



Version 3

Dec 21, 2020

# 'Frankenstein' protocol for nuclei isolation from fresh and frozen tissue for snRNAseq V.3

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Works for me

[dx.doi.org/10.17504/protocols.io.bqxymxpw](https://dx.doi.org/10.17504/protocols.io.bqxymxpw)

Human Cell Atlas Method Development Community

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## ABSTRACT

This protocol is the result of the combination of various nuclei isolation protocols for single cell RNA-seq experiments using droplet-based methods, hence the name Frankenstein. Developed to prepare nuclei isolates from small sample sizes (as little as a grain of rice), this protocol uses FACS to identify cell subpopulations based on ploidy (e.g. tumor versus stroma), to ensure that nuclei suspensions are not clumped, and to remove any debris, especially ambient RNA, to help reduce background. The reference protocols can be found in the following papers: Hu, et al., Habib, et al. (2016), Habib, et al. (2017), Lake, et al., and Lacar, et al.

This protocol is routinely used in the single-cell innovation lab for single nuclei experiments using 10x Genomics technologies.

The protocol has been demonstrated to work successfully with fresh, snap/flash frozen, cryopreserved cells, and cell lines, as well as various solid cancers: pancreas, pheochromocytomas, paragangliomas, breast cancer, lymphoma, xenografts and tumors.

## EXTERNAL LINK

<https://research.unimelb.edu.au/centre-for-cancer-research/our-research/single-cell-innovation-lab>

## ATTACHMENTS

[\\_\\_\\_Frankenstein\\_\\_\\_protocol\\_for\\_nuclei\\_isolation\\_from\\_fresh\\_and\\_frozen\\_tissue\\_FINAL.pdf](#)

## DOI

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## PROTOCOL CITATION

Luciano G Martelotto, Luciano Martelotto 2020. 'Frankenstein' protocol for nuclei isolation from fresh and frozen tissue for snRNAseq. **protocols.io**  
<https://dx.doi.org/10.17504/protocols.io.bqxymxpw>  
Version created by Luciano Martelotto

MANUSCRIPT CITATION please remember to cite the following publication along with this protocol

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#### KEYWORDS

snRNAseq, 10x, nuclei, isolation, FACS

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#### CREATED

Dec 21, 2020

#### LAST MODIFIED

Dec 21, 2020

#### PROTOCOL INTEGER ID

45784

#### ATTACHMENTS

\_\_\_\_Frankenstein\_\_\_\_proto  
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e\_FINAL.pdf

#### GUIDELINES

This protocol requires access to a cell sorter and familiarity with sorting cells/nuclei into 96-well plates.

1. Use a plastic pestle to mechanically homogenize tissue and release nuclei
2. Separate the nuclei from debris using a cell sorter
3. Collect a specific number of nuclei in a 96-well plate containing 10x RT Buffer\*
4. Immediately load the sample into a Single Cell Chip for processing according the [Single Cell 3' Reagents User Guide](#) or [Single Cell V\(D\)J 5' Reagents User Guide](#)

\*Assume that nuclei recovery is 57%, and use this to determine the number of nuclei to collect for each of your samples. (This value is derived from the Cell Suspension Volume Calculator Table in the [Single Cell 3' Reagents User Guide](#) or [Single Cell V\(D\)J 5' Reagents User Guide](#))

The protocol did not work with cardiomyocytes due to the high level of myosin heavy chain (MHC).

#### 10x Genomics Products

Chromium Single Cell Immune Profiling Solution - <https://www.10xgenomics.com/solutions/vdj/>

Chromium Single Cell Gene Expression Solution - <https://www.10xgenomics.com/single-cell/>

#### MATERIALS TEXT

##### MATERIALS

 [Nuclei EZ lysis buffer](#)

