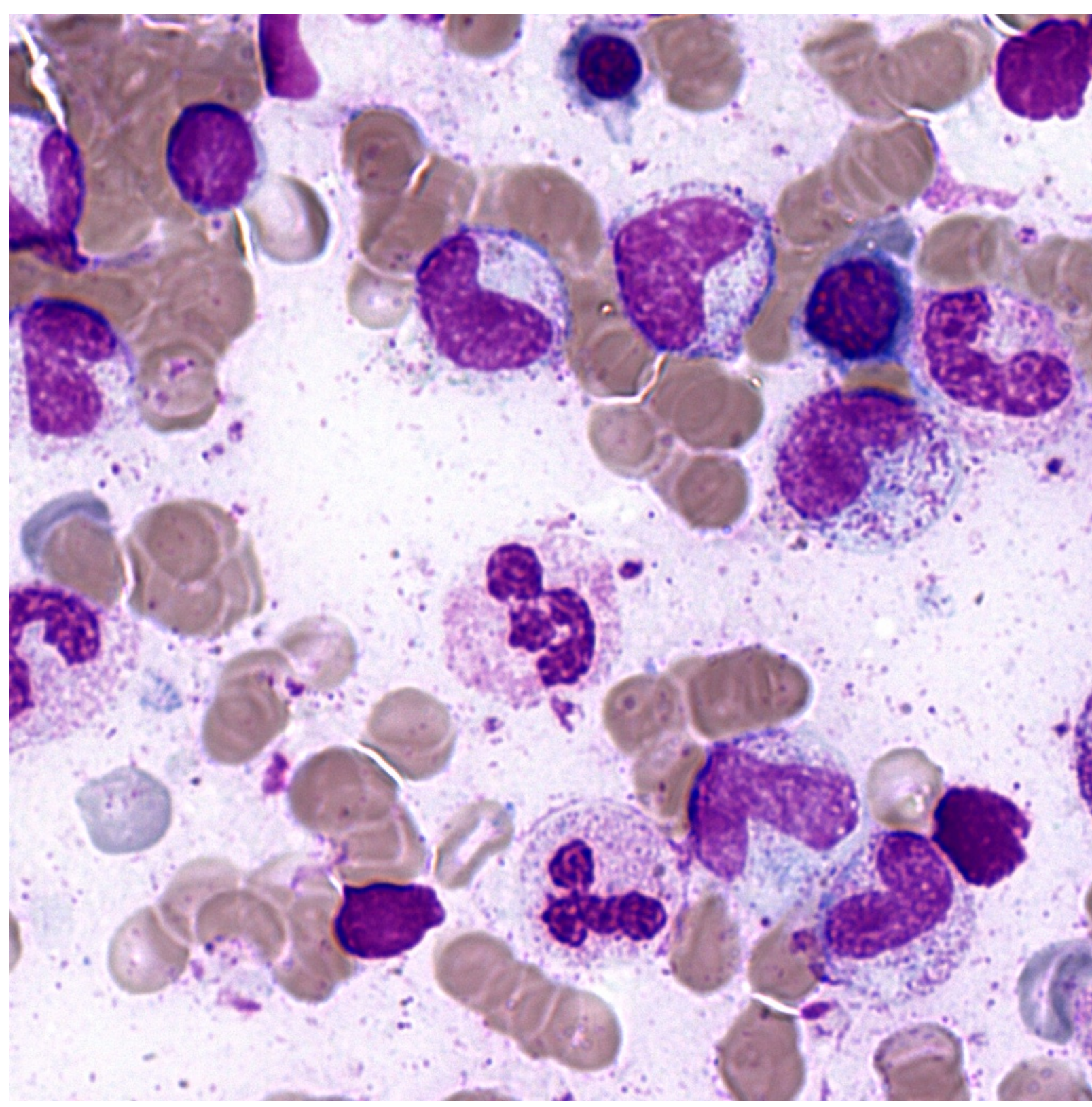
