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**Protocol status:** In development  
 We are still developing and optimizing this protocol

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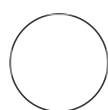
# Whole-Genome Amplification of Respiratory Syncytial Virus (RSV) using Illumina CovidSeq reagents for Next-Generation Sequencing

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## DISCLAIMER

Protocol in development. Further primer optimisations on the way.

## ABSTRACT

This protocol has been tested for amplification of RSV-positive nasopharyngeal swabs of CT value up to 25 using Seegene Allplex Respiratory Panel. This protocol does not require prior subtyping as it covers RSV-A and RSV-B in the same reaction. Panel of primers is an optimisation of a previously published panel by Wang et al.

This panel was modified to optimise the multiplex PCR, so the whole genome can be amplified in just two PCR reactions. In addition to this, primers have been modified to account for commonly-occurring mutations in the 22-23 season that affect primer-binding areas and were causing suboptimal amplification.

These primers were used to cover the complete hRSV genome (both A and B) by splitting into two pools of non-consecutive amplicons (odd-numbered amplicon primers in one pool, even-numbered amplicon primers in other). This allowed for Whole-genome amplification in two reactions.

Illumina CovidSeq reagents were used for the RT-PCR, with a mix previously published for amplification of Influenza RNA and a thermocycling program optimised in our lab. The library preparation part of the protocol was performed according to the Illumina CovidSeq protocol.

**Keywords:** Respiratory Syncytial Virus, RSV, NGS, Illumina, CovidSeq, amplification, PCR

## MATERIALS



QIASymphony DSP Virus/Pathogen Midi Kit Qiagen Catalog #937055



Illumina CovidSeq Assay Illumina, Inc.



Qubit™ dsDNA HS Assay Kit Invitrogen - Thermo Fisher Catalog #Q32851



BioAnalyzer High Sensitivity Chip Agilent Technologies Catalog #5067-4626

## BEFORE START INSTRUCTIONS

This protocol uses as input RNA extracted from nasopharyngeal swabs after confirmation of RSV infection via RT-PCR. Samples were extracted using the QIASymphony DSP Virus/Pathogen Midi Kit.

## Primer pools preparation

- 1 Prepare both primer mixes according to Table 1.

**For a final concentration of 10uM: add 1017 ul of Nuclease-Free water to Pool 1 and 1035 ul to Pool 2.**

Primer	Volume (100uM)	Reference	Sequence	Base	Pool
A1f	5	Wang	ACGSGAAAAAATGCGTACAAC	1	1
A1r	5	Wang	GAAGATTGTGCTATACCAAATG AACA	1779	1
AB3f	10	Goya	GCYATGGCAAGACTYAGGAATG	2897	1
A3r	5	Wang	GTTTGCYGAGGCTATGAATATGA T	4826	1
A5f	5	Wang	GAACAACAGACTACTAGAGATTA CCAG	6374	1
A5r	10	This publication	AGGAGTTTRCTCATRGCAA	7929	1
A7f	5	Wang	AGCTTAGGCTTAAGATGYGGA	9423	1
A7r	5	Wang	TGAGTTTGACCTTCCATGAGT	10997	1
A9f	7	Wang	GGGTTGGTTCATCTACACAAGAG	12316	1
A9r	7	This publication	CGCAATAATAAATTCCCTGCTCC	14094	1
B1f	5	Wang	ACGCGAAAAAATGCGTACTACA	1	1
B1r	5	Wang	CATTGTTTGCCTCCTAATTACT G	1661	1

