

SURGICAL VIDEO ANALYSIS

SEMANTIC SEGMENTATION

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Steps We Follow During SEMANTIC SEGMENTATION:

01 Data collection

Gather a dataset of images with corresponding pixel-level annotations that indicate the class of each pixel.

02 Preprocessing

Preprocess the images by resizing them to a fixed size, normalizing pixel values and Augmenting the dataset

03 Model selection

we choose suitable architecture(U-Net) to learn a mapping between image pixels and class labels.

04 Training:

Train the model on the dataset using an appropriate loss function. Monitor the training process using metrics such as accuracy and loss.

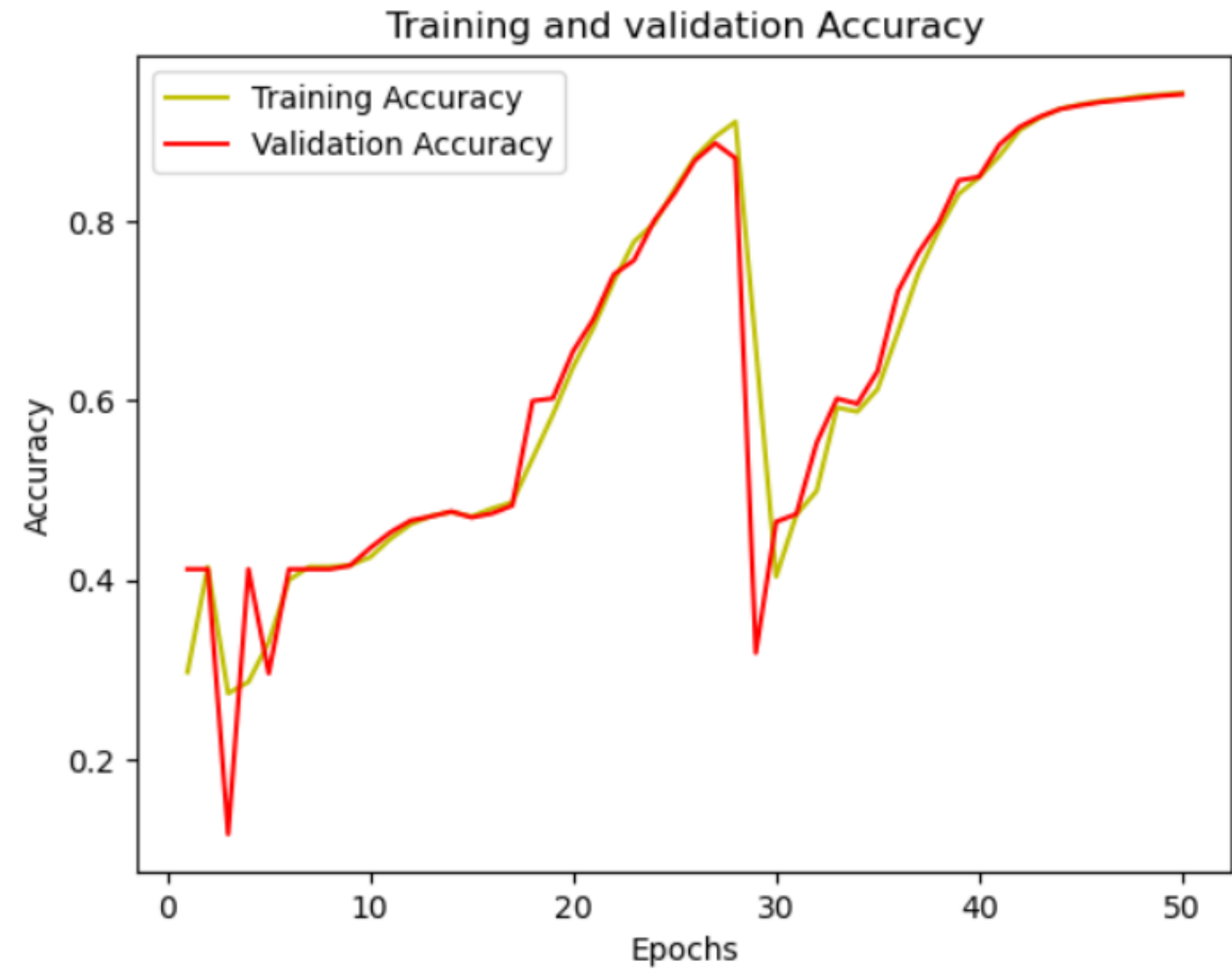
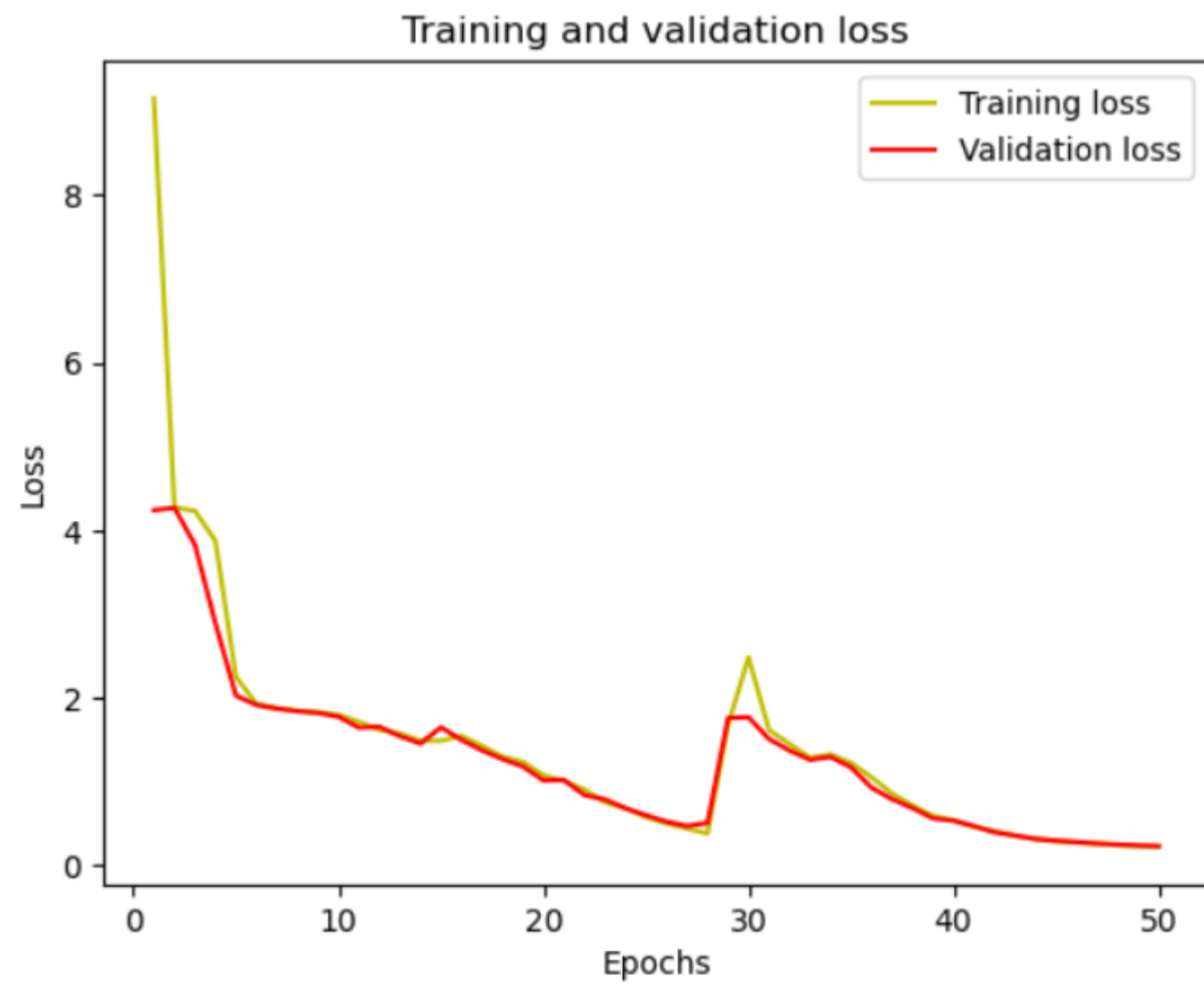
05 Validation

Evaluate the model on a validation dataset to check its generalization performance.

06 Testing

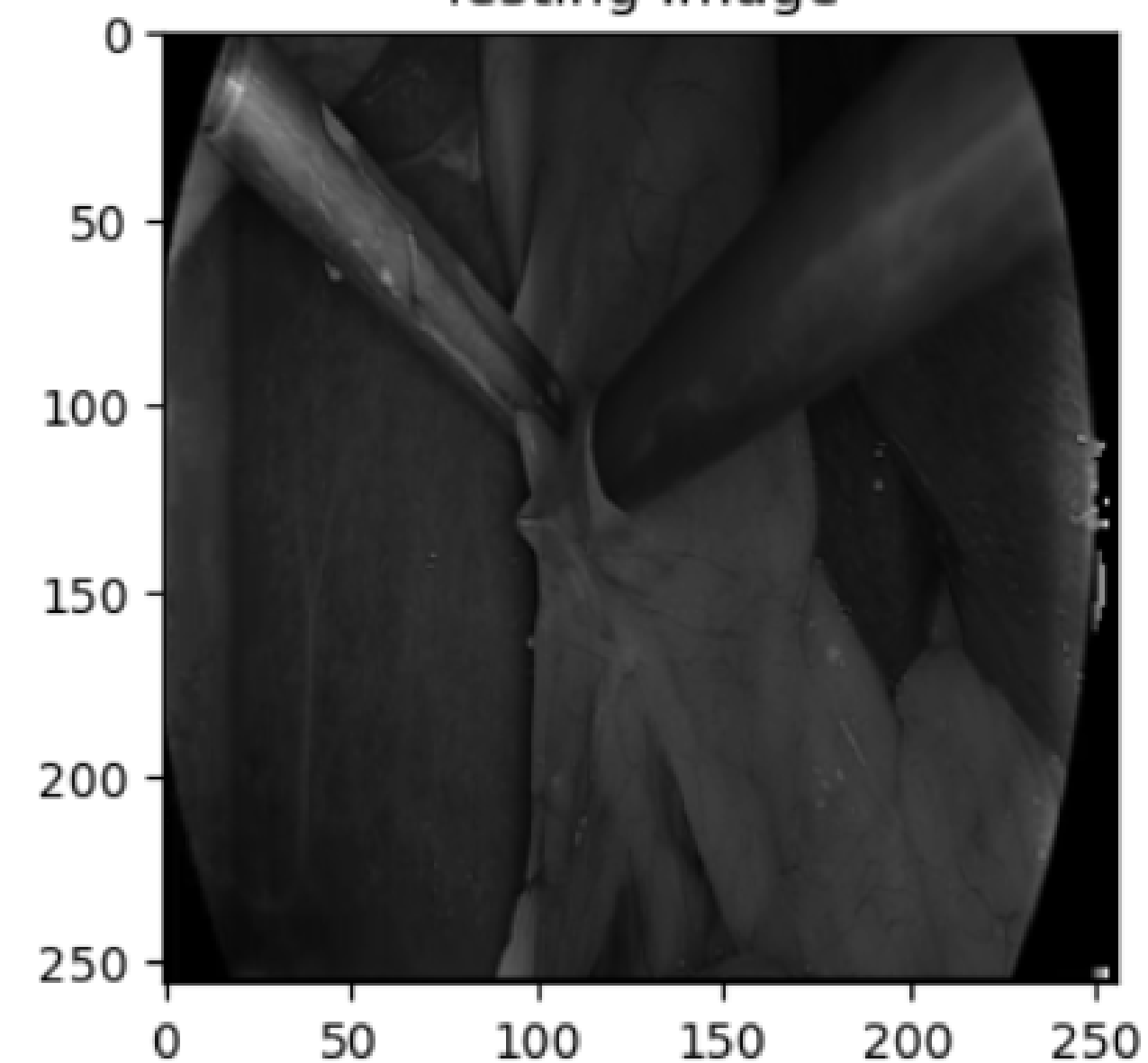
Apply the trained model to new images for semantic segmentation.

UNet

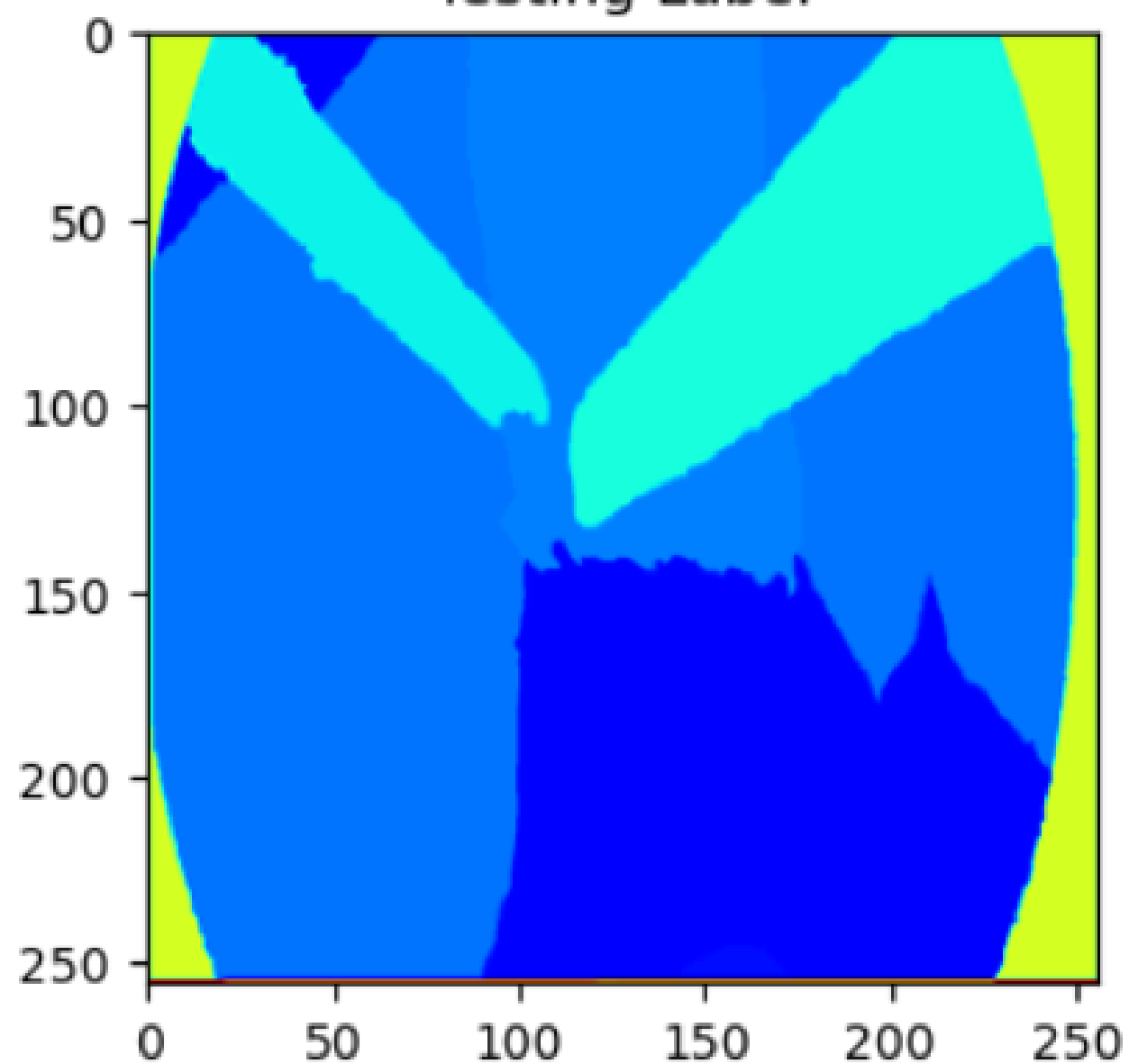


Predictions

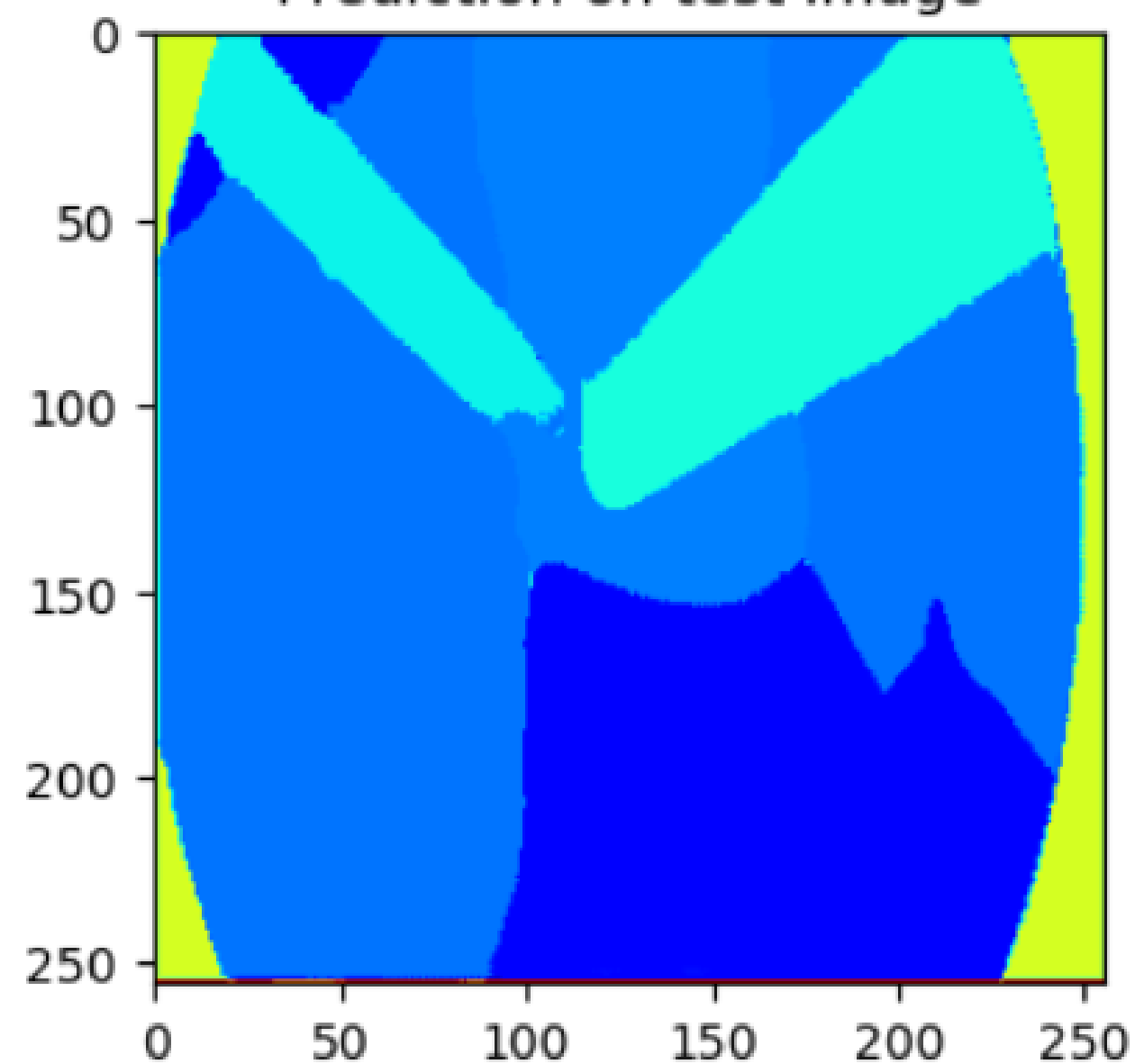
Testing Image



Testing Label



Prediction on test image



ADAM optimier:

