF0001997
RF04104	MIR918	MIPF0000374
RF04105	mir-3165	MIPF0001635
RF04106	mir-1303	MIPF0000608
RF04107	mir-5391	MIPF0001944
RF04108	mir-2513	MIPF0000980
RF04109	mir-1305	MIPF0000965
RF04110	MIR5084	MIPF0002026
RF04111	MIR6274	MIPF0001706
RF04112	MIR5512	MIPF0001478
RF04113	MIR1523	MIPF0001327
RF04114	MIR4374	MIPF0001152
RF04115	mir-6130	MIPF0001413
RF04116	MIR9672	MIPF0001942
RF04117	MIR5200	MIPF0001904
RF04118	MIR9481	MIPF0002096
RF04119	MIR1858	MIPF0000650

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RF04120	MIR5998	MIPF0001613
RF04121	mir-1289	MIPF0000626
RF04122	mir-1204	MIPF0000671
RF04123	mir-3127	MIPF0001439
RF04124	MIR8565	MIPF0001889
RF04125	MIR9408	MIPF0002027
RF04126	mir-9198	MIPF0001887
RF04127	MIR8007	MIPF0001839
RF04128	MIR8562	MIPF0001861
RF04129	MIR4240	MIPF0001198
RF04130	MIR7996	MIPF0001691
RF04131	mir-2032	MIPF0000736
RF04132	mir-4436	MIPF0001236
RF04133	MIR2646	MIPF0001010
RF04134	MIR7504	MIPF0001798
RF04135	MIR5062	MIPF0001922
RF04136	MIR1862	MIPF0000580
RF04137	MIR834	MIPF0001183
RF04138	mir-9243	MIPF0001926
RF04139	MIR841	MIPF0001112
RF04140	mir-3118	MIPF0001928
RF04141	MIR8622	MIPF0001931
RF04142	mir-1299	MIPF0000625
RF04143	MIR869	MIPF0001167
RF04144	MIR9783	MIPF0001947
RF04145	MIR8706	MIPF0001953
RF04146	mir-4742	MIPF0001552
RF04147	MIR6224	MIPF0001435
RF04148	MIR844	MIPF0001197
RF04149	MIR447	MIPF0000170
RF04150	MIR2655	MIPF0000813
RF04151	MIR4387	MIPF0001109
RF04152	mir-3618	MIPF0001710

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RF04153	MIR856	MIPF0001162
RF04154	mir-1277	MIPF0001937
RF04155	mir-9236	MIPF0001905
RF04156	MIR2670	MIPF0000855
RF04157	MIR9486	MIPF0002054
RF04158	mir-568	MIPF0000408
RF04159	MIR1437	MIPF0001762
RF04160	MIR868	MIPF0001173
RF04161	mir-3688	MIPF0001263
RF04162	MIR9662	MIPF0002119
RF04163	mir-8364	MIPF0001877
RF04164	MIR1507	MIPF0000699
RF04165	mir-2483	MIPF0001532
RF04166	mir-2278	MIPF0001522
RF04167	mir-1972	MIPF0001025
RF04168	MIR839	MIPF0001143
RF04169	mir-2235	MIPF0000825
RF04170	MIR7723	MIPF0001739
RF04171	MIR1509	MIPF0000771
RF04172	MIR8675	MIPF0002106
RF04173	MIR847	MIPF0001171
RF04174	MIR4208	MIPF0001108
RF04175	mir-1260b	MIPF0001381
RF04176	mir-3149	MIPF0001935
RF04185	MIR2118_2	MIPF0001409
RF04186	mir-278_2	MIPF0000728
RF04187	MIR862	MIPF0001145
RF04193	mir-51	MIPF0000268
RF04194	mir-57	MIPF0000271
RF04195	MIR6217	MIPF0001550
RF04196	MIR5638	MIPF0001350
RF04197	mir-9457	MIPF0002122
RF04198	MIR8670	MIPF0002041