Primer	Volume (100uM)	Reference	Sequence	Base	Pool
B3r	5	Wang	ATAGGGCCAAAATTTGCTTGTG	4309	1
B5f	5	Wang	AGTGCAATCTTCCTAACTCTTGC	5700	1
B5r	5	Wang	TGATTCCACTTAGTTGGTCTTTG C	7375	1
B7f	5	Wang	GGTGAAGTGAATAGAGAAGAAC AAC	8760	1
B7r	5	Wang	CACCATATCTTGTCAAACCTCTCA GG	10507	1
B9f	7	Wang	GAACCAACTTACCCTCATGGATT	11860	1
B9r	7	Wang	TTCTGGGGTTGGGTGATATAG	13650	1
A2f	5	Wang	ACAGGCATGACTCTCCTGAT	1556	2
A2r	5	Wang	TTGGGTGTGGATATTTGTTTCAC	3400	2
A4f	5	Wang	ACCTGGGACACTCTCAATCA	4697	2
A4r	5	Wang	GACATGATAGAGTAACTTTGCTG TCT	6540	2
A6f	5	Wang	GTCACGAAGGAATCCTTGCA	7642	2
A6r	5	Wang	CCCTCTACCTCTTTTATTATGTAG AACC	9521	2
A8f	5	Wang	GGTGTACAATCTCTATTTTCCTG GT	10704	2
A8r	5	Wang	CGATTAATAGGGCTAGTATCAAA GTG	12615	2
A10f	10	This publication	CRTCTACAATGATTAGAACCAAT TAC	13742	2
A10r	10	Wang	ACGAGAAAAAAGTGTCAAAAAC TAA	15225	2
B2f	5	Wang	CAGRTTAGGAAGGGAAGACACTA	1316	2
B2r	5	Wang	CAAGTCACTCAATTTTTTGGAGG TTGG	2982	2
B4f	10	Wang	TGGAAGCAYACAGCTACACG	3943	2
B4r	10	Wang	CTACATGTYGATTGGTAAAACTC C	5788	2
B6f	5	Wang	CCTCTAGTGTTTCCTTCTGATGA G	7113	2
B6r	5	Wang	GTTGTAGCAATTTGTTTCAGACGA G	8834	2
B8f	5	Wang	AAGTTCTCTGAAAGCGACAGATC	10231	2
B8r	5	Wang	TAATACTTGGYGATGTTACTCCT AC	12190	2
B10f	5	Wang	TAGTCAATCAAGACACAAGTTTG C	13289	2

Primer	Volume (100uM)	Reference	Sequence	Base	Pool
B10r	5	Wang	ACGAGAAAAAAAGTGTCAAAAAC TAATG	15222	2

**Table 1:** mix of primers used for amplification. Two mixes are required, one for pool 1 and another for pool 2. References for base number: hRSV/A/England/397/2017 and hRSV/B/Australia/VIC-RCH056/2019 for RSV-A and RSV-B respectively. Citation to the original papers for the primers can be found below.

## RT-PCR

- Two Master Mixes must be prepared per sample: one for Pool1 and one for Pool 2 (Table 2). Manipulate reagents according to the Illumina CovidSeq Reference Guide.

Reagent	Amount (ul) Reaction 1	Amount (ul) Reaction 2
IPM	15	15
FSM	3.2	3.2
RVT	1	1
Nuclease-Free Water	3.6	3.6
Primer pool 1 (10uM)	1.2	-
Primer pool 2 (10uM)	-	1.2

**Table 2:** Master mixes required for amplification of the RSV genome. Reaction 1 targets odd-numbered amplicons while reaction 2 targets even-numbered amplicons.

In a PCR tube, mix 20 ul of MasterMix with 5 ul of extracted RNA.

Place all tubes (two per sample) in a thermocycler and run the following program (Table 3):