**Sigma Catalog #EZ PREP NUC-101**

##### **Nuclei wash and resuspension buffer (prepare chilled, 4°C)**

1x PBS

1.0% BSA

0.2 U/μl RNase Inhibitor

**Nuclei wash and resuspension buffer with DAPI (prepare chilled, 4°C)**

1x PBS  
1.0% BSA  
0.2 U/μl RNase Inhibitor  
10 μg/mL DAPI

**10x RT Buffer<sup>1</sup> for Single Cell Gene Expression 3' reagents (DO NOT add RT enzyme)**

RT Reagent Mix	50 μL
RT primer	3.8 μL
Additive A	2.4 μL
H2O	(31.7 - X - Y) μL

**10x RT Buffer<sup>1</sup> for Single Cell Immune Profiling 5' reagents (DO NOT add RT enzyme)**

RT Reagent Mix	50 μL
RT primer	5.9 μL
Additive A	2.4 μL
H2O	(31.7 - X - Y) μL

**<sup>1</sup>RT Buffer Notes**

- X ('sorting volume'): In the cytometric analysis setup described in this protocol, each droplet is 1 nL. Example: 10,000 nuclei = 10,000 nL = 10 μL 'sorting volume'.
- Y ('additional volume'): This accounts for any additional volume deposited by the flow cytometer nozzle. In the cytometric analysis setup described in this protocol (i.e. 75 μm nozzle) there is no additional volume deposited by the nozzle, so Y = 0. If in doubt, or to be on the safe side, just make Y = 5-10 μL.
- The 1 nuclei/nL assumption was corroborated empirically by sorting 10,000 nuclei in ten wells containing 70 μL PBS and then measuring the final volume post sorting. It is highly recommended to determine X empirically as value may vary depending on different sorters/nozzle combinations. It is recommended to determine it at least once.
- Always measure the volume after sorting and top up to 90 μL with PBS or H<sub>2</sub>O if required.
- After adding the RT Enzyme Mix the final volume will be 100 μL.
- It is crucial to work as fast as possible. Do not leave nuclei sitting on ice for too long (e.g. 30' is too long).
- Reduce as much as possible the time from sorting-to-controller run, ideally keep it under 40 minutes. The longer the time the higher the background will be.

**SAFETY WARNINGS**

See SDS (Safety Data Sheet) for safety warnings and hazards.

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## BEFORE STARTING



All samples and reagents are kept on ice or at 4 °C (wet ice).

Prepare all buffers and reagents as described in the "Materials" section.







## Tissue Homogenization

- 1 Mince/chop tissue with a razor blade to small pieces. The tissue may be as small as a grain of rice.

For mincing the tissue, you may take the tube out of ice, however, be quick and return to ice.

- 2 Add  500 µl chilled Nuclei EZ Lysis Buffer to the tissue in 1.5 mL tube.
- 3 Homogenize the sample using a douncer (stroking 10-20 times).
- 4 Transfer the homogenate (~  500 µl ) into a 2 mL tube.

## Nuclei Isolation and Staining

- 5 Add  1 mL of chilled Nuclei EZ Lysis Buffer, mix gently and incubate on ice for  00:05:00 . Gently mix with a wide bore tip. Repeat 1-2 times during the incubation.
- 6 Filter homogenate using a 70 µm-strainer mesh. Collect flow through in a polystyrene round-bottom FACS tube and transfer volume back into a new 2 mL tube.
- 7 Centrifuge the nuclei at  500 x g for  00:05:00 at  4 °C and remove supernatant leaving behind ~  50 µl .


- 8 Gently resuspend nuclei in another  **1.5 mL** of EZ Lysis buffer, incubate for  **00:05:00** on ice.
- 9 Centrifuge the nuclei at  **500 x g** for  **00:05:00** at  **4 °C** , remove supernatant as much as possible without disturbing pellet (if pellet looks loose leave ~  **50 µl** behind).
- 10 Add  **500 µl** Nuclei Wash and Resuspension Buffer and incubate  **00:05:00** **without resuspending** to allow buffer interchange.
- 11 After incubation, add  **1 mL** of Nuclei Wash and Resuspension Buffer and resuspend the nuclei.
- 12 Centrifuge the nuclei at  **500 x g** for  **00:05:00** at  **4 °C** , remove supernatant leaving behind ~  **50 µl** .
- 13 Gently resuspend nuclei in  **1.4 mL** Nuclei Wash and Resuspension Buffer and transfer to a 1.5 mL tube (easier to see small pellets).
- 14 Repeat Step 13 and resuspend in  **500 µl** **Nuclei Wash and Resuspension Buffer supplemented with DAPI**. Collect all nuclei by washing off nuclei from the wall of centrifuge tube.

**IMPORTANT:** Protect from light from here forward.



## Cytometry and 10x

- 15 Filter nuclei (at least once) with a 35-µm cell strainer. Visually inspect nuclei integrity under a microscope.

Count the number of nuclei with a cell counter or hemacytometer if required.
- 16 Perform cytometric analysis. Identify single nuclei and sub-populations based on DNA content, gate and sort directly into 10x RT Buffer prepared **without the RT Enzyme Mix**.
- 17 Proceed immediately with the 10x Genomics Single Cell Protocol and minimize the time between nuclei preparation/sorting and chip loading.
- 18 Add  **10 µl** RT Enzyme Mix to the sorted nuclei in RT buffer, mix well but gently and load chip as per the [Single Cell 3' Reagents User Guide](#) or [Single Cell V\(D\)J 5' Reagents User Guide](#).