Accuracy

Epoch 48/50

8/8 [=====] - 10s 1s/step - loss: 0.2453 - accuracy: 0.9393 - val_loss: 0.2521 - val_accuracy: 0.9369

Epoch 49/50

8/8 [=====] - 10s 1s/step - loss: 0.2357 - accuracy: 0.9409 - val_loss: 0.2406 - val_accuracy: 0.9395

Epoch 50/50

8/8 [=====] - 10s 1s/step - loss: 0.2260 - accuracy: 0.9427 - val_loss: 0.2325 - val_accuracy: 0.9411

Mean IOU:

Mean IoU = 0.2286782

F1 Score:

F1 Score = 0.9309

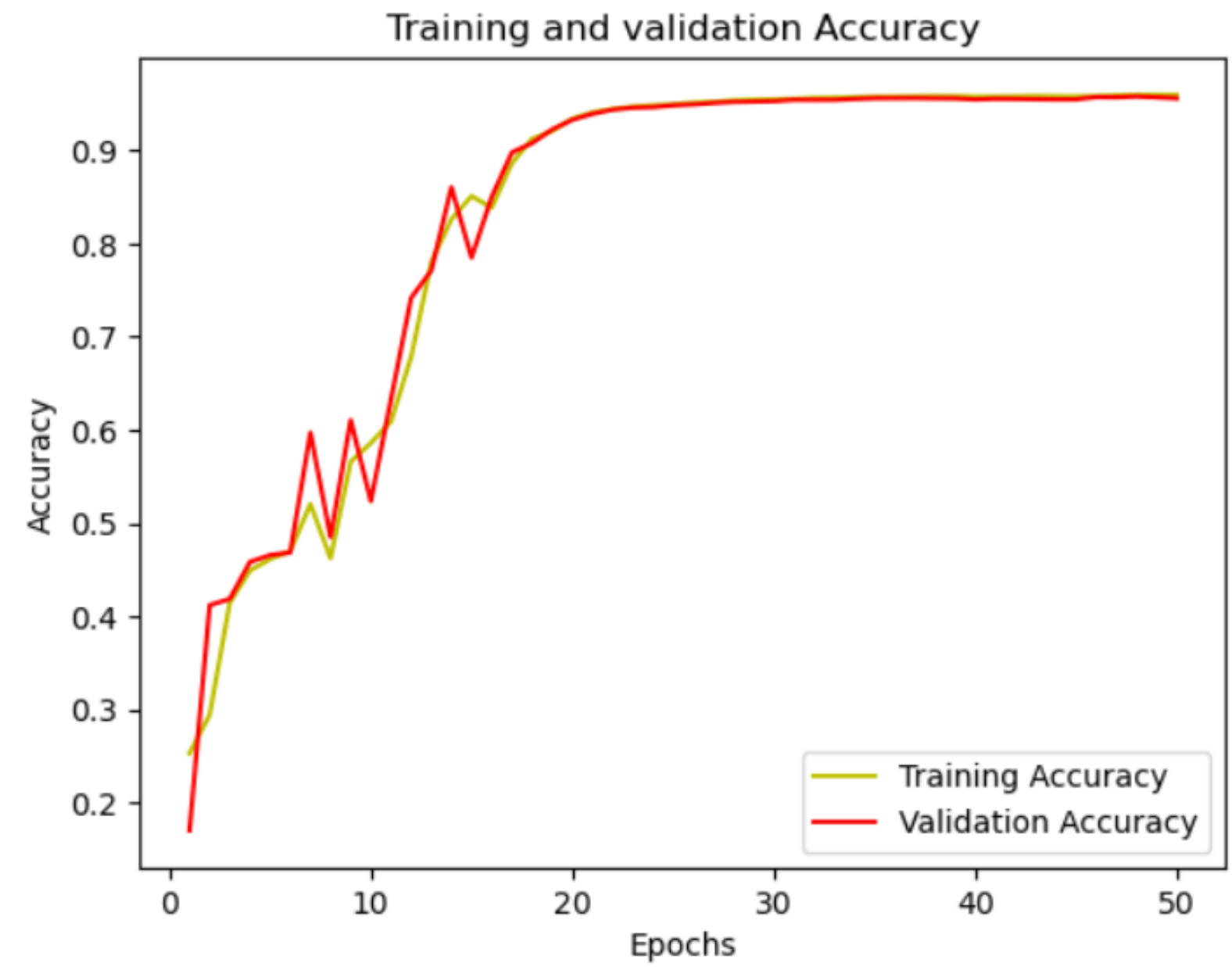
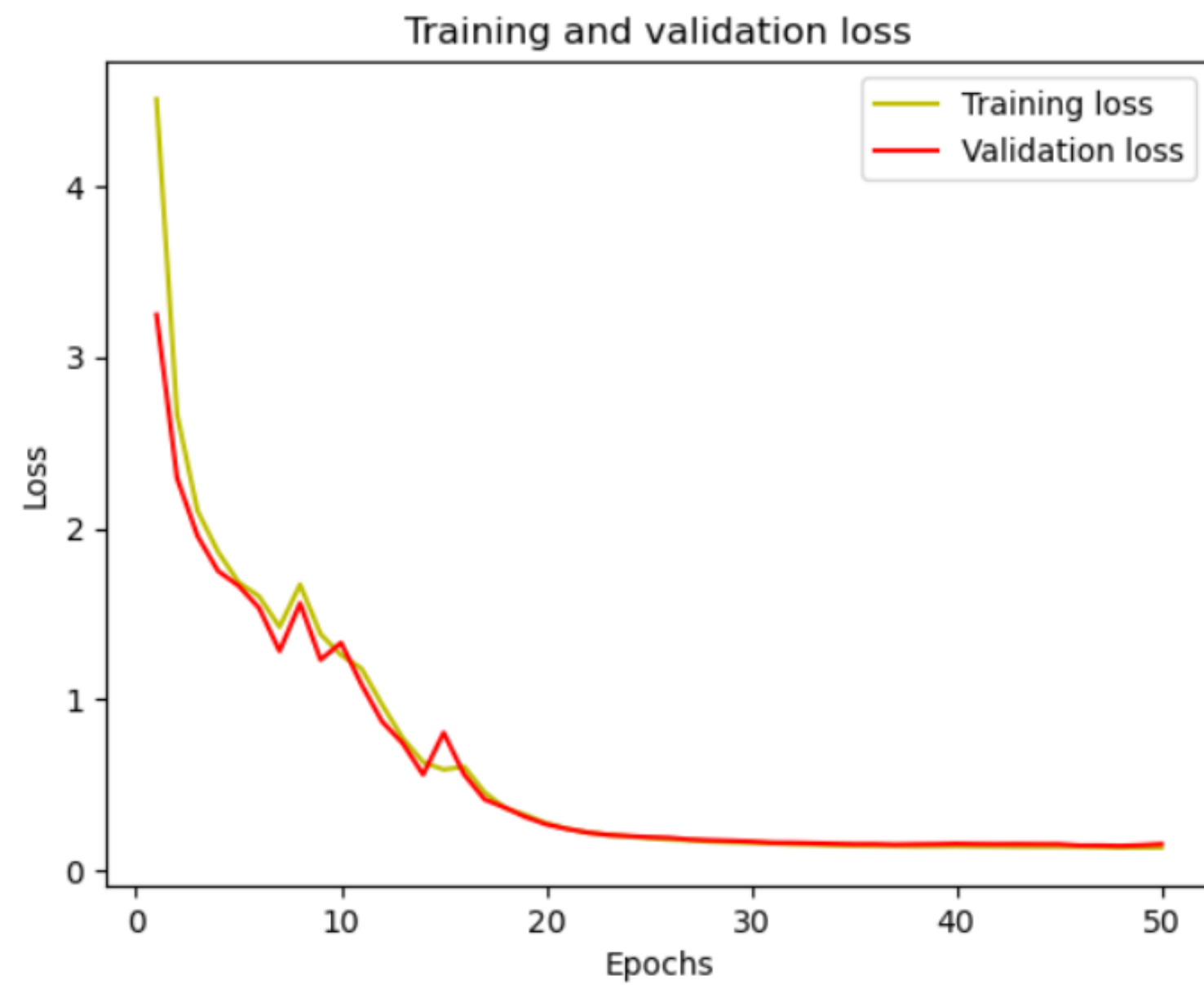
IOU:

```
IoU for class 0 : 0.9813176362534277
IoU for class 1 : 0.9585455891655782
IoU for class 2 : 0.9354976109305521
IoU for class 3 : 0.9565876042593294
IoU for class 4 : 0.8305727484073548
IoU for class 5 : 0.9159442447505814
IoU for class 6 : 0.9980400017479628
IoU for class 7 : 1.0
```

DICE COEFFICIENT:

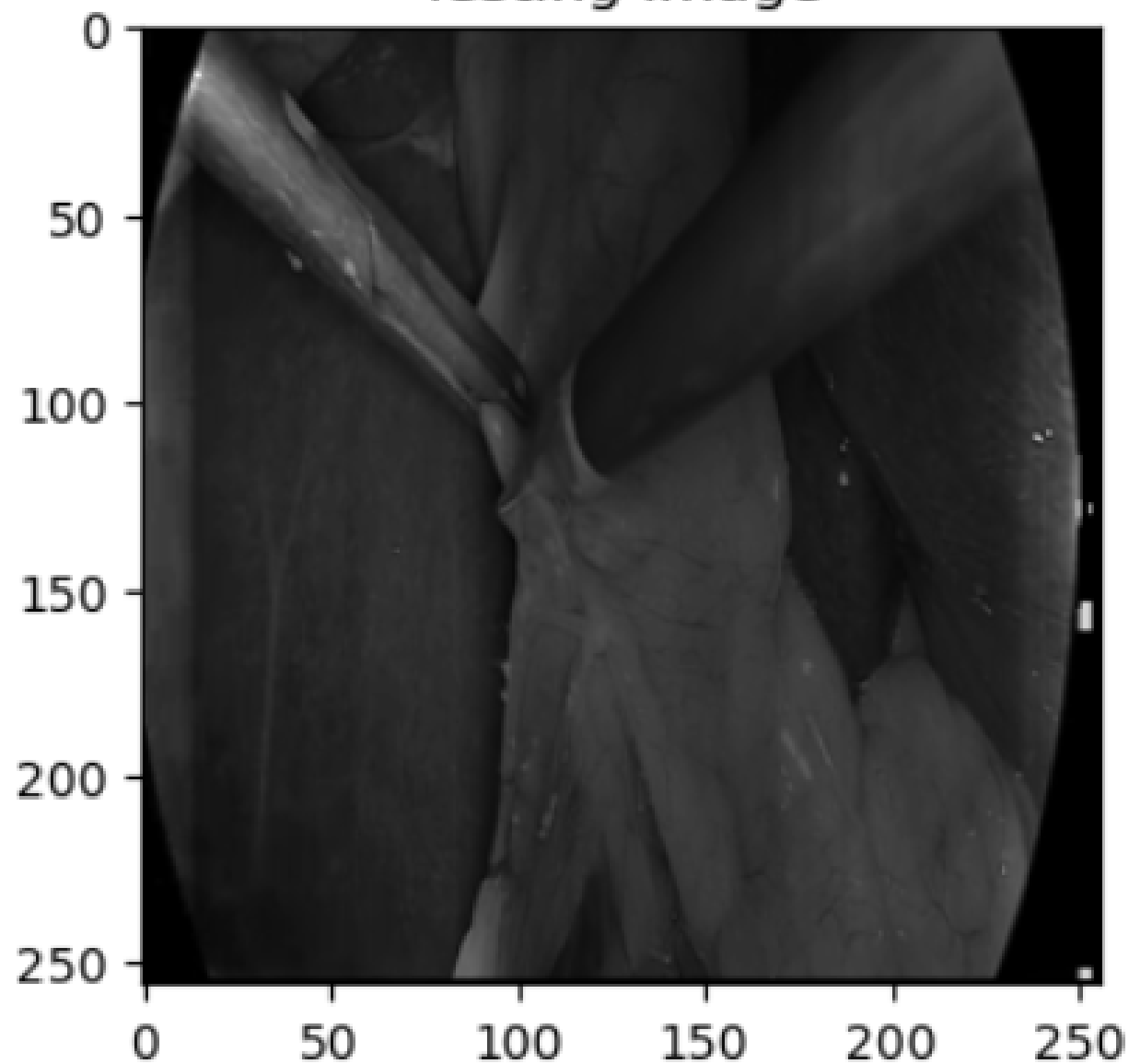
```
Dice coefficient for class 0 : 0.9905707376723807
Dice coefficient for class 1 : 0.9788340843002367
Dice coefficient for class 2 : 0.9666740022280698
Dice coefficient for class 3 : 0.9778121891163138
Dice coefficient for class 4 : 0.9074457697788568
Dice coefficient for class 5 : 0.9561282874072565
Dice coefficient for class 6 : 0.9990190395335816
Dice coefficient for class 7 : 1.0
Mean Dice coefficient: 0.972060513754587
```

UNet++

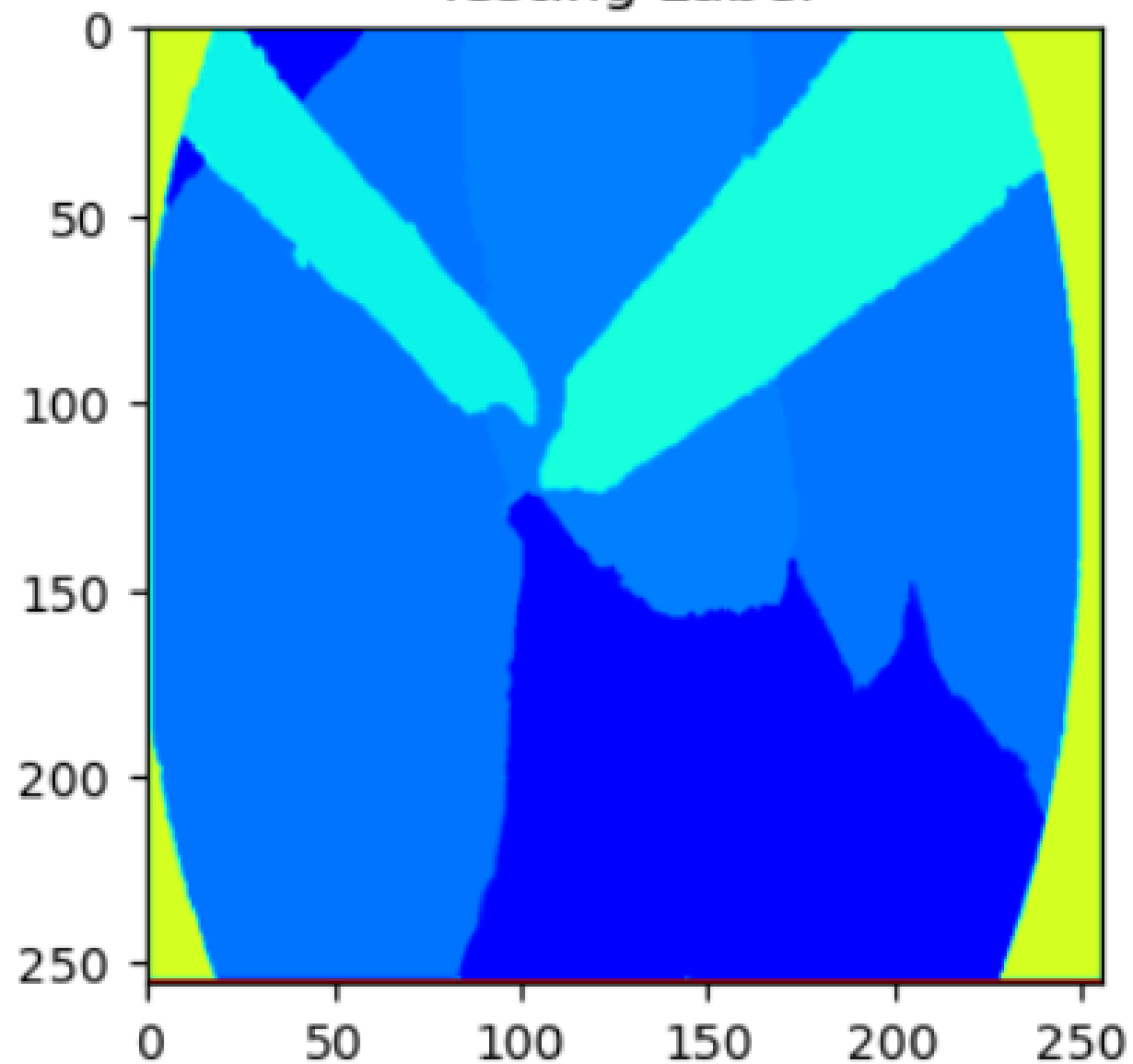


Predictions

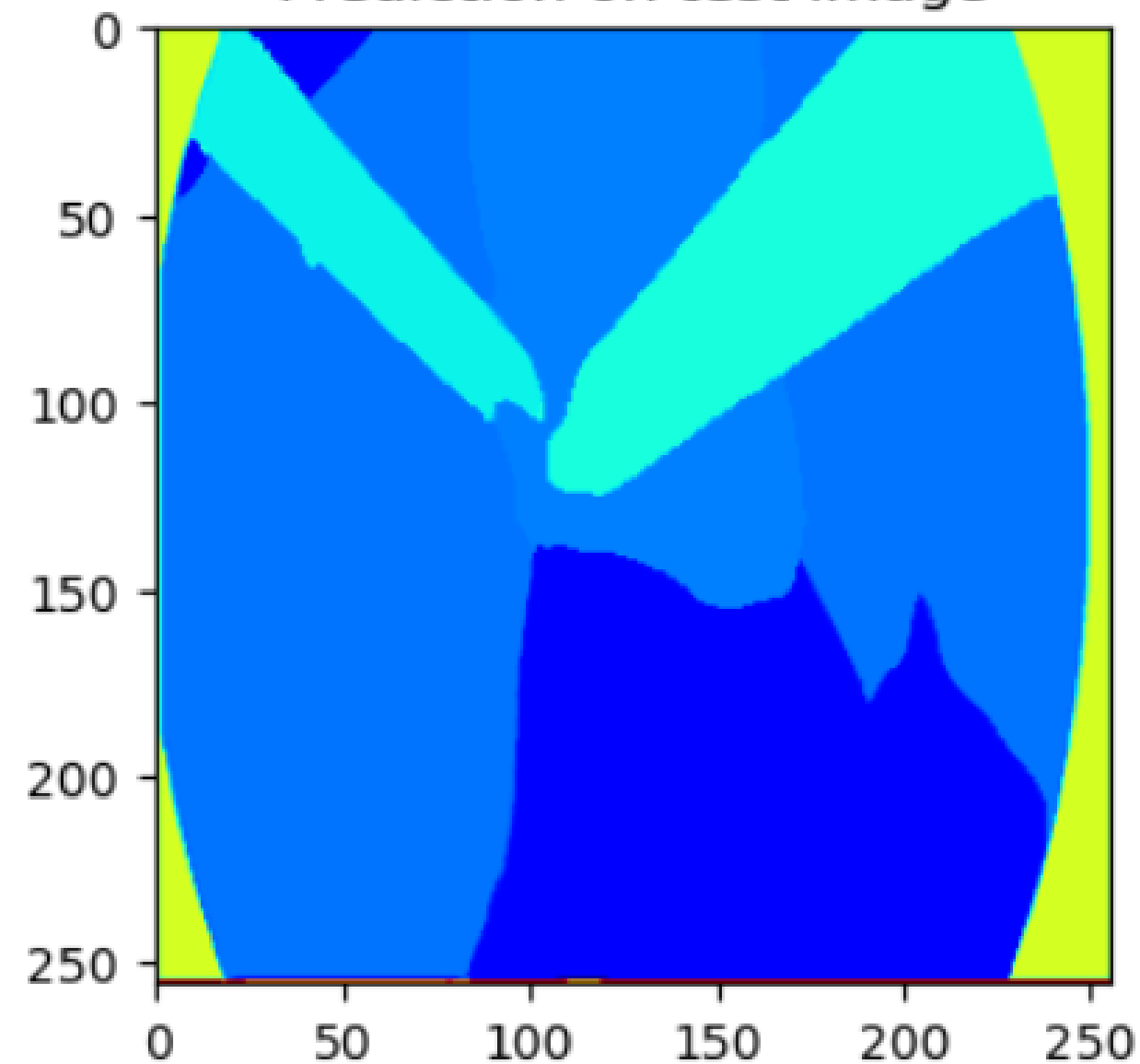
Testing Image



Testing Label



Prediction on test image



ADAM optimier:

Accuracy

```
8/8 [=====] - 9s 1s/step - loss: 0.1362 - accuracy: 0.9595 - val_loss: 0.1465 - val_accuracy: 0.9573
Epoch 48/50
8/8 [=====] - 9s 1s/step - loss: 0.1342 - accuracy: 0.9599 - val_loss: 0.1440 - val_accuracy: 0.9582
Epoch 49/50
8/8 [=====] - 9s 1s/step - loss: 0.1337 - accuracy: 0.9600 - val_loss: 0.1483 - val_accuracy: 0.9573
Epoch 50/50
8/8 [=====] - 9s 1s/step - loss: 0.1343 - accuracy: 0.9599 - val_loss: 0.1548 - val_accuracy: 0.9562
```

Mean IOU:

Mean IoU = 0.32694516

F1 Score:

F1 Score = 0.9514

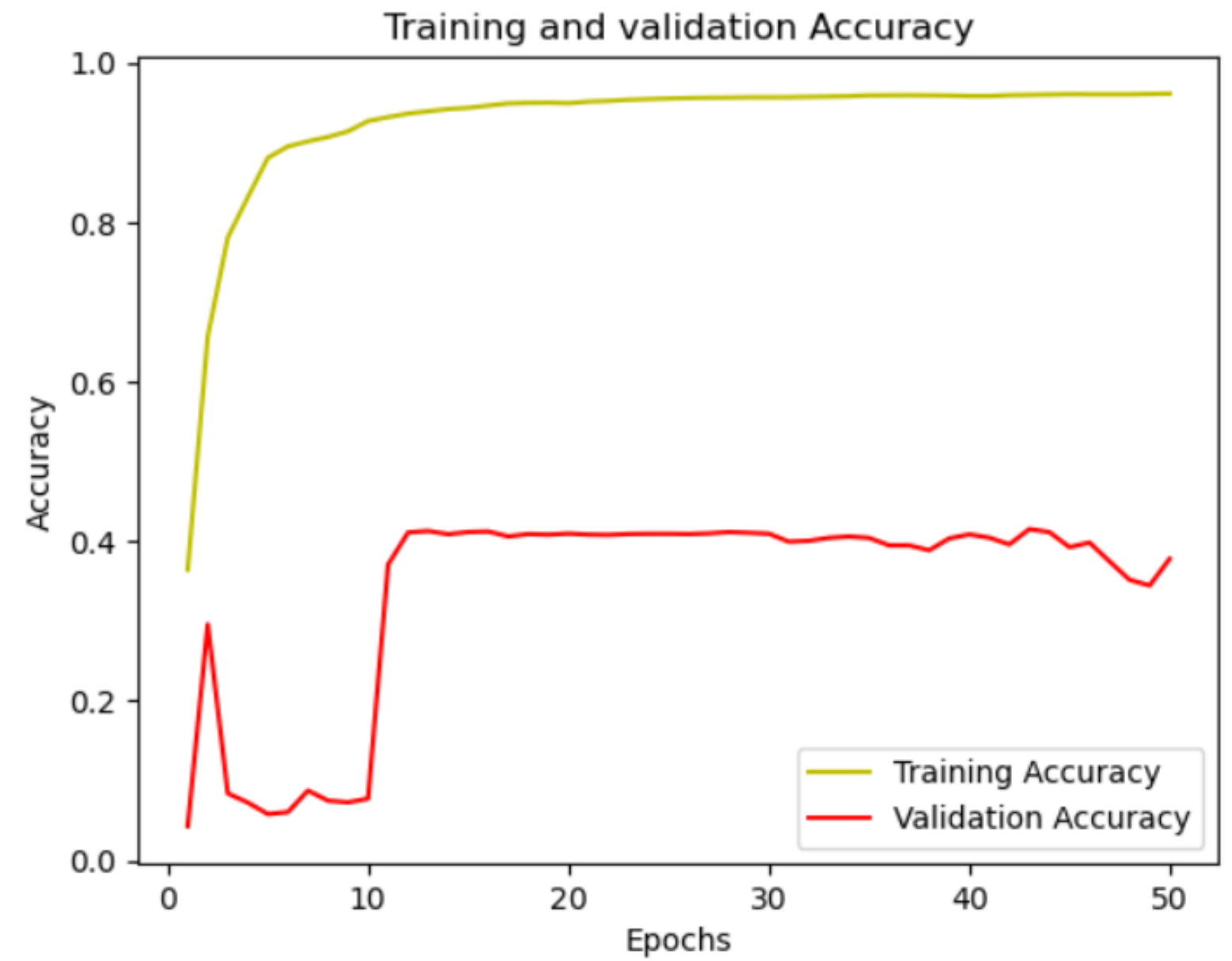
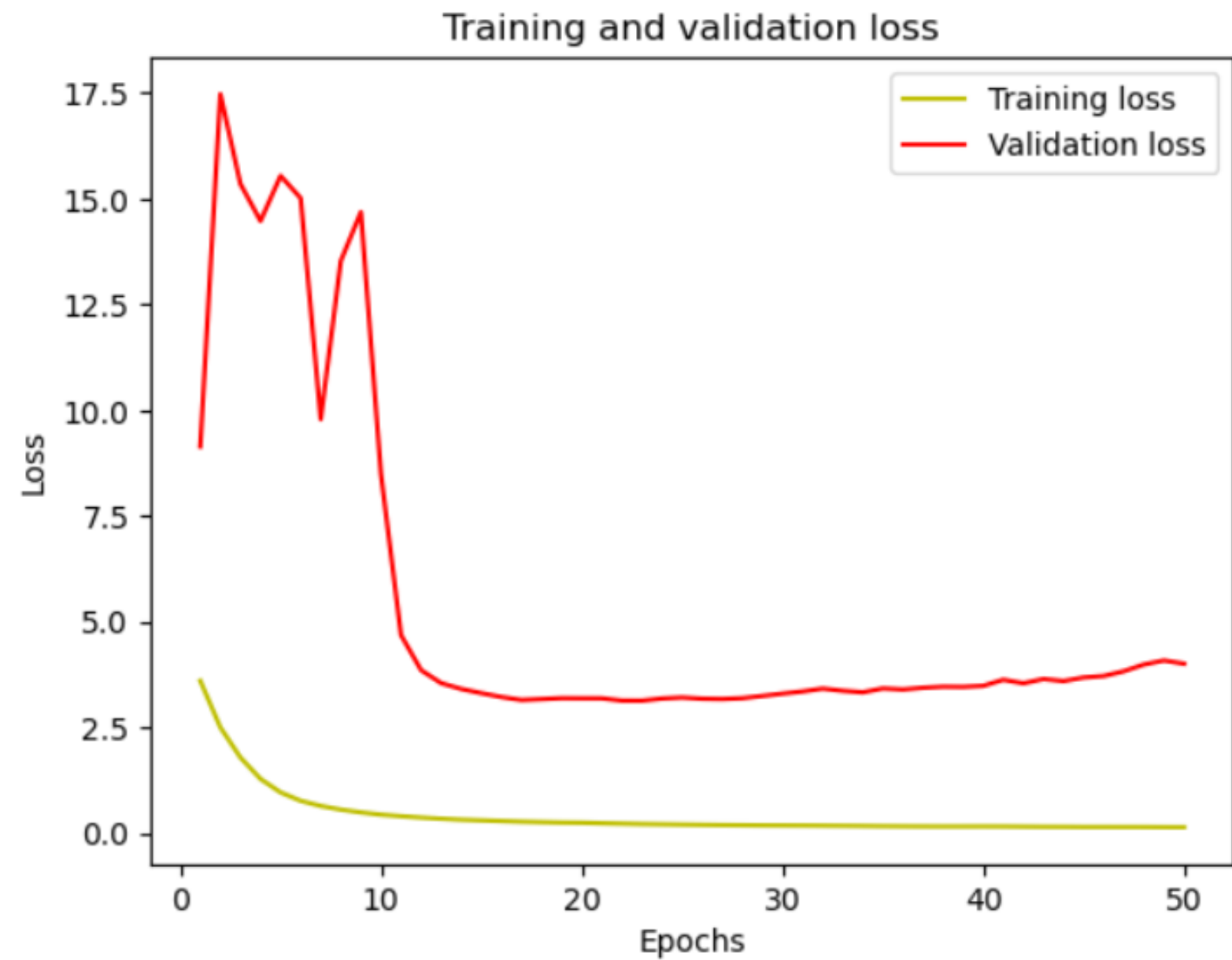
IOU:

```
IoU for class 0 : 0.9817416484637822
IoU for class 1 : 0.9645402845793151
IoU for class 2 : 0.9421838623773983
IoU for class 3 : 0.9604778454410887
IoU for class 4 : 0.8463534828620106
IoU for class 5 : 0.930945230707969
IoU for class 6 : 0.9984529228883386
IoU for class 7 : 1.0
Mean IoU = 0.9530869
```

DICE COEFFICIENT:

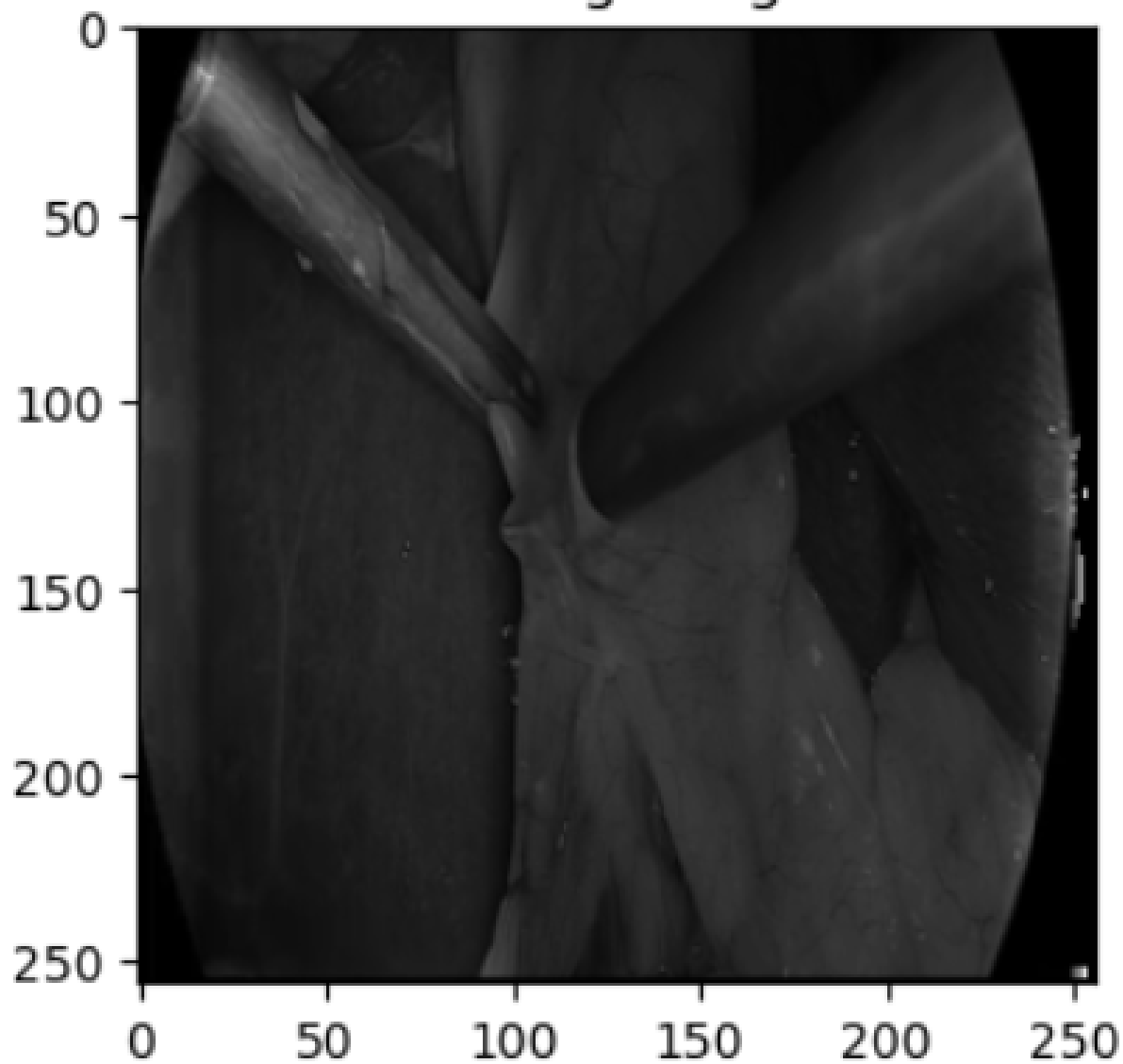
```
Dice coefficient for class 0 : 0.9907867145294285
Dice coefficient for class 1 : 0.9819501204943332
Dice coefficient for class 2 : 0.9702313778100133
Dice coefficient for class 3 : 0.97984055027665
Dice coefficient for class 4 : 0.9167838019295071
Dice coefficient for class 5 : 0.9642378415535315
Dice coefficient for class 6 : 0.9992258626190577
Dice coefficient for class 7 : 1.0
Mean Dice coefficient: 0.9753820336515652
```

Attention Unet

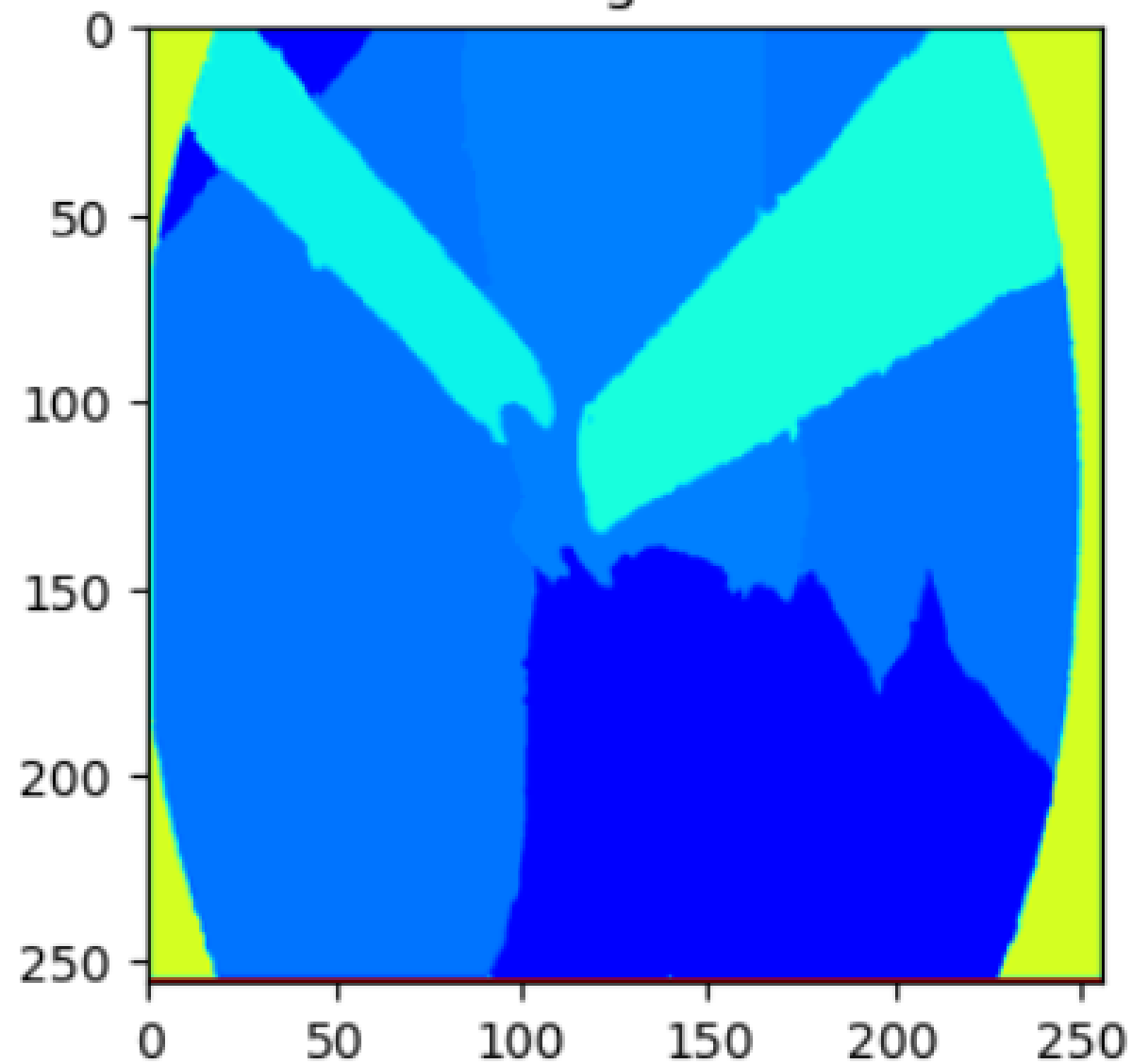


Predictions

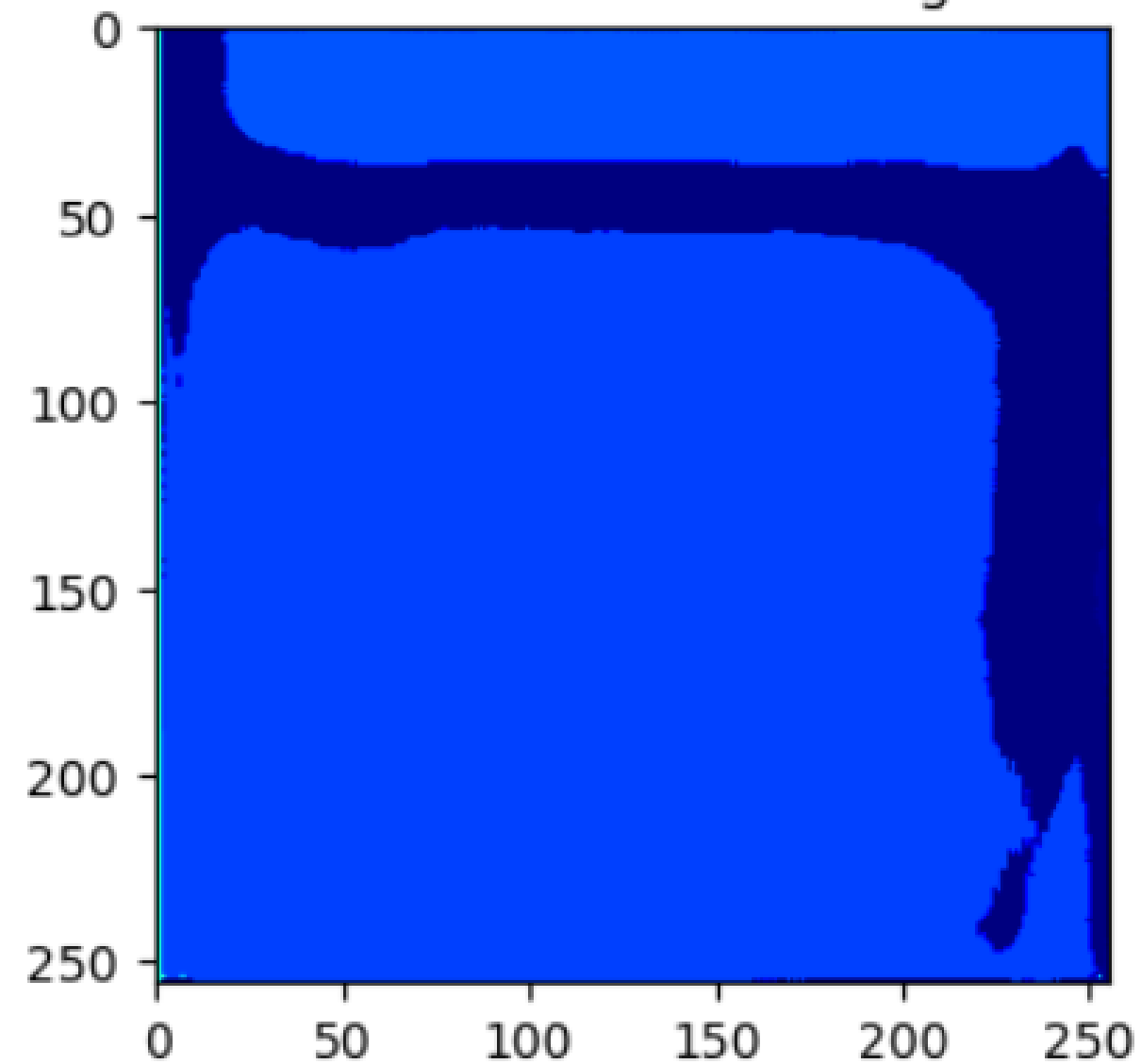
Testing Image



Testing Label



Prediction on test image



ADAM optimier:

Accuracy

```
Epoch 48/50
8/8 [=====] - 13s 2s/step - loss: 0.1456 - accuracy: 0.9601 - val_loss: 3.9867 - val_accuracy: 0.3517
Epoch 49/50
8/8 [=====] - 13s 2s/step - loss: 0.1428 - accuracy: 0.9606 - val_loss: 4.0828 - val_accuracy: 0.3445
Epoch 50/50
8/8 [=====] - 14s 2s/step - loss: 0.1410 - accuracy: 0.9610 - val_loss: 4.0066 - val_accuracy: 0.3780
```

Mean IOU:

Mean IoU = 0.027995652

F1 Score:

F1 Score = 0.2957

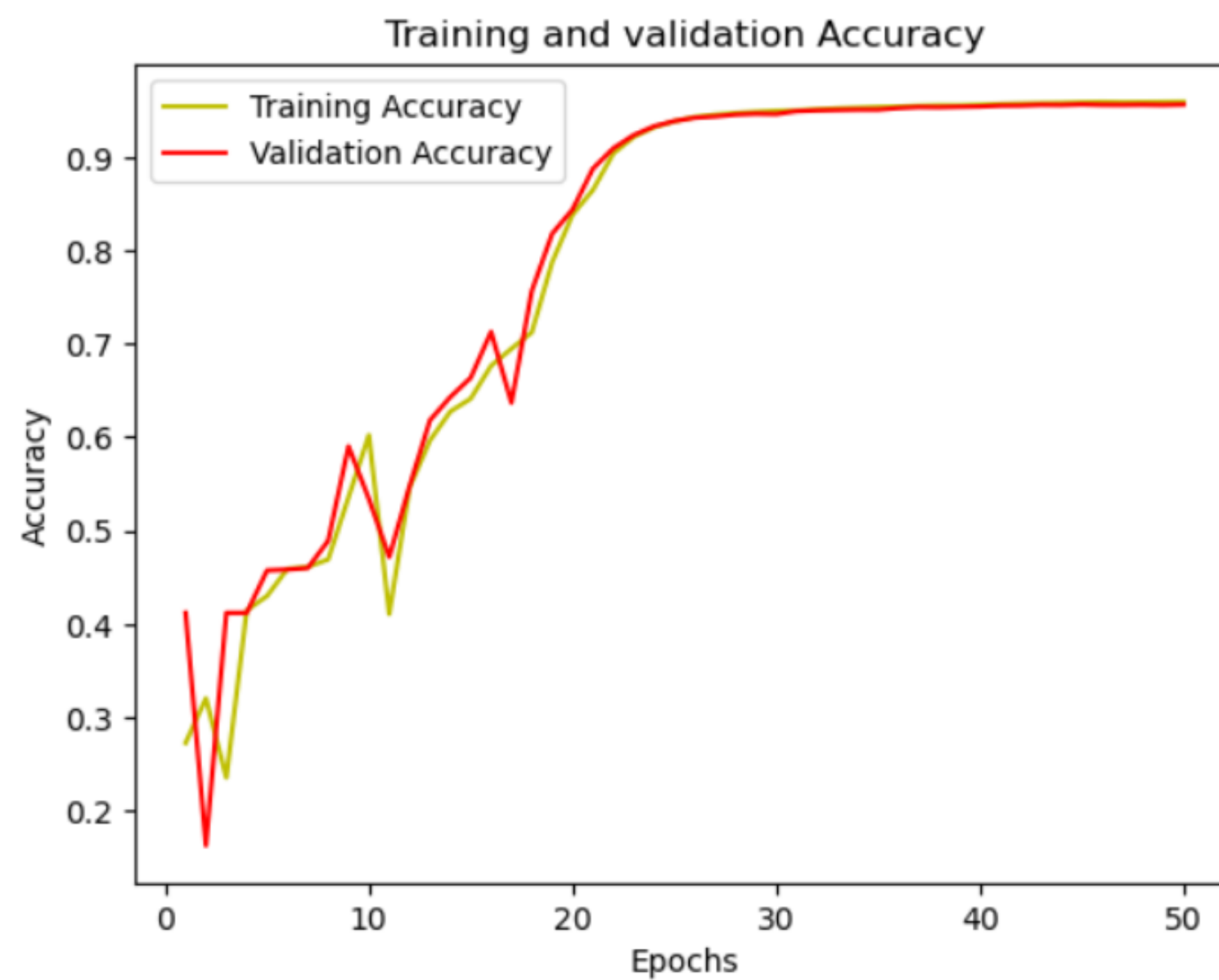
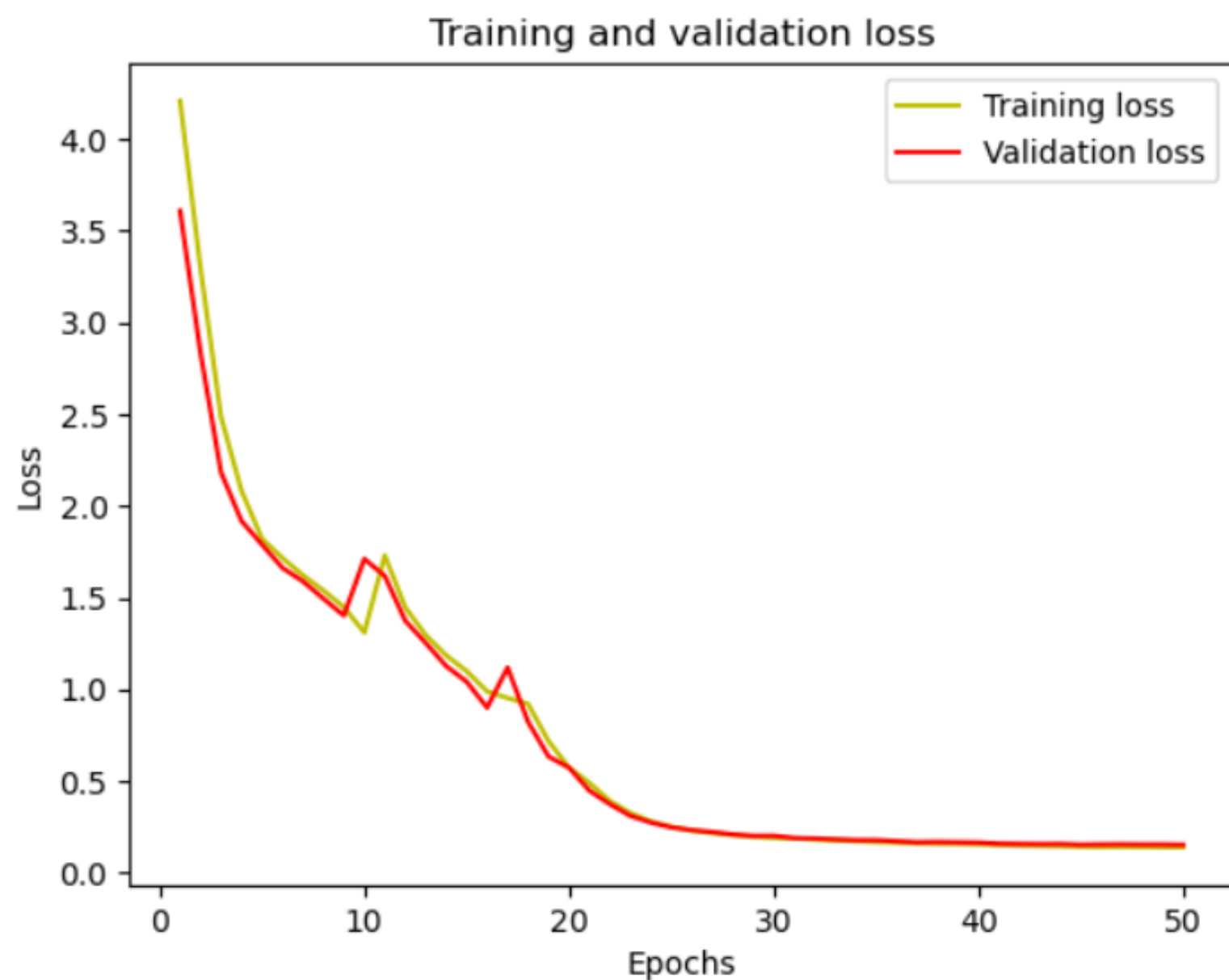
IoU:

```
IoU for class 0 : 0.8952999768844432
IoU for class 1 : 0.6256342732352752
IoU for class 2 : 0.2737904997802725
IoU for class 3 : 0.4764151403793879
IoU for class 4 : 0.05377752897316483
IoU for class 5 : 0.11482427134346267
IoU for class 6 : 0.9652549779413304
IoU for class 7 : 1.0
Mean IoU = 0.5506246
```

DICE COEFFICIENT:

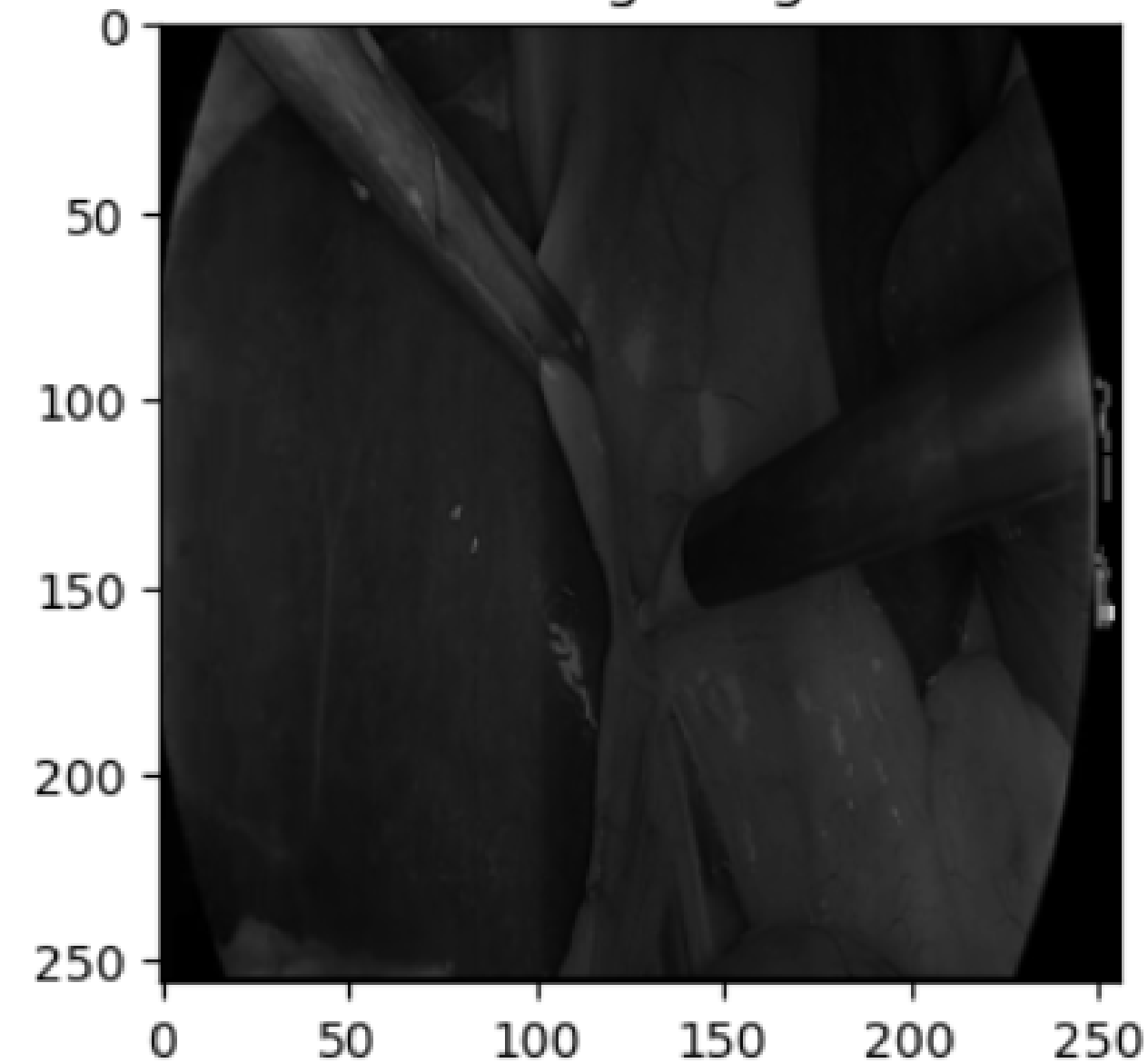
```
Dice coefficient for class 0 : 0.944758072921171
Dice coefficient for class 1 : 0.7697109780912306
Dice coefficient for class 2 : 0.42988309274955505
Dice coefficient for class 3 : 0.6453674543827363
Dice coefficient for class 4 : 0.10206619043313139
Dice coefficient for class 5 : 0.20599528427038852
Dice coefficient for class 6 : 0.9823203490393566
Dice coefficient for class 7 : 1.0
Mean Dice coefficient: 0.6350126777359462
```

Nested Unet

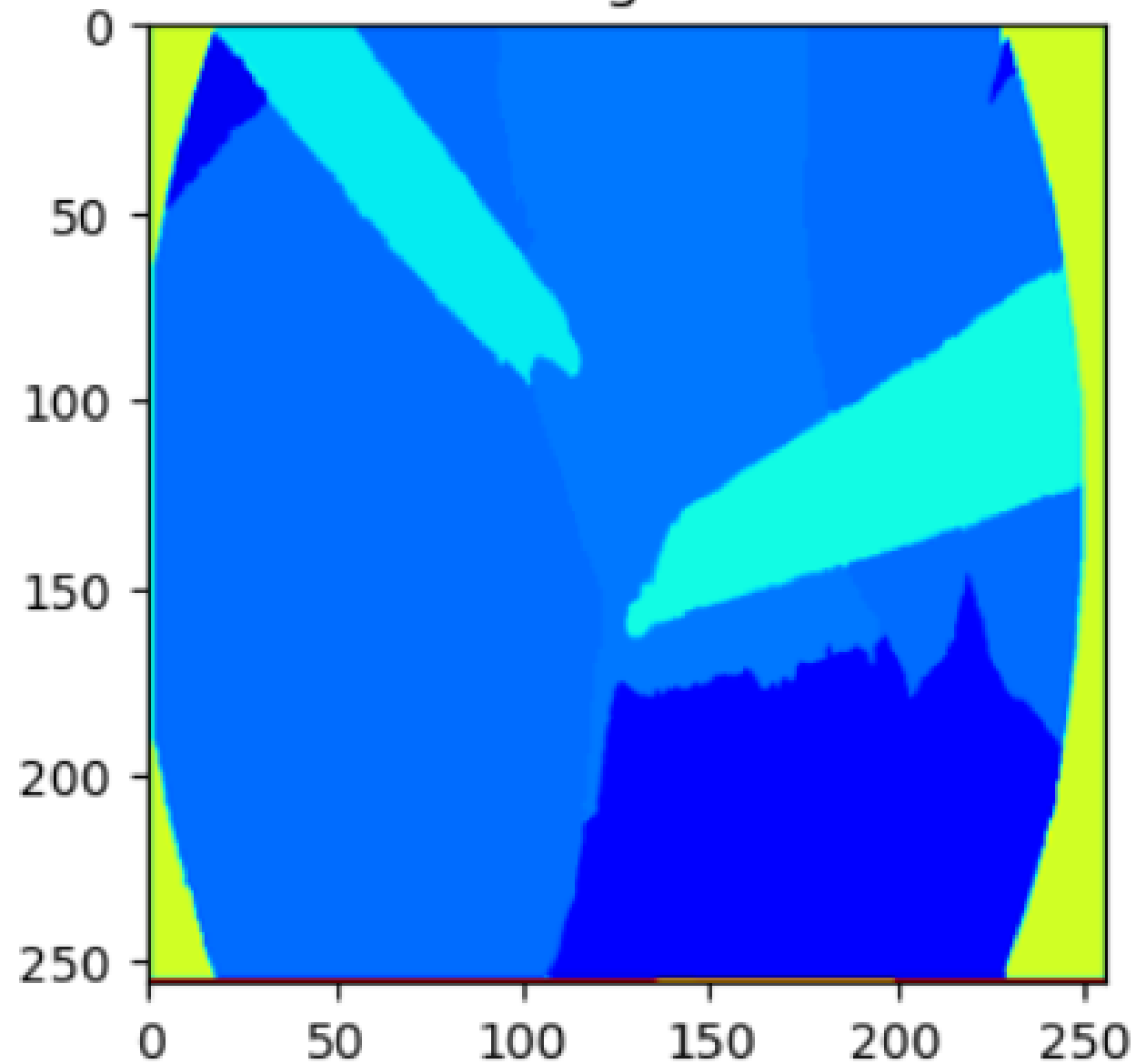


Predictions

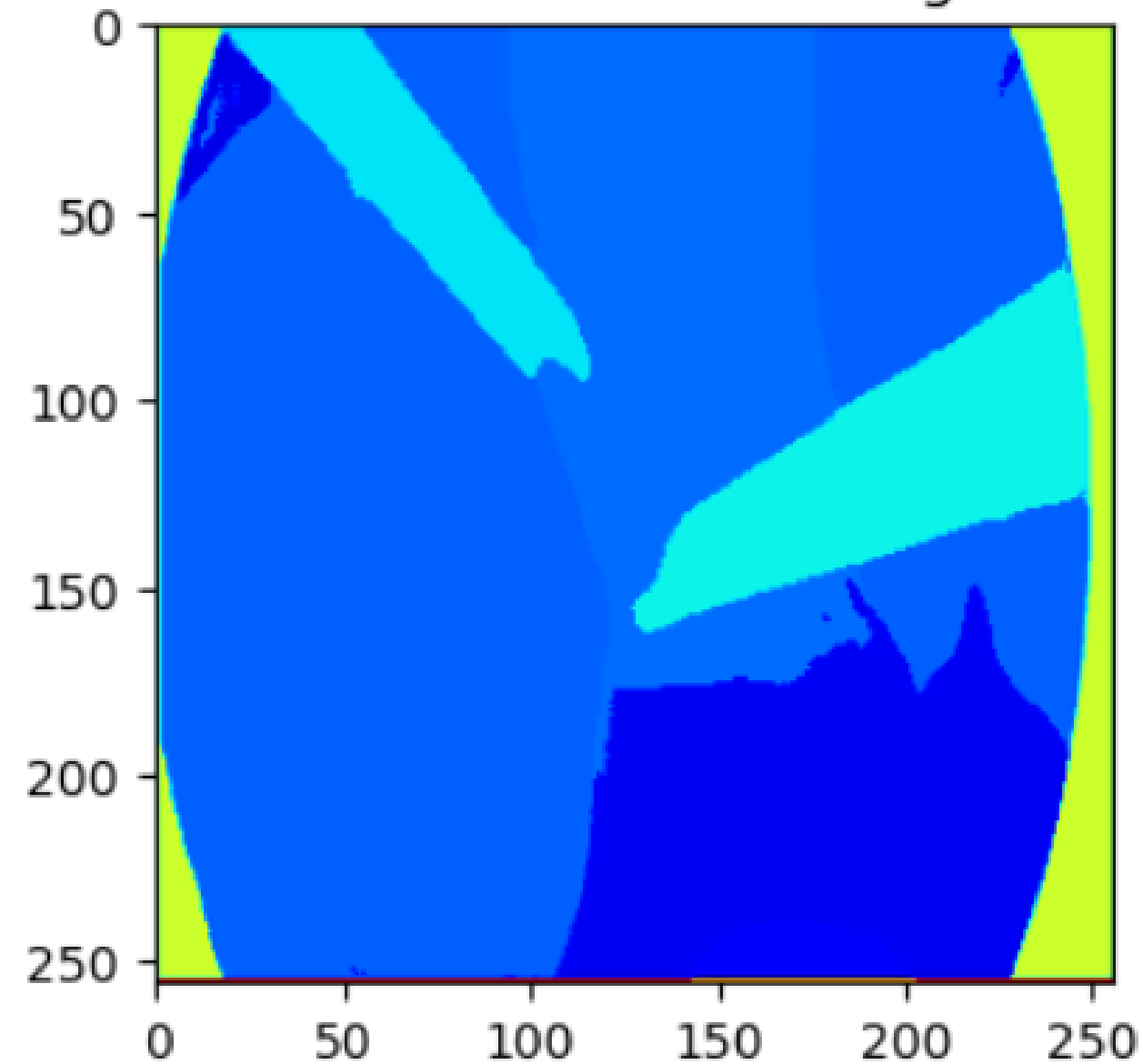
Testing Image



Testing Label



Prediction on test image



ADAM optimier:

Accuracy

```
Epoch 48/50
8/8 [=====] - 7s 943ms/step - loss: 0.1405 - accuracy: 0.9591 - val_loss: 0.1539 - val_accuracy: 0.9563
Epoch 49/50
8/8 [=====] - 7s 885ms/step - loss: 0.1388 - accuracy: 0.9593 - val_loss: 0.1543 - val_accuracy: 0.9560
Epoch 50/50
8/8 [=====] - 7s 903ms/step - loss: 0.1383 - accuracy: 0.9595 - val_loss: 0.1525 - val_accuracy: 0.9564
```

Mean IOU:

Mean IoU = 0.30440912

F1 Score:

F1 Score = 0.9504

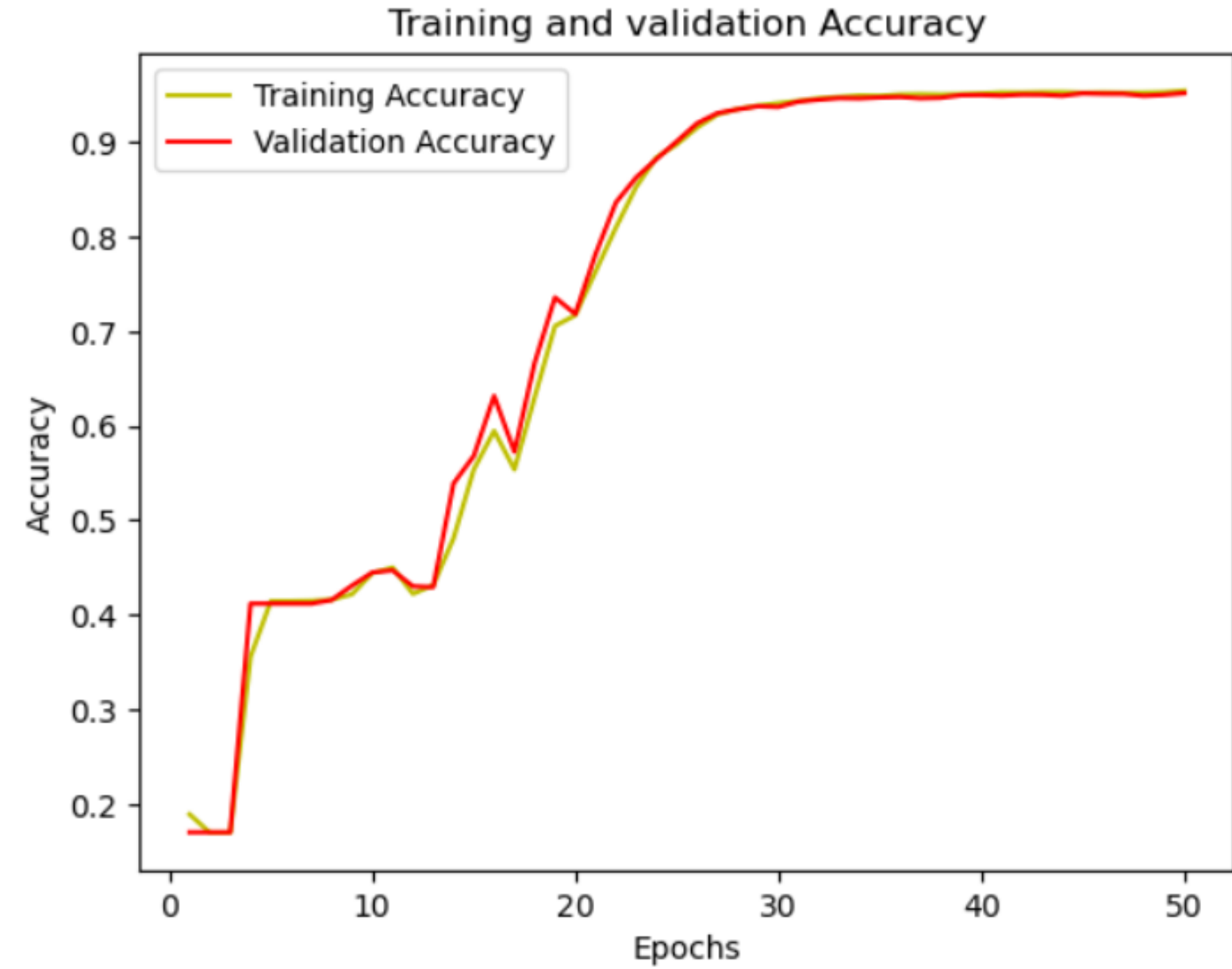
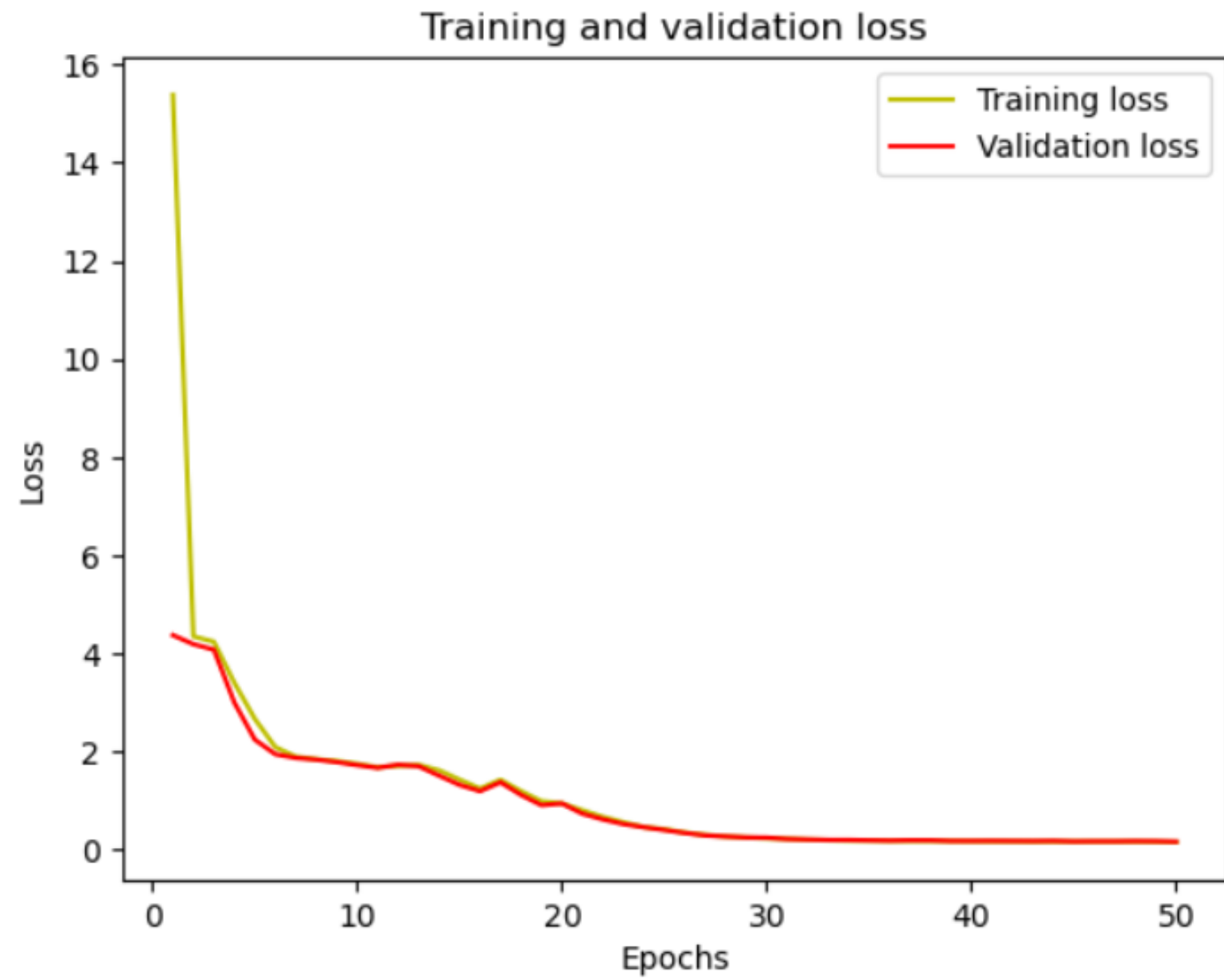
IOU:

```
IoU for class 0 : 0.970563567735038
IoU for class 1 : 0.9368660936332776
IoU for class 2 : 0.9051112104670987
IoU for class 3 : 0.9303261793914586
IoU for class 4 : 0.6866368246943257
IoU for class 5 : 0.7850634510134119
IoU for class 6 : 0.9962000273406647
IoU for class 7 : 0.9998982747395834
Mean IoU = 0.9013332
```

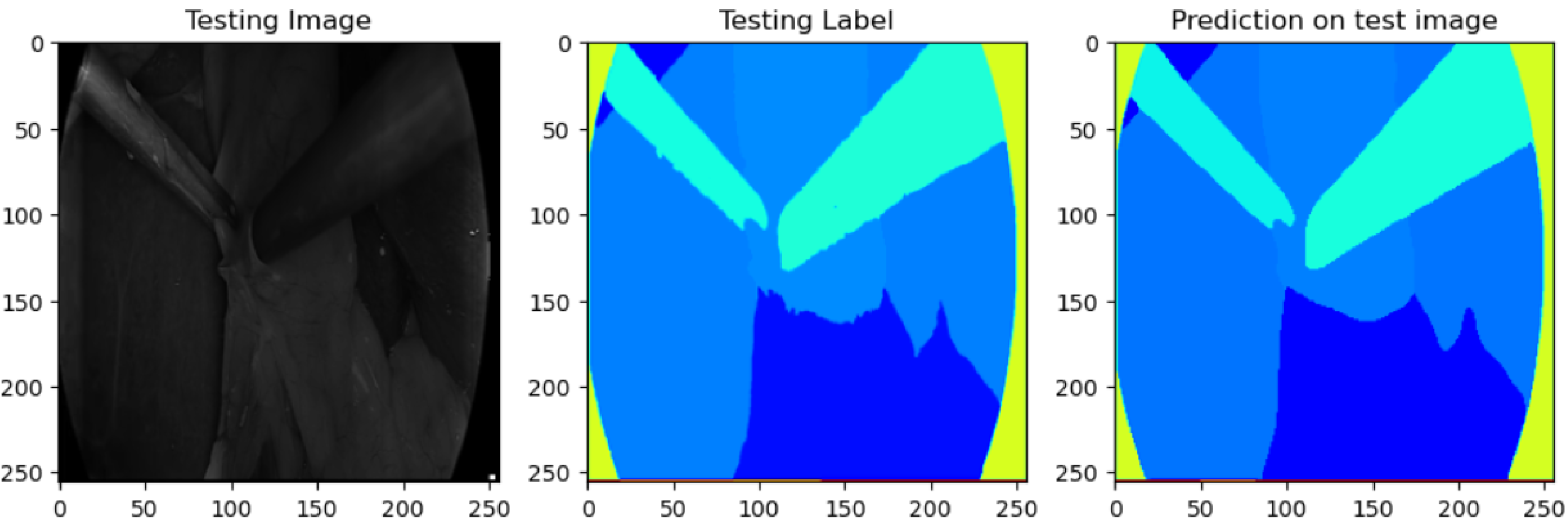
DICE COEFFICIENT:

```
Dice coefficient for class 0 : 0.9850619220070144
Dice coefficient for class 1 : 0.9674040933576918
Dice coefficient for class 2 : 0.9501925194647107
Dice coefficient for class 3 : 0.9639056749308004
Dice coefficient for class 4 : 0.8142082689541265
Dice coefficient for class 5 : 0.8795916476444774
Dice coefficient for class 6 : 0.9980963968503709
Dice coefficient for class 7 : 0.9999491347826529
Mean Dice coefficient: 0.9448012072489805
```

Ensemble Unet



Predictions



ADAM optimier:

Accuracy

```
Epoch 48/50
8/8 [=====] - 9s 1s/step - loss: 0.1685 - accuracy: 0.9526 - val_loss: 0.1796 - val_accuracy: 0.9492
Epoch 49/50
8/8 [=====] - 9s 1s/step - loss: 0.1657 - accuracy: 0.9530 - val_loss: 0.1776 - val_accuracy: 0.9502
Epoch 50/50
8/8 [=====] - 8s 1s/step - loss: 0.1598 - accuracy: 0.9547 - val_loss: 0.1688 - val_accuracy: 0.9520
```

Mean IOU:

Mean IoU = 0.29665196

F1 Score:

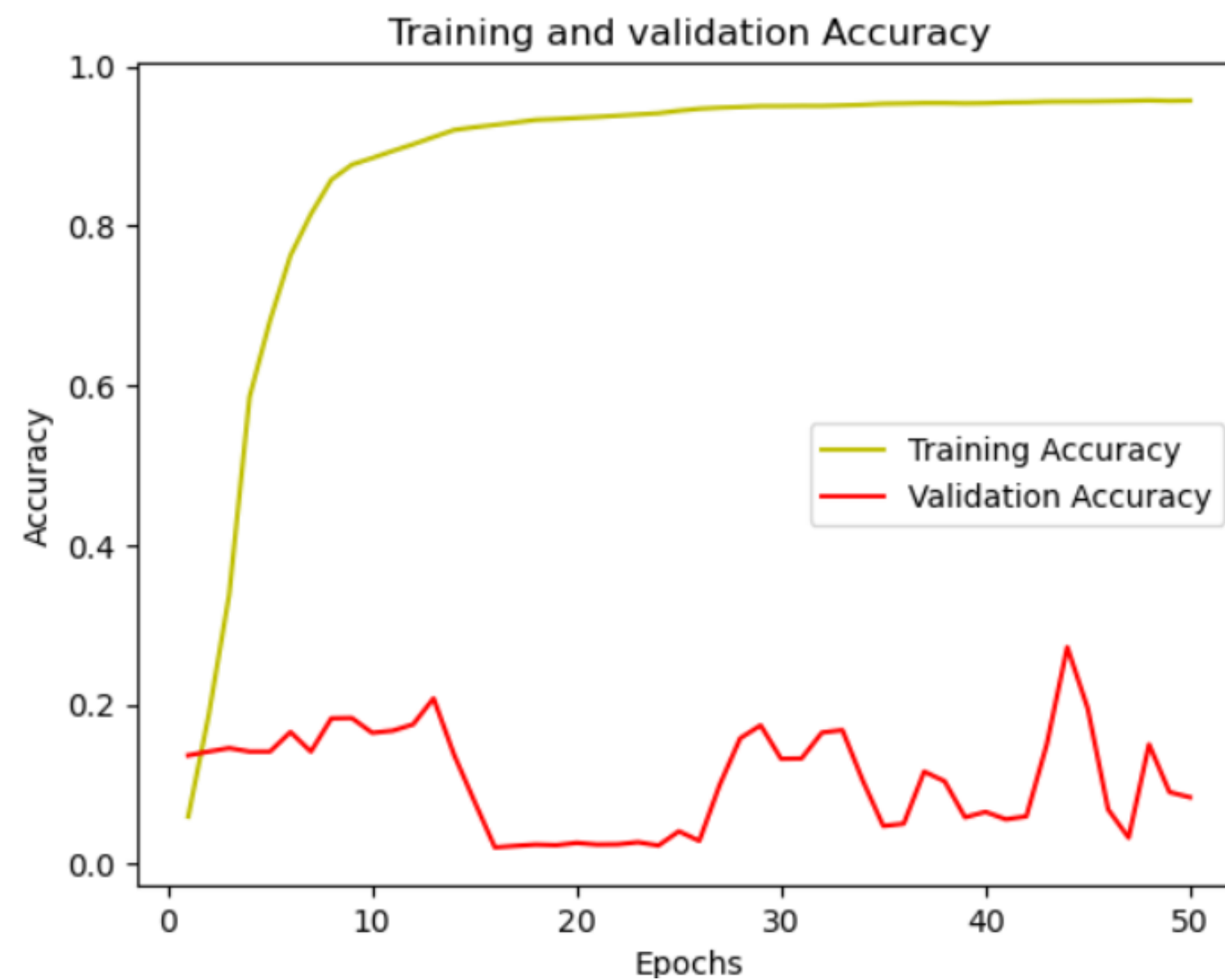
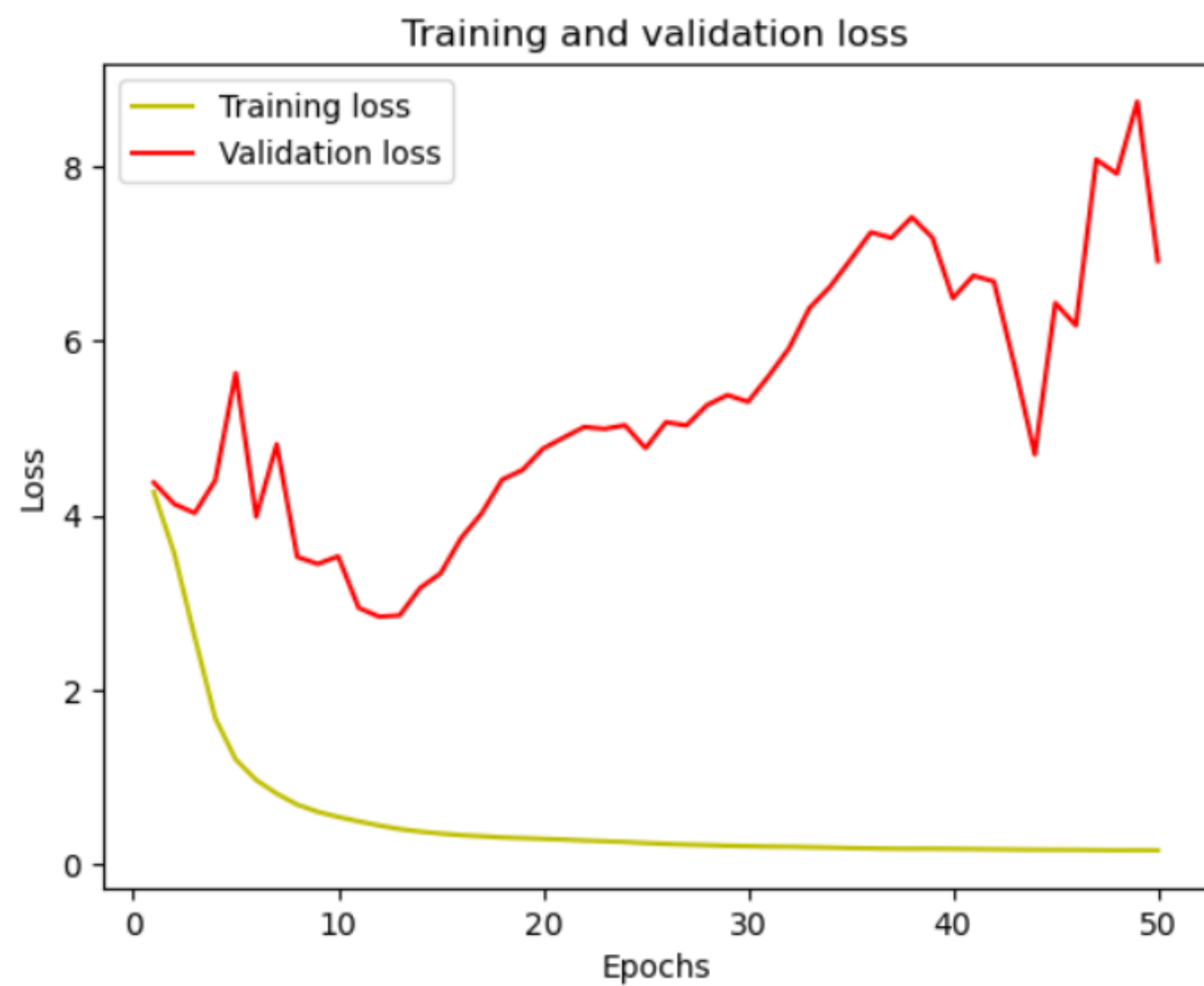
F1 Score = 0.9458

IoU:

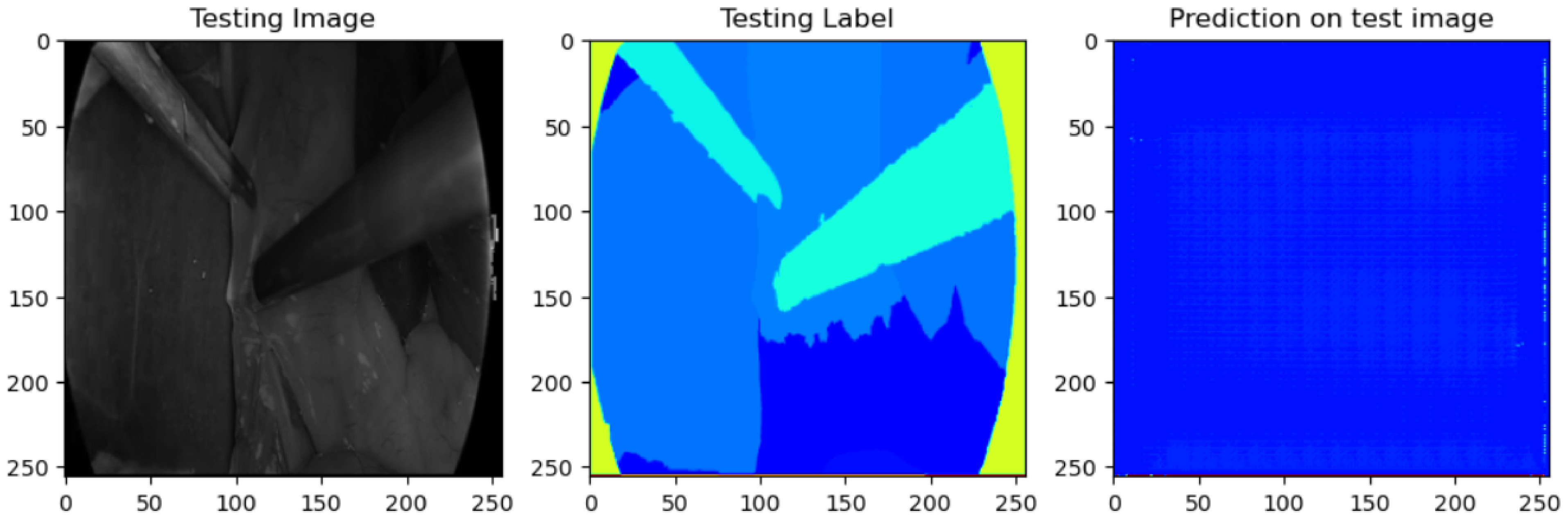
```
IoU for class 0 : 0.9796149985868056
IoU for class 1 : 0.9578817400006493
IoU for class 2 : 0.9377541097322576
IoU for class 3 : 0.9571209102333562
IoU for class 4 : 0.8215136279439005
IoU for class 5 : 0.9116839818821667
IoU for class 6 : 0.9981310400127689
IoU for class 7 : 1.0
Mean IoU = 0.9454626
```

```
Dice coefficient for class 0 : 0.9897025424500487
Dice coefficient for class 1 : 0.9784878426828084
Dice coefficient for class 2 : 0.9678773018954696
Dice coefficient for class 3 : 0.9780907303465829
Dice coefficient for class 4 : 0.9020120578194233
Dice coefficient for class 5 : 0.953801978279443
Dice coefficient for class 6 : 0.9990646459367253
Dice coefficient for class 7 : 1.0
Mean Dice coefficient: 0.9711296374263125
```

ResUnet



Predictions



ADAM optimier:

Accuracy

```
Epoch 48/50
8/8 [=====] - 4s 591ms/step - loss: 0.1570 - accuracy: 0.9577 - val_loss: 7.9155 - val_accuracy: 0.1499
Epoch 49/50
8/8 [=====] - 4s 571ms/step - loss: 0.1580 - accuracy: 0.9571 - val_loss: 8.7440 - val_accuracy: 0.0901
Epoch 50/50
8/8 [=====] - 5s 619ms/step - loss: 0.1568 - accuracy: 0.9574 - val_loss: 6.9166 - val_accuracy: 0.0836
```

Mean IOU:

Mean IoU = 0.006392777

F1 Score:

F1 Score = 0.0467

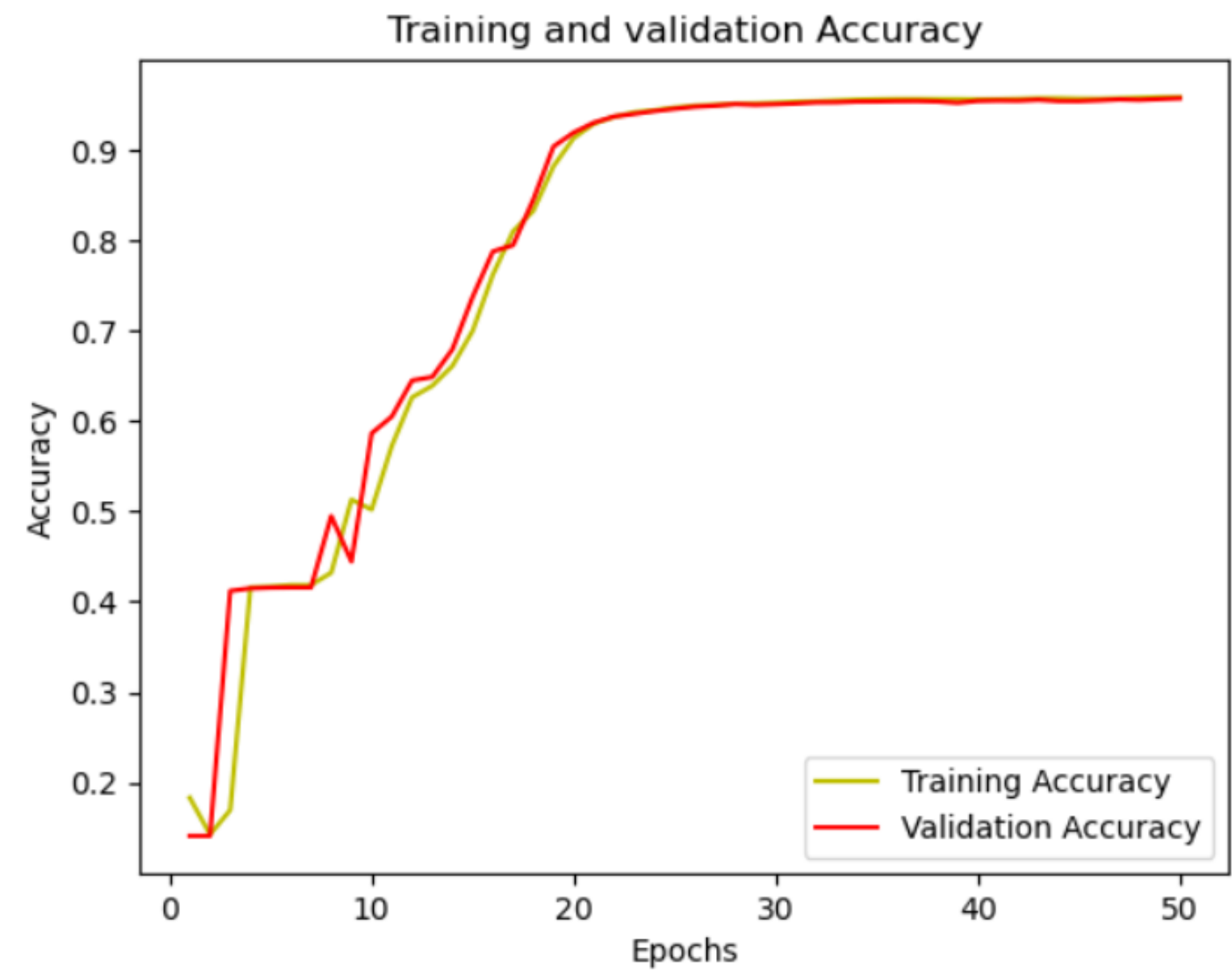
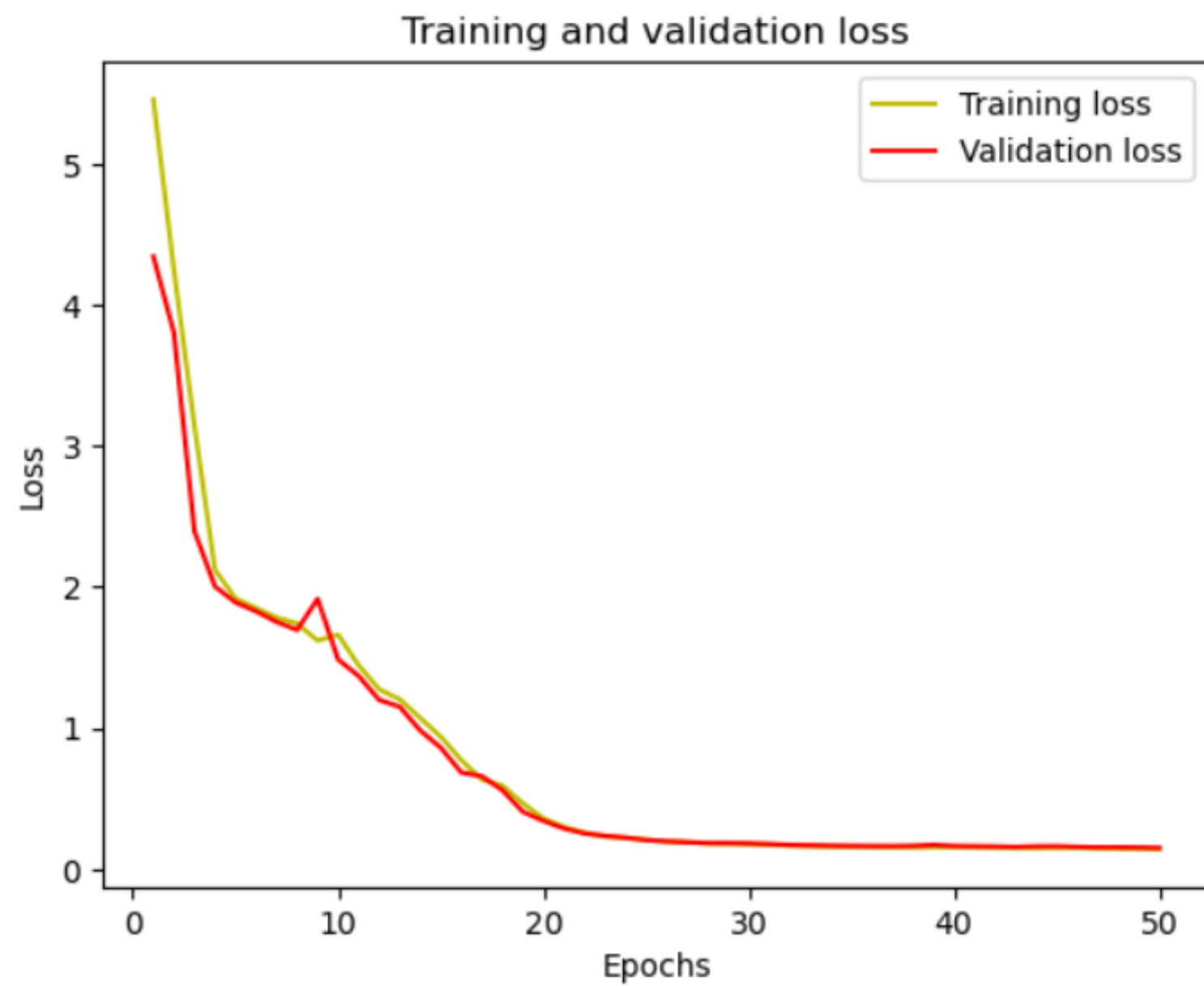
IoU:

```
IoU for class 0 : 0.42356481231121035
IoU for class 1 : 0.4788020843633874
IoU for class 2 : 0.05971466524574662
IoU for class 3 : 0.07820267740494194
IoU for class 4 : 0.011140184667208036
IoU for class 5 : 0.03682900921089009
IoU for class 6 : 0.854566271959538
IoU for class 7 : 1.0
Mean IoU = 0.36785245
```

DICE COEFFICIENT:

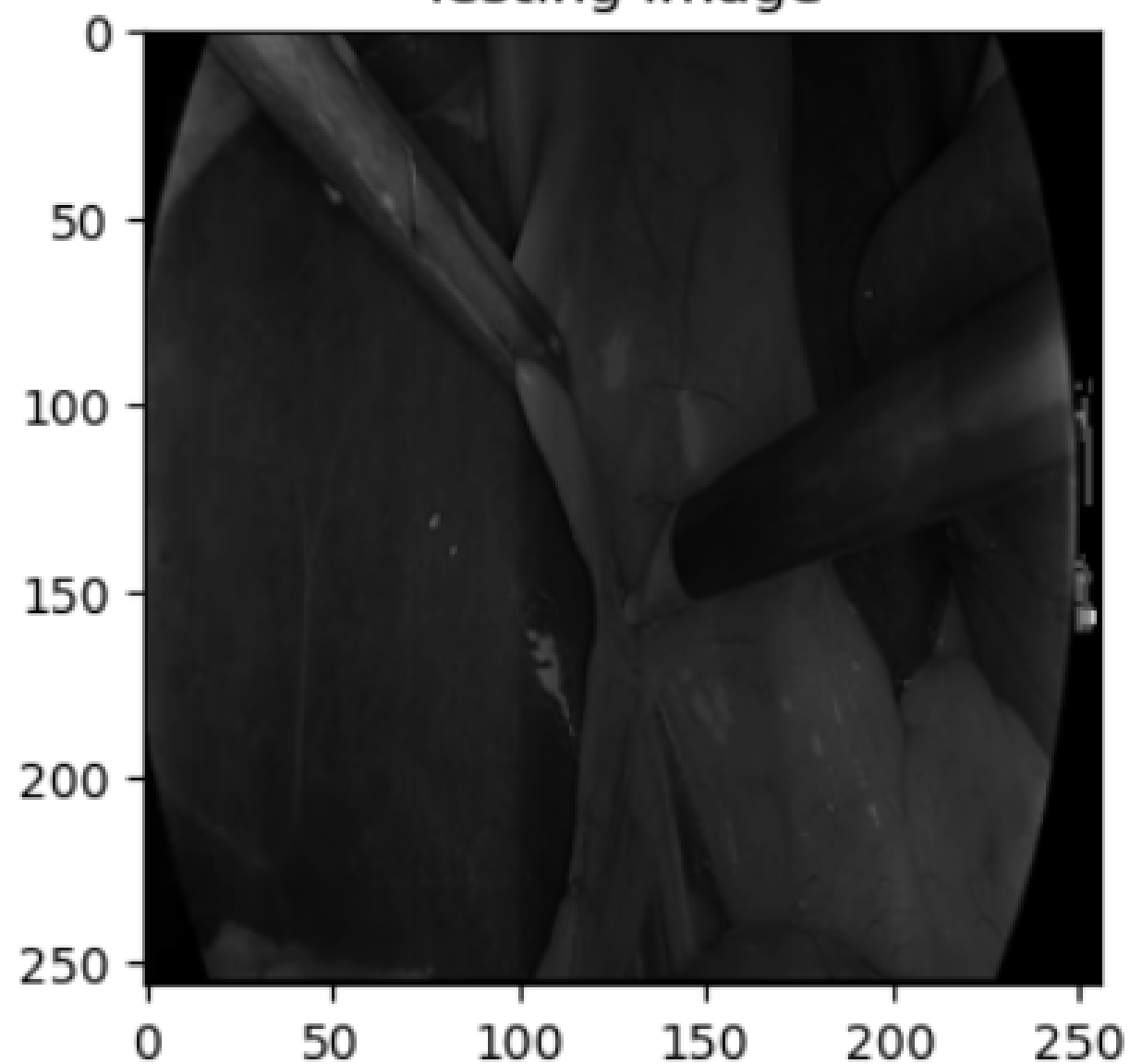
```
Dice coefficient for class 0 : 0.5950762601718669
Dice coefficient for class 1 : 0.6475539755132383
Dice coefficient for class 2 : 0.11269951658524771
Dice coefficient for class 3 : 0.14506118199068666
Dice coefficient for class 4 : 0.022034896518081822
Dice coefficient for class 5 : 0.07104162573329216
Dice coefficient for class 6 : 0.9215807327894536
Dice coefficient for class 7 : 1.0
Mean Dice coefficient: 0.43938102366273346
```

Dilated Unet

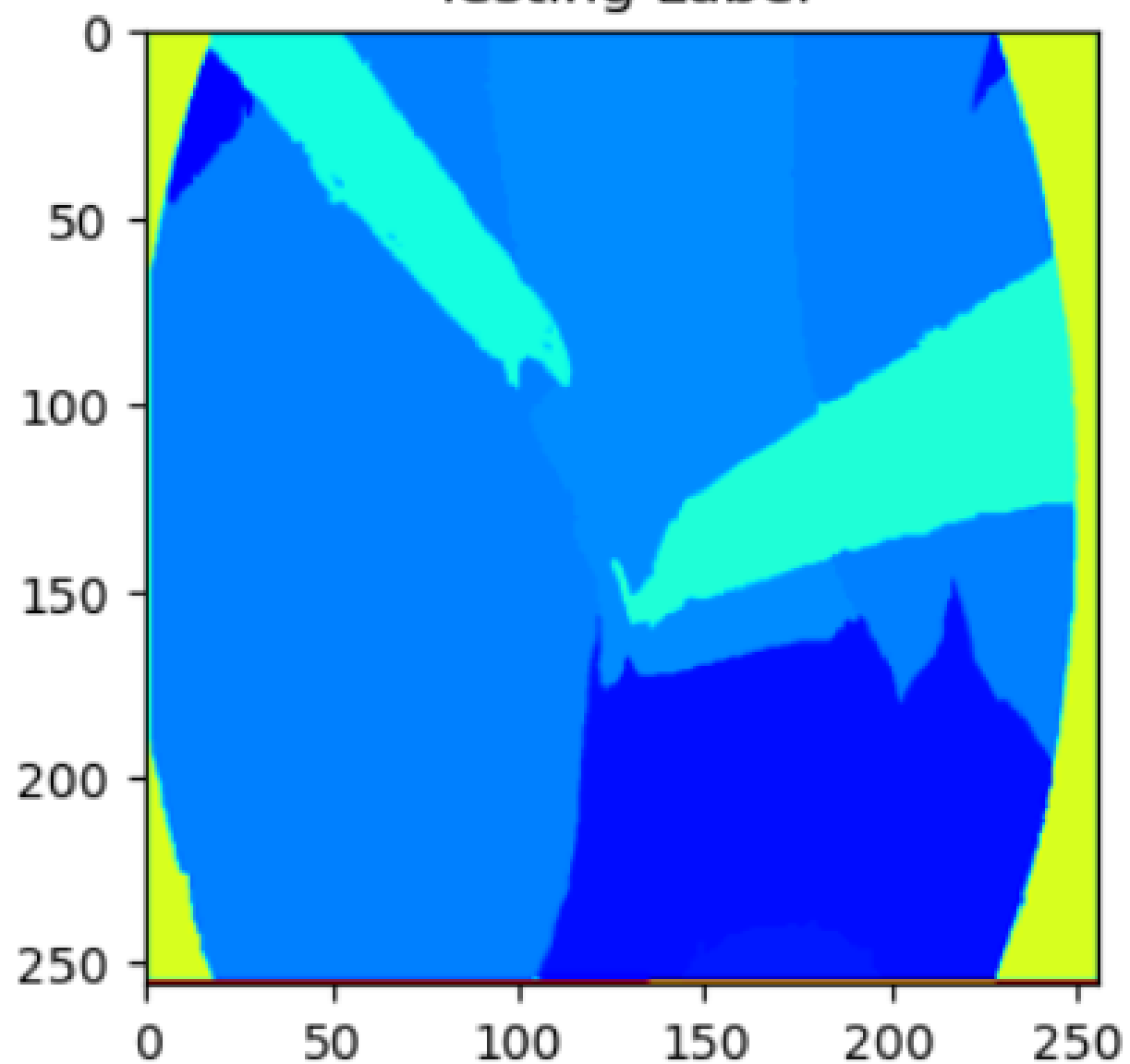


Predictions

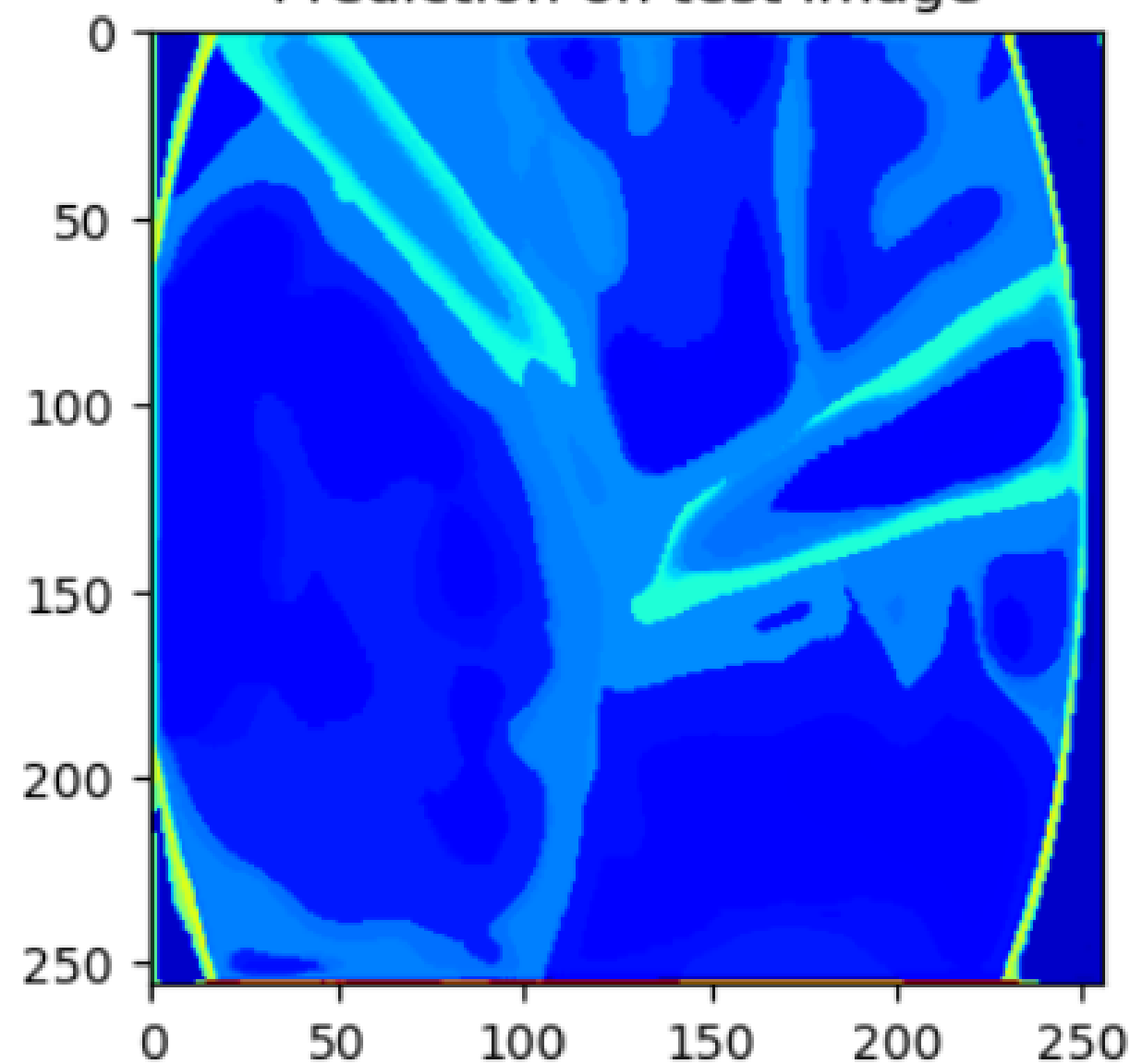
Testing Image



Testing Label



Prediction on test image



ADAM optimier:

Accuracy

```
Epoch 48/50
8/8 [=====] - 7s 930ms/step - loss: 0.1436 - accuracy: 0.9574 - val_loss: 0.1539 - val_accuracy: 0.9550
Epoch 49/50
8/8 [=====] - 8s 986ms/step - loss: 0.1419 - accuracy: 0.9580 - val_loss: 0.1525 - val_accuracy: 0.9558
Epoch 50/50
8/8 [=====] - 8s 981ms/step - loss: 0.1405 - accuracy: 0.9582 - val_loss: 0.1496 - val_accuracy: 0.9567
```

Mean IOU:

Mean IoU = 0.109356135

F1 Score:

F1 Score = 0.3586

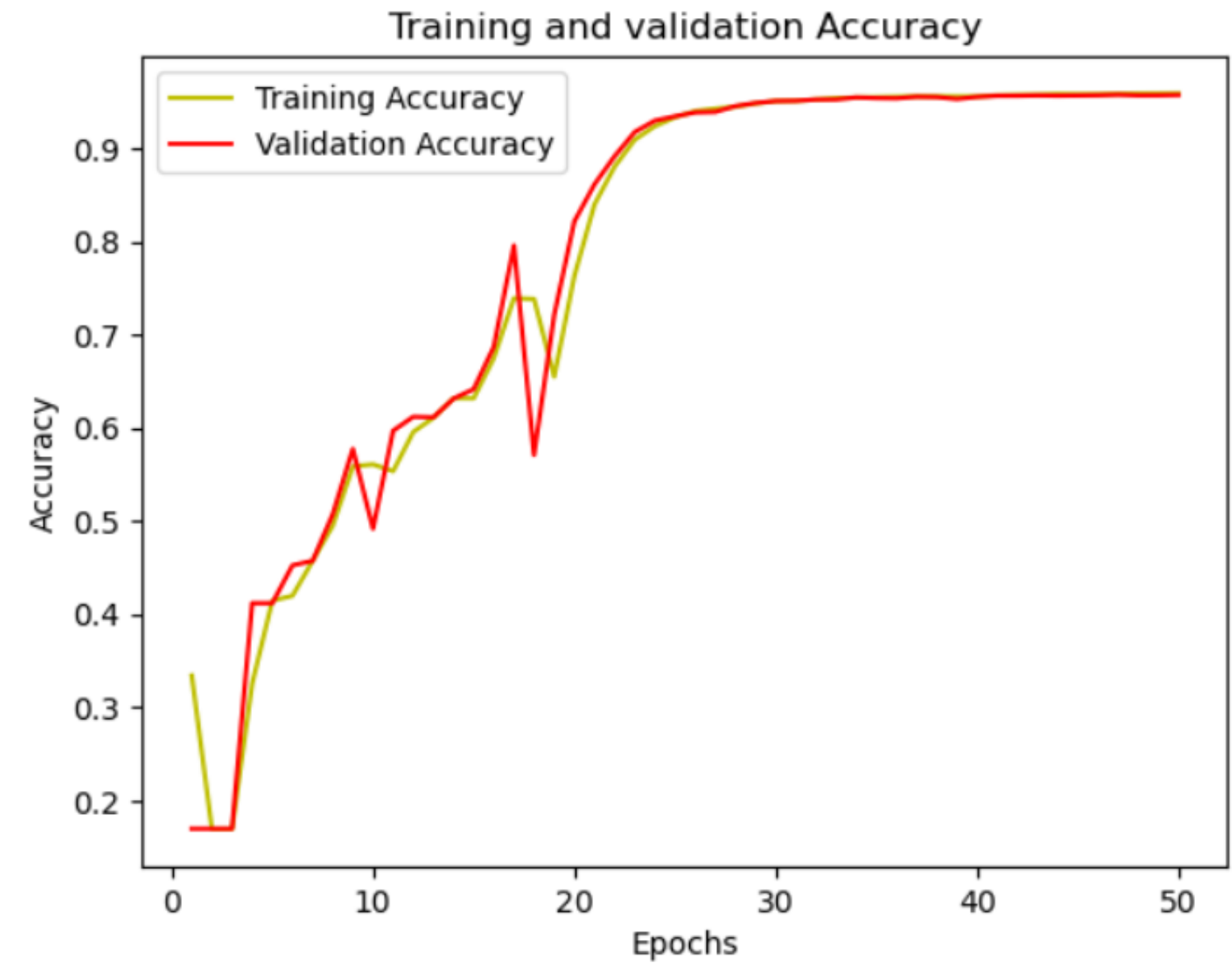
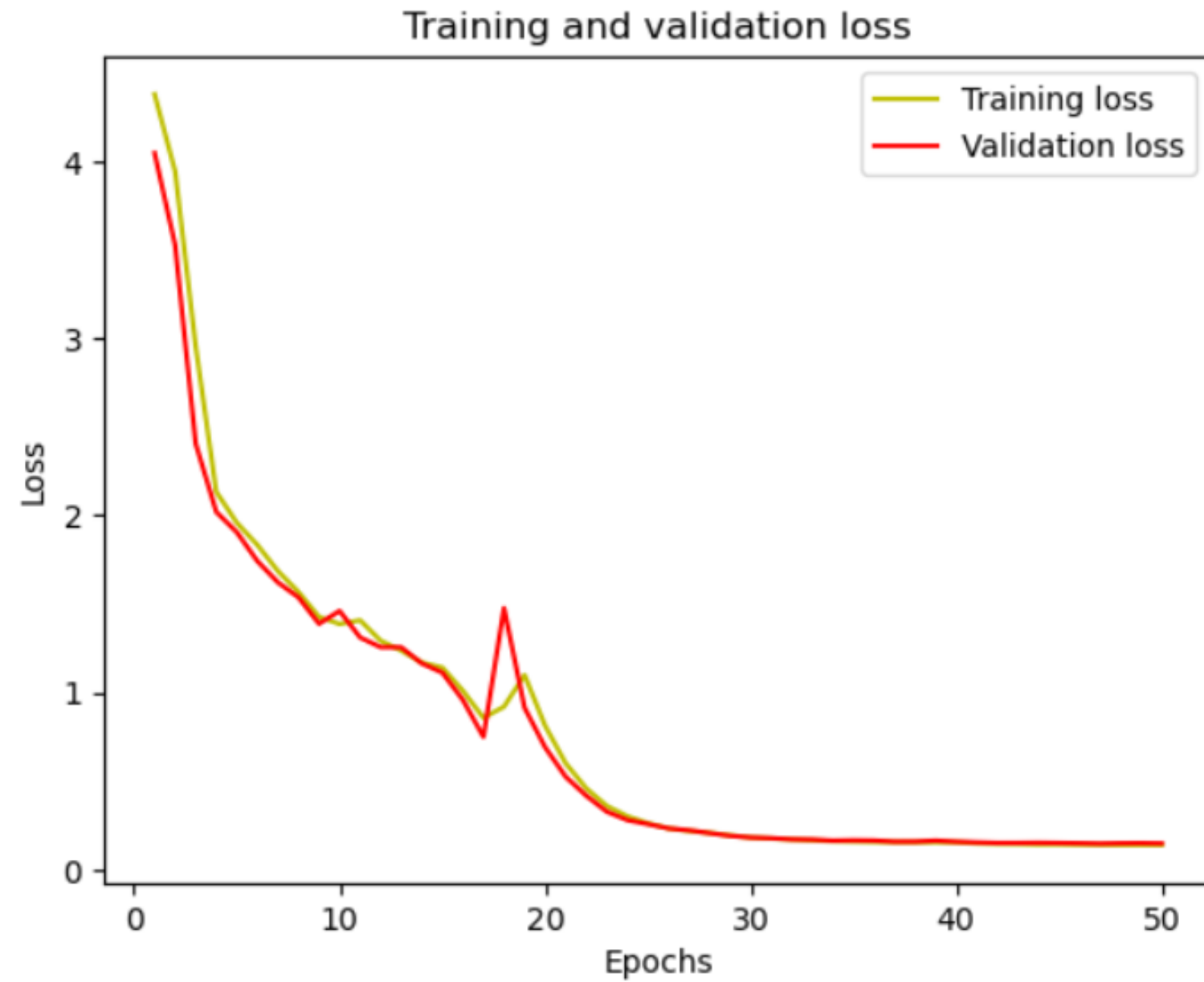
IOU:

```
IoU for class 0 : 0.5231922263692681
IoU for class 1 : 0.9387179569931258
IoU for class 2 : 0.7936408338702591
IoU for class 3 : 0.9340662863938302
IoU for class 4 : 0.12442977549185173
IoU for class 5 : 0.8371658012706809
IoU for class 6 : 0.25750197400388725
IoU for class 7 : 0.9358927408854166
Mean IoU = 0.6680759
```

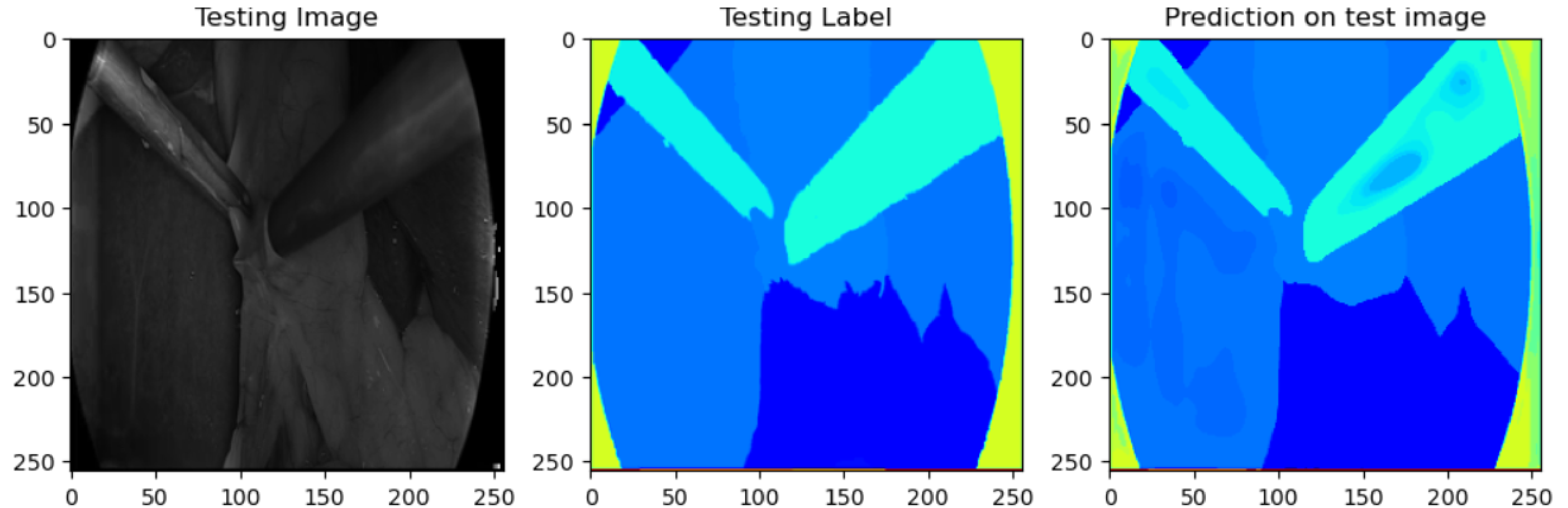
DICE COEFFICIENT:

```
Dice coefficient for class 0 : 0.686968088875252
Dice coefficient for class 1 : 0.9683904289503151
Dice coefficient for class 2 : 0.8849495605625426
Dice coefficient for class 3 : 0.9659092792889189
Dice coefficient for class 4 : 0.2213206697366641
Dice coefficient for class 5 : 0.9113666286316159
Dice coefficient for class 6 : 0.4095452402098436
Dice coefficient for class 7 : 0.9668849116685758
Mean Dice coefficient: 0.751916850990466
```

Inception Unet



Predictions



ADAM optimier:

Accuracy

```
Epoch 48/50
8/8 [=====] - 13s 2s/step - loss: 0.1386 - accuracy: 0.9586 - val_loss: 0.1488 - val_accuracy: 0.9566
Epoch 49/50
8/8 [=====] - 13s 2s/step - loss: 0.1385 - accuracy: 0.9587 - val_loss: 0.1495 - val_accuracy: 0.9567
Epoch 50/50
8/8 [=====] - 13s 2s/step - loss: 0.1384 - accuracy: 0.9588 - val_loss: 0.1479 - val_accuracy: 0.9570
```

Mean IOU:

Mean IoU = 0.23716986

F1 Score:

F1 Score = 0.8316

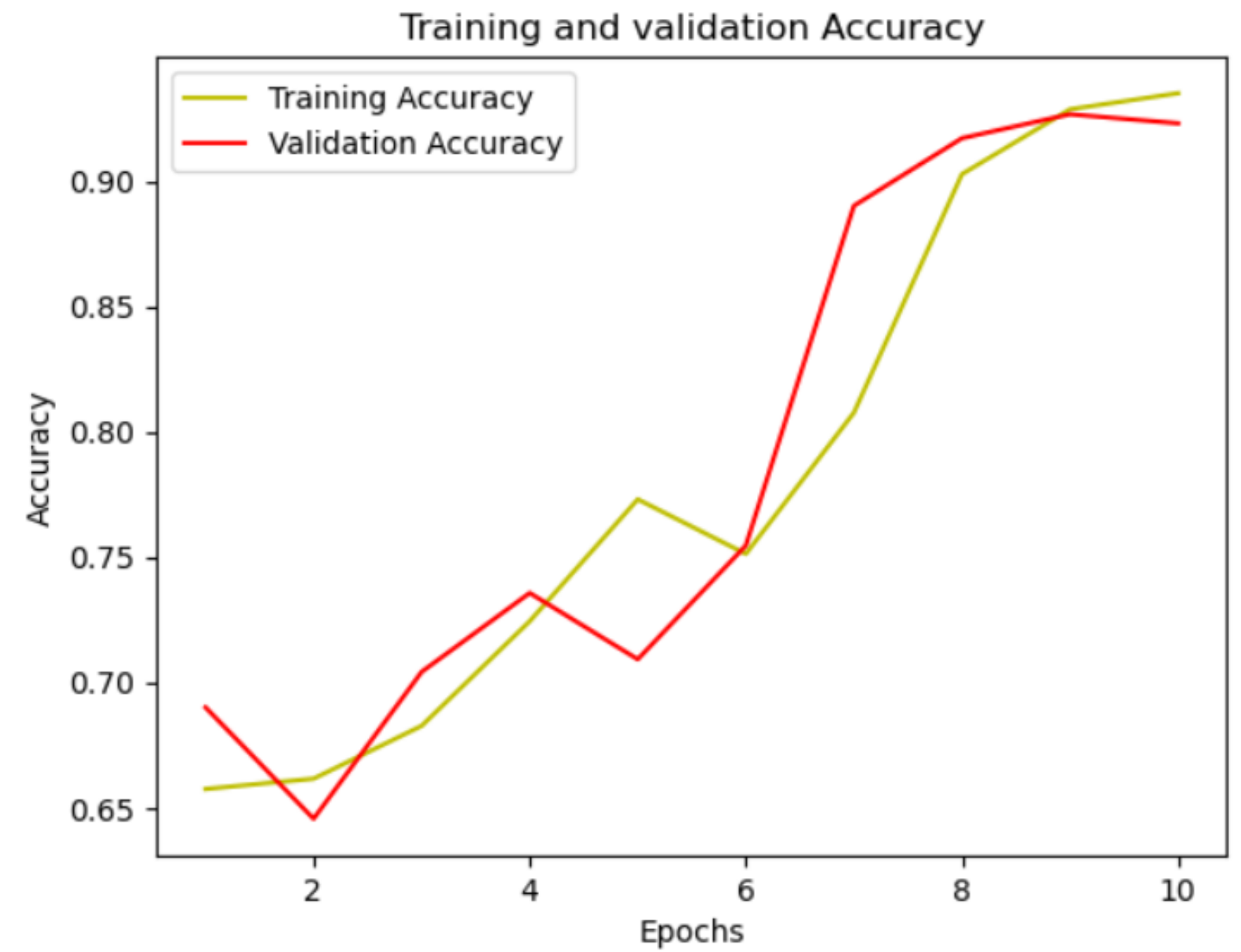
IoU:

```
IoU for class 0 : 0.982069824452153
IoU for class 1 : 0.9621653569287003
IoU for class 2 : 0.9410175633728672
IoU for class 3 : 0.9586969485841147
IoU for class 4 : 0.8456608993963908
IoU for class 5 : 0.9327283686043397
IoU for class 6 : 0.998361624143654
IoU for class 7 : 0.9993896484375
Mean IoU = 0.9525113
```

DICE COEFFICIENT:

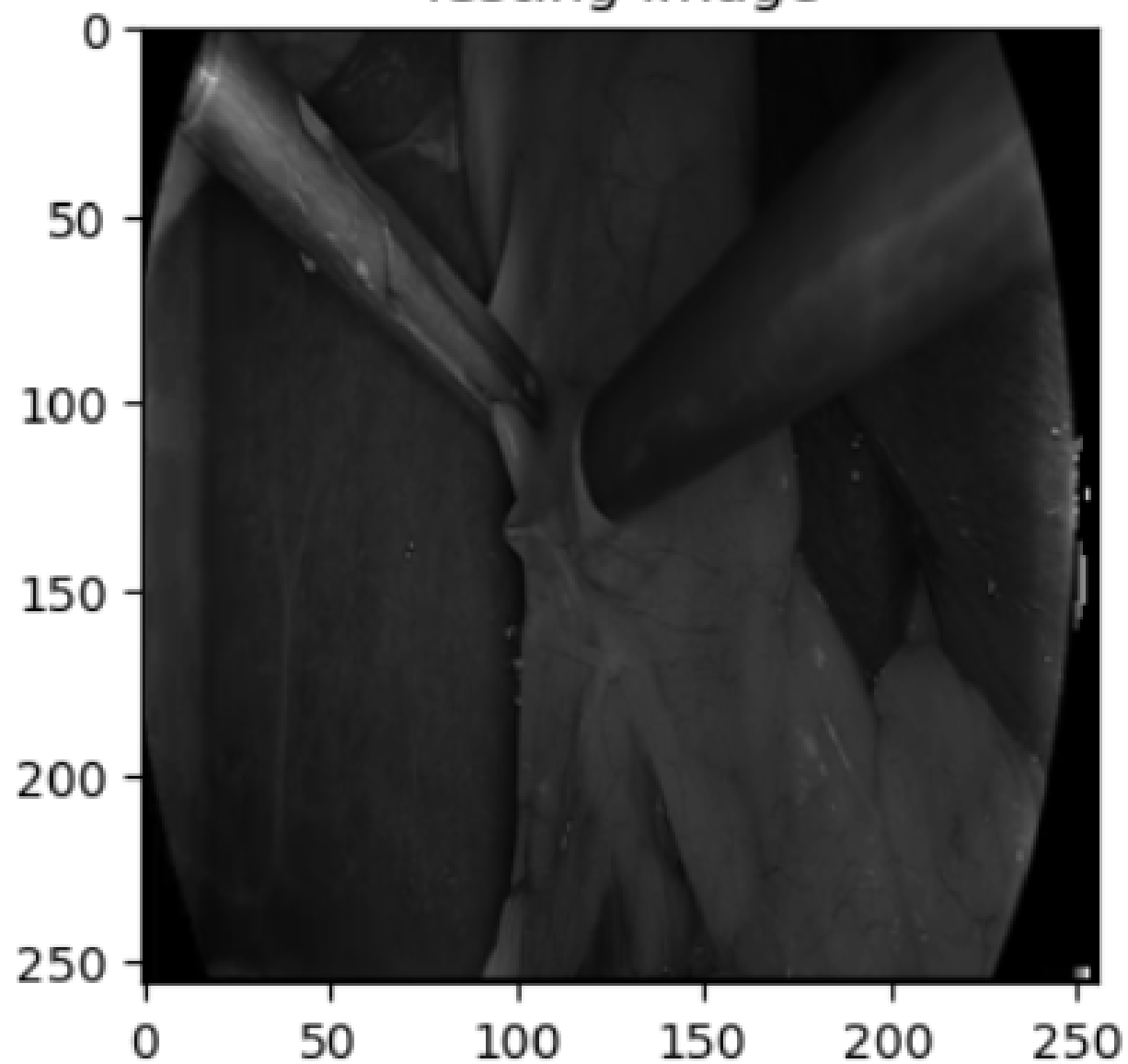
```
Dice coefficient for class 0 : 0.9909538123598634
Dice coefficient for class 1 : 0.980717913025169
Dice coefficient for class 2 : 0.9696126208540637
Dice coefficient for class 3 : 0.9789129954760271
Dice coefficient for class 4 : 0.9163773255129993
Dice coefficient for class 5 : 0.9651934371697362
Dice coefficient for class 6 : 0.9991801404527831
Dice coefficient for class 7 : 0.9996947310580622
Mean Dice coefficient: 0.9750803719885879
```

Dense Unet