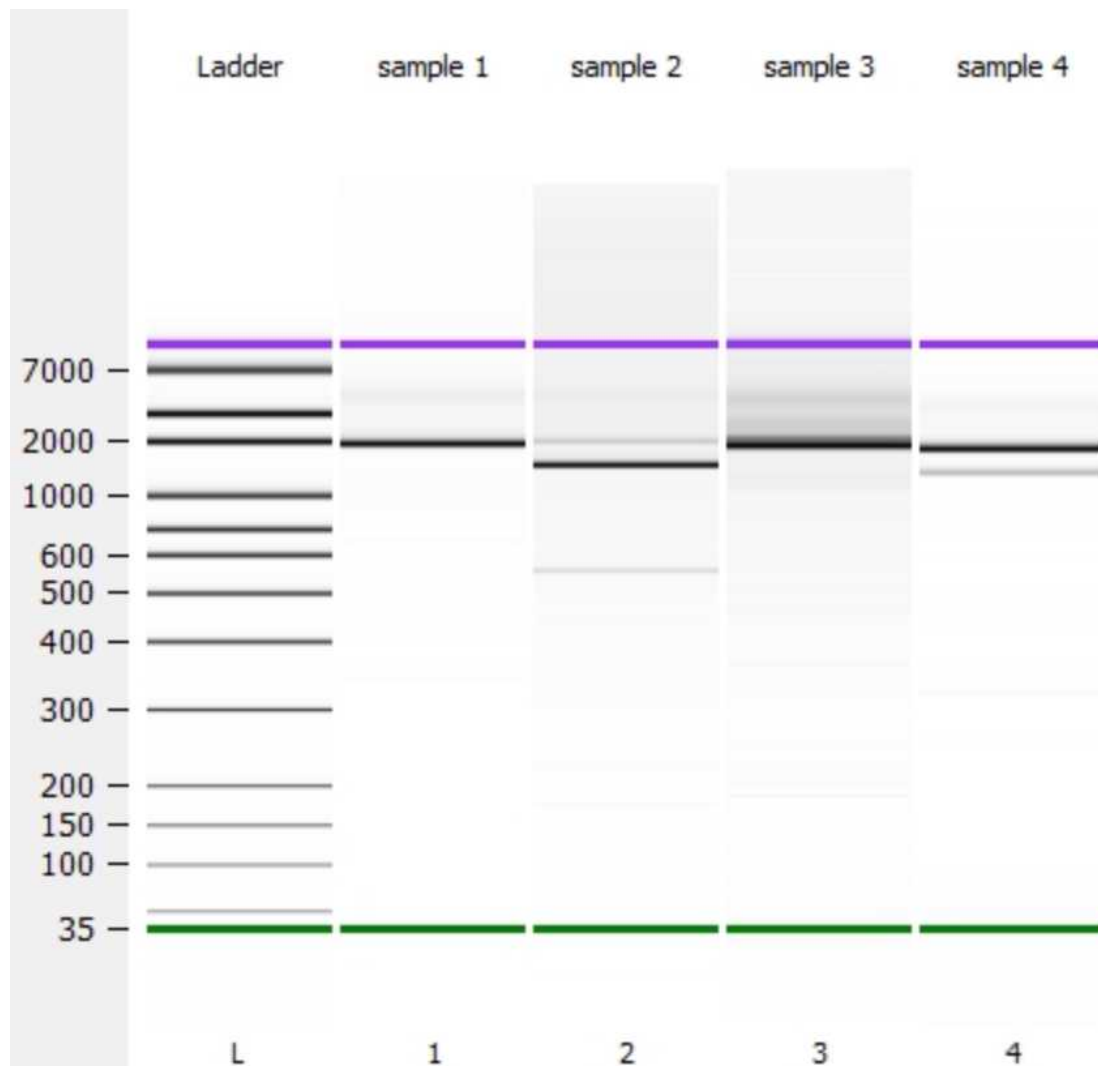
A	B	C
42°	60 min	
98°	2 min	
98°	15 s	35 cycles
63°	7 min	
4°	PAUSE	

**Table 3:** Thermocycler program for RT-PCR. Indicate 25 ul as volume and heat lid at 99°C.

### **(OPTIONAL) Check RT-PCR result with Agilent Bioanalyzer**

- 3** Use an Agilent Bioanalyzer to check for amplification peaks. Expect PCR peaks around ~1900 bps.

## Expected result



**RT-PCR result: peaks expected between 1500-2000 bps.** Representative image of an Agilent bioanalyzer of the amplification products. From left to right: ladder; RSV-A, pool 1; RSV-A, pool 2; RSV-B, pool 1; RSV-B, pool 2. Scale indicates size in base pairs.

## Library preparation

- 4 Mix 10ul of tube one and tube two on each sample for a final 20 ul of PCR product. Follow instructions of the Illumina CovidSeq Reference Guide to generate sequencing-ready

libraries.

**Recommended:** To ensure optimal normalisation, perform the library Clean-up on each tube and normalise individually instead of pooling. This improves normalisation especially in the presence of low-concentration PCR products.