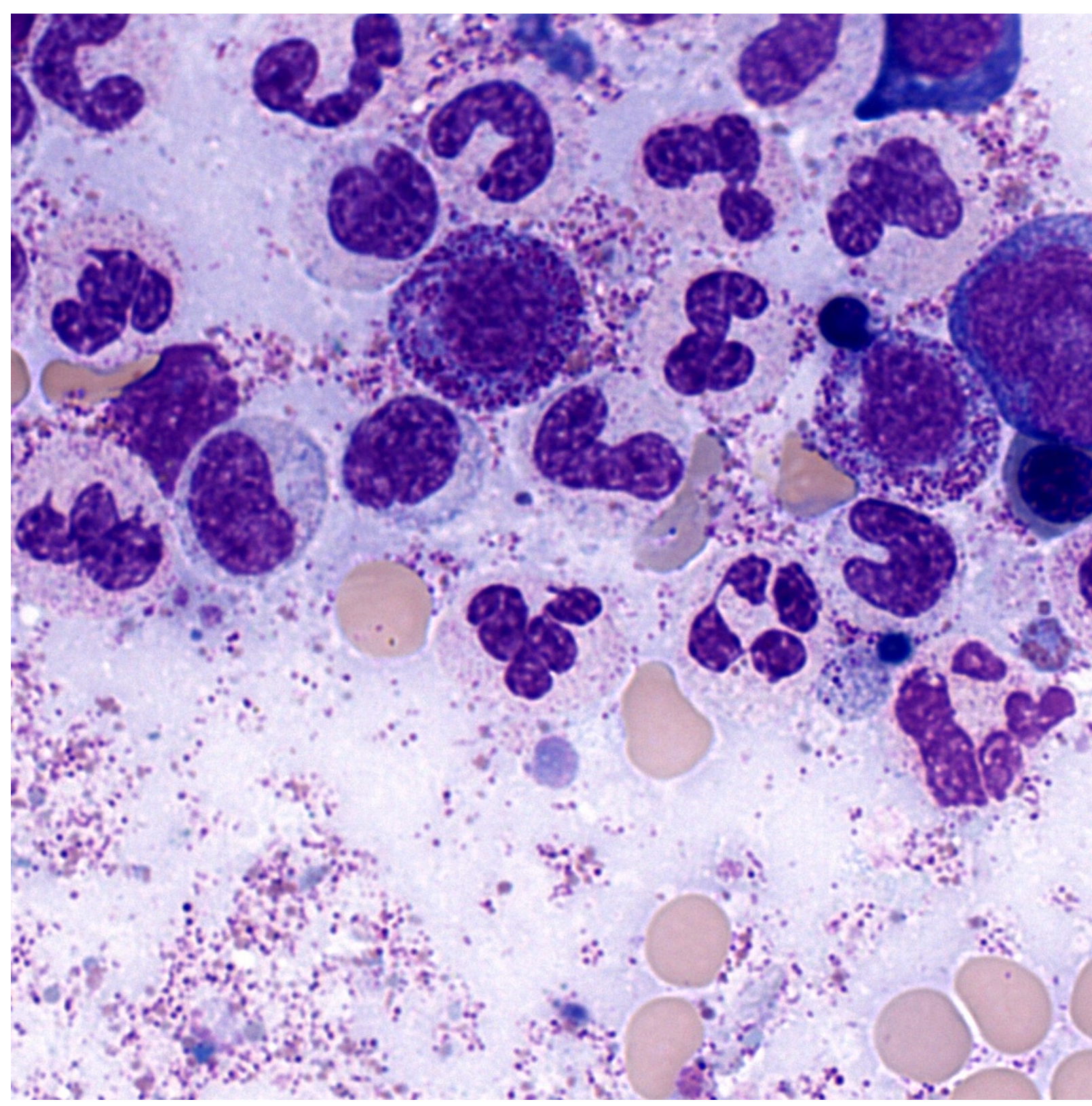


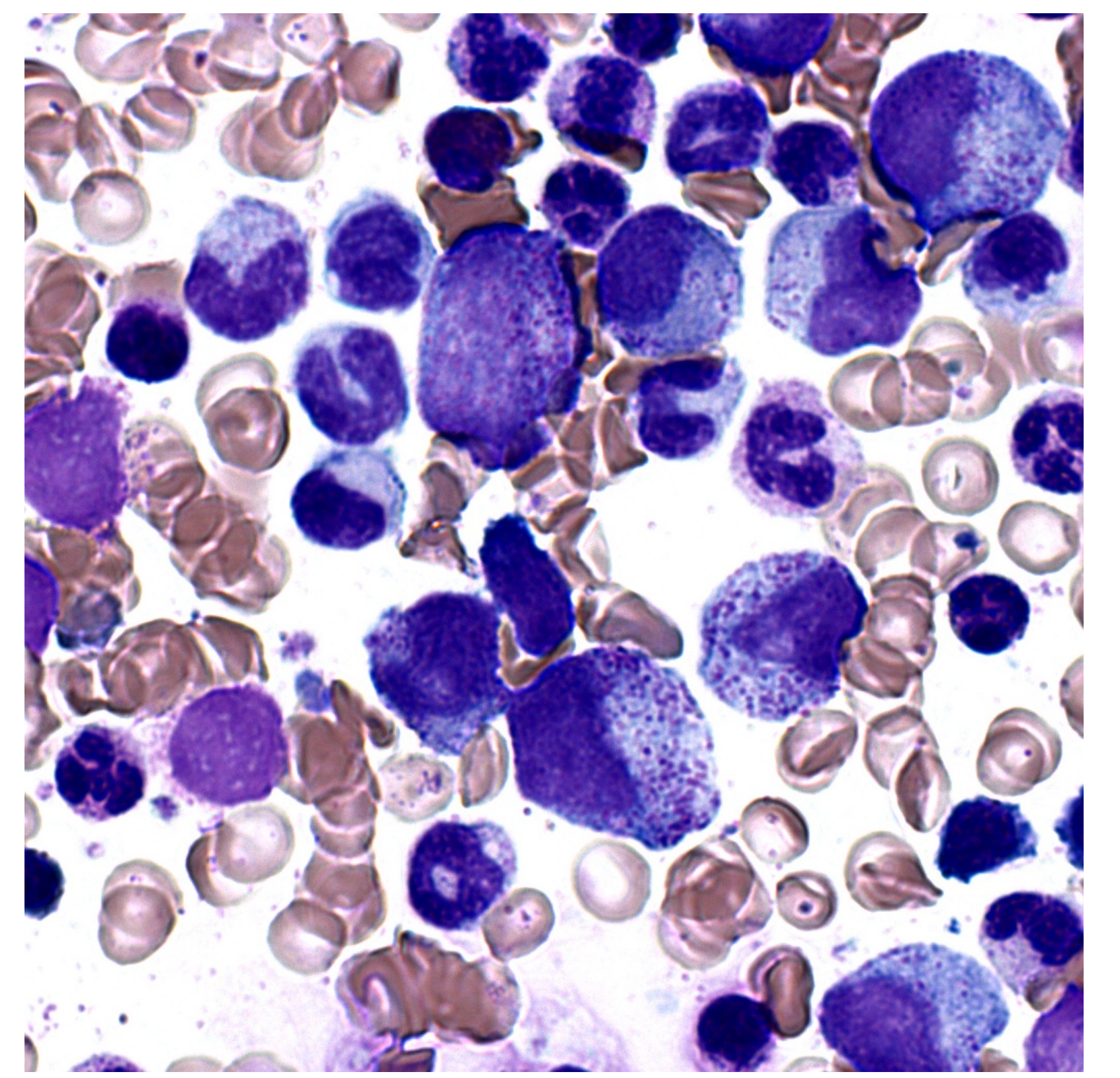
Stain OS1



Normal Stain



Stain OS2



We compare classical Stain Augmentation and Normalisation methods for Classification and Detection of haematopoietic cells.

Motivation

Analysis of the blood cell distribution in bone marrow is necessary for a detailed diagnosis of many haematopoietic diseases, such as leukaemia. While this task is performed manually on microscope images in clinical routine, automating it could improve reliability and objectivity.

Cell detection and classification accuracy both depend heavily on the stain intensity. A decline in performance can be mitigated by using data augmentation or normalisation. Both have different impact on detection and classification tasks.

Pipeline

1. Train on normally stained images (subset of NI)
 - a) with data augmentation
 - b) with normalisation
2. Evaluate separately on NI (other subsets), OS1, and OS2
 - a) without augmentation
 - b) with normalisation

Classification

DenseNet-121 + CrossEntropy

Detection

UNet (depth 4) + DiceLoss followed by Watershed

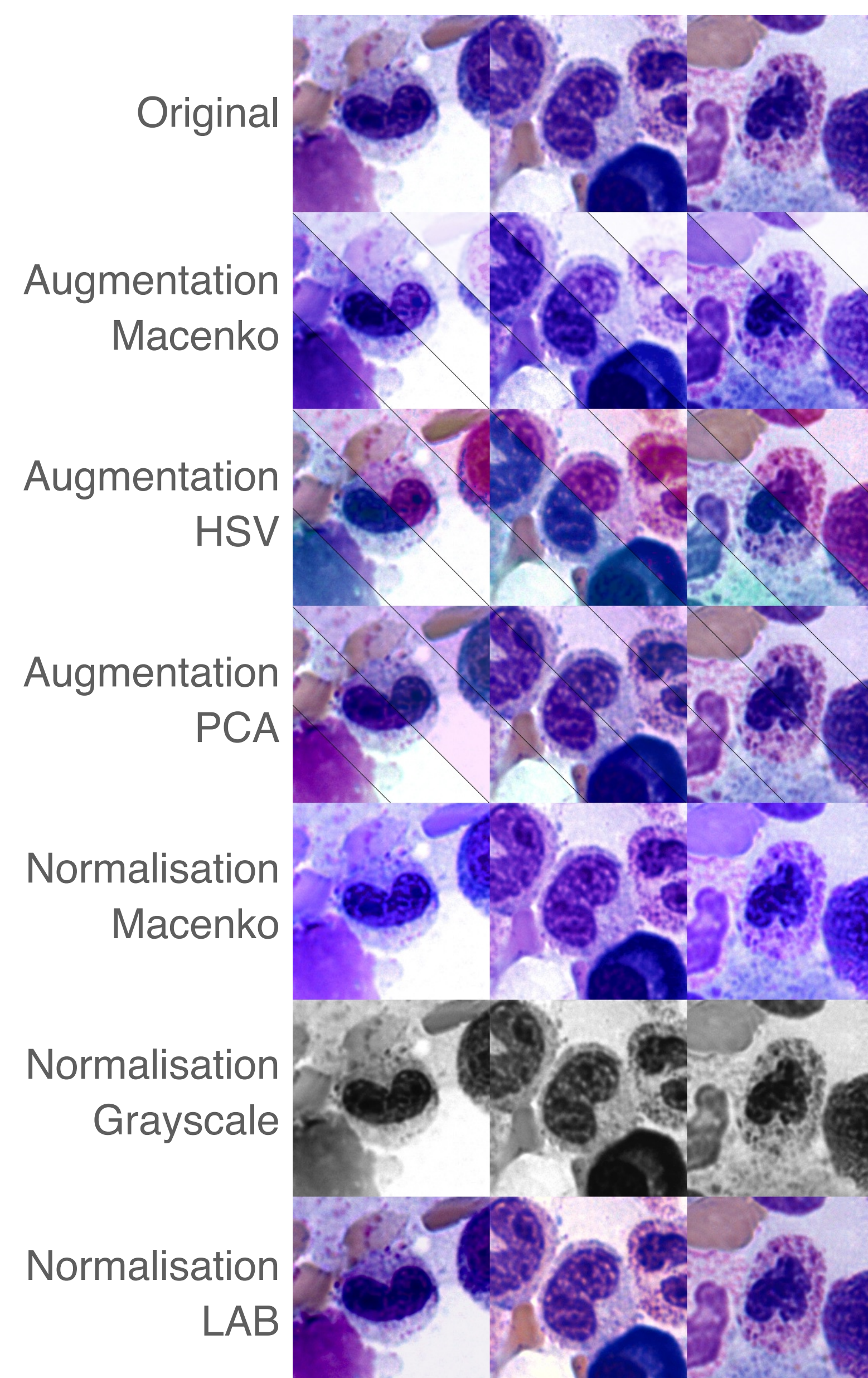
Data

Images are obtained from Pappenheim-stained human bone marrow samples using 63x magnification. Depending on the stain intensity, image regions are categorised as either normal (NI) or as one of two “over-stained” categories (OS1, OS2).

Detection: 913 (NI) + 268 (OS1) + 215 (OS2) patches of size 1600x1600 px² with multiple cells each

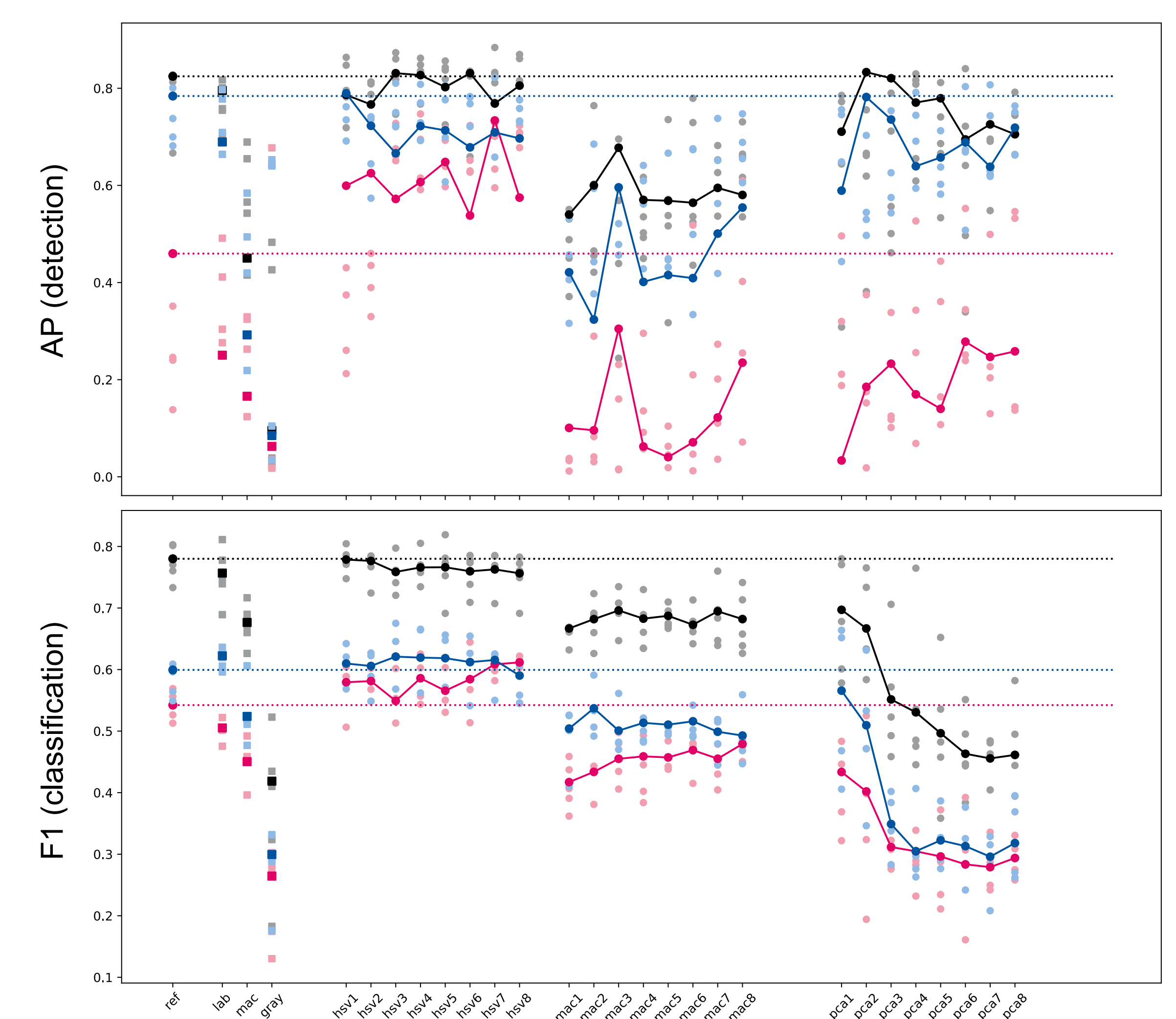
Classification: 4560 (NI) + 1385 (OS1) + 1075 (OS2) patches of size 244x244 px² centred around one individual cell.

Augmentation and Normalisation



Results

The following graph shows the results in terms of Average Precision (AP) for detection and F1-Score for classification on **NI**, **OS1** and **OS2**.



P. Gräbel¹, M. Crysandt², R. Herwartz², M. Baumann², B. M. Klinkhammer³, P. Boor³, T. H. Brümmendorf², D. Merhof¹

Reduction of stain variability in bone marrow microscopy images

¹ Institute of Imaging and Computer Vision, RWTH Aachen

² Department of Hematology, Oncology, Hemostaseology and Stem Cell Transplantation, University Hospital Aachen

³ Institute of Pathology, University Hospital Aachen