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RF04199	MIR6027	MIPF0001424
RF04200	mir-9437	MIPF0001943
RF04201	MIR7510	MIPF0001684
RF04202	MIR5380	MIPF0001331
RF04203	MIR1144	MIPF0000432
RF04204	mir-3473	MIPF0001230
RF04205	MIR2606	MIPF0000888
RF04206	MIR9555	MIPF0002081
RF04207	MIR5048	MIPF0001453
RF04208	MIR8742	MIPF0002016
RF04209	MIR7533	MIPF0001834
RF04210	MIR8643	MIPF0002008
RF04211	MIR5185	MIPF0001246
RF04212	mir-8904	MIPF0001977
RF04213	MIR7807	MIPF0002091
RF04214	MIR7526	MIPF0001651
RF04215	mir-9214	MIPF0002108
RF04216	mir-509	MIPF0000130
RF04217	mir-297	MIPF0000204
RF04223	MIR2619	MIPF0001294
RF04224	mir-9229	MIPF0001875
RF04225	MIR7502	MIPF0001869
RF04226	mir-9186	MIPF0001868
RF04227	mir-9215	MIPF0001893
RF04228	MIR6140	MIPF0001666
RF04229	mir-9279	MIPF0001911
RF04230	mir-9261	MIPF0001938
RF04231	mir-9191	MIPF0001987
RF04232	mir-9318	MIPF0002056
RF04233	mir-680	MIPF0000338
RF04234	mir-1421	MIPF0000564
RF04235	mir-242_2	MIPF0000731
RF04236	mir-1285	MIPF0000559

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RF04237	mir-1490	MIPF0000525
RF04238	mir-4012	MIPF0000964
RF04239	mir-4679	MIPF0001228
RF04240	mir-4716	MIPF0001476
RF04241	mir-5014	MIPF0001634
RF04242	mir-5595	MIPF0001590
RF04243	MIR169_3	MIPF0000253
RF04244	MIR169_6	MIPF0001058
RF04245	MIR169_7	MIPF0001690
RF04246	MIR169_8	MIPF0001712
RF04248	MIR7486	MIPF0001682
RF04249	mir-310	MIPF0000566
RF04250	mir-236	MIPF0000232
RF04251	MIR5070	MIPF0002013
RF04252	mir-8186	MIPF0002035
RF04254	mir-1677	MIPF0000849
RF04255	MIR8001	MIPF0001852
RF04257	mir-9230	MIPF0002035
RF04258	mir-994	MIPF0001045
RF04259	mir-2003	MIPF0002049
RF04260	mir-2005	MIPF0001956
RF04261	MIR1861	MIPF0000567
RF04262	MIR1319	MIPF0001448
RF04263	MIR2593	MIPF0000733
RF04264	mir-5408	MIPF0001313
RF04265	mir-4650	MIPF00001234
RF04266	mir-9412	MIPF0001891
RF04267	mir-362	MIPF0000209
RF04268	mir-512	MIPF0000518
RF04269	mir-373	MIPF0000500
RF04270	mir-743	MIPF0000386
RF04271	mir-1244	MIPF0000569
RF04272	mir-8908	MIPF0001890

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RF04273	MIR827_2	MIPF0001769
RF04274	mir-9223	MIPF0001885
RF04275	mir-2733	MIPF0000766
RF04276	MIR4371	MIPF0001141
RF04277	mir-1268	MIPF0000946
RF04278	MIR4372	MIPF0001257
RF04279	mir-H20	MIPF0001760
RF04280	mir-890	MIPF0000386
RF04281	mir-8791	MIPF0001882
RF04282	mir-507	MIPF0000130
RF04283	mir-3135	MIPF0001219
RF04284	mir-532	MIPF0000113
RF04285	mir-660	MIPF0000113
RF04286	mir-513	MIPF0000130
RF04287	mir-9195	MIPF0001939
RF04288	mir-9201	MIPF0001898
RF04289	mir-3596	MIPF0001194
RF04290	mir-1197	MIPF0000126
RF04291	mir-368	MIPF0000091
RF04292	mir-379	MIPF0000126
RF04293	mir-889	MIPF0000514
RF04294	mir-3578	MIPF0001166
RF04295	mir-329	MIPF0000110
RF04296	mir-485	MIPF0000201
RF04297	mir-35_2	MIPF0001648
RF04298	mir-36_2	MIPF0001664
RF04299	MIR814	MIPF0000351
RF04300	mir-39	MIPF0000304
RF04301	mir-200	MIPF0000491
RF04302	mir-506	MIPF0000130
RF04303	MIR162_2	MIPF0000169

Table S1: The mapping between Rfam accessions, ids and miRBase family accessions.