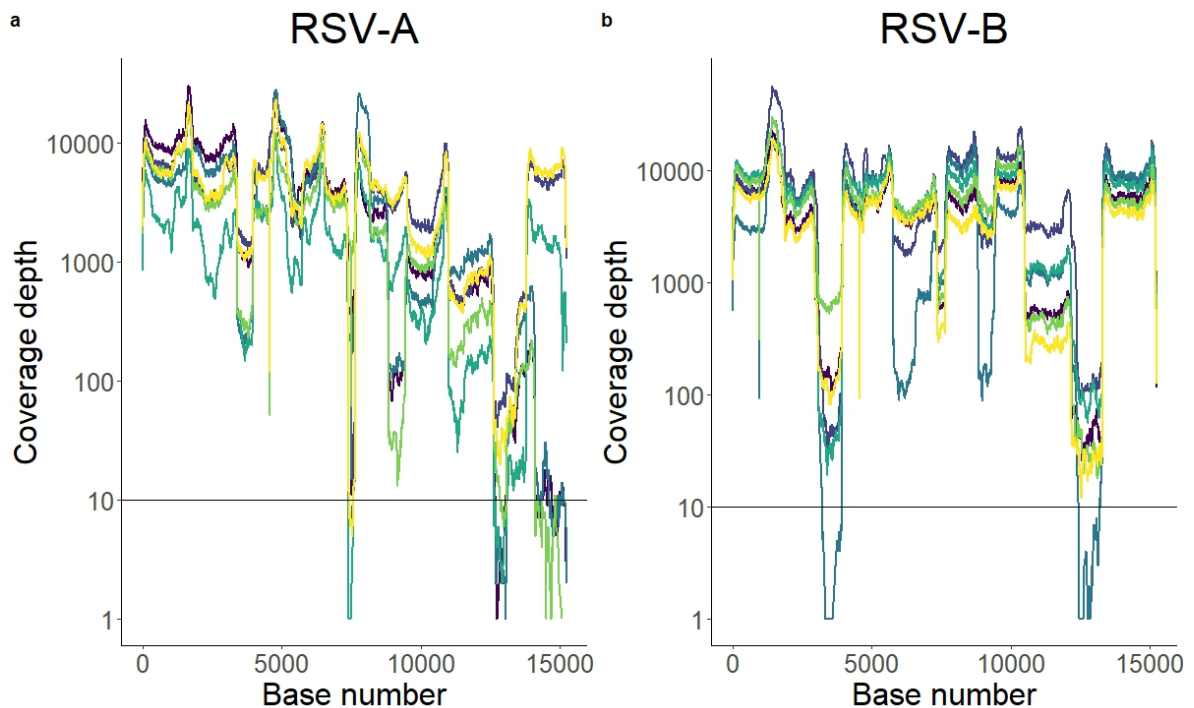
Quantify samples after Clean-up using Qubit Flex and normalise samples.

(OPTIONAL): Check library preparation on an Agilent Bioanalyzer. The pattern expected is the usual post-tagmentation pattern from Illumina libraries with the highest peak around ~330bps.

## Expected results

- 5 Coverage obtained after an iSeq run with 12 samples: 6 from RSV-A and 6 from RSV-B.  
Average reads per sample: 662k  
Average reads mapped to reference: 80.2%

## Expected result



**Expected result after sequencing:** All samples had a depth above 10 for more than 90% of the genome. Additionally depth over 10 was reached for the full G protein and 98% of the F protein in all samples.

Optimisation of the panel is currently underway to improve depth homogeneity.

## References

### 6 The illumina CovidSeq protocol can be found in:

[Illumina CovidSeq Reference Guide](#)

The primers found in Table 1 were obtained from:



#### CITATION

Wang L, Ng TFF, Castro CJ, Marine RL, Magaña LC, Esona M, Peret TCT, Thornburg NJ (2022). Next-generation sequencing of human respiratory syncytial virus subgroups A and B genomes..

LINK

<https://doi.org/10.1016/j.jviromet.2021.114335>

#### CITATION

Stephanie Goya, Gabriel L. Rojo, Mercedes S. Nabaes Jordar, Laura E. Valinotto, Alicia S Mistchenko, Mariana Viegas. Whole genome sequencing of respiratory syncytial (RSV) virus from clinical samples with low viral load. protocols.io.

LINK

<https://protocols.io/view/whole-genome-sequencing-of-respiratory-syncytial-r-bmhak32e>

**The Master Mix used for RT-PCR with Illumina CovidSeq was first published in:**

#### CITATION

Ying Lin, Jeffrey Koble, Priyanka Prashar, Anita Pottekat, Christina Middle, Scott Kuersten, Michael Oberholzer, Robert Brazas, Darcy Whitlock, Robert Schlaberg, Gary P. Schroth. A sequencing and subtyping protocol for Influenza A and B viruses using Illumina® COVIDSeq™ Assay Kit. protocols.io.

LINK

<https://protocols.io/view/a-sequencing-and-subtyping-protocol-for-influenza-crv3v68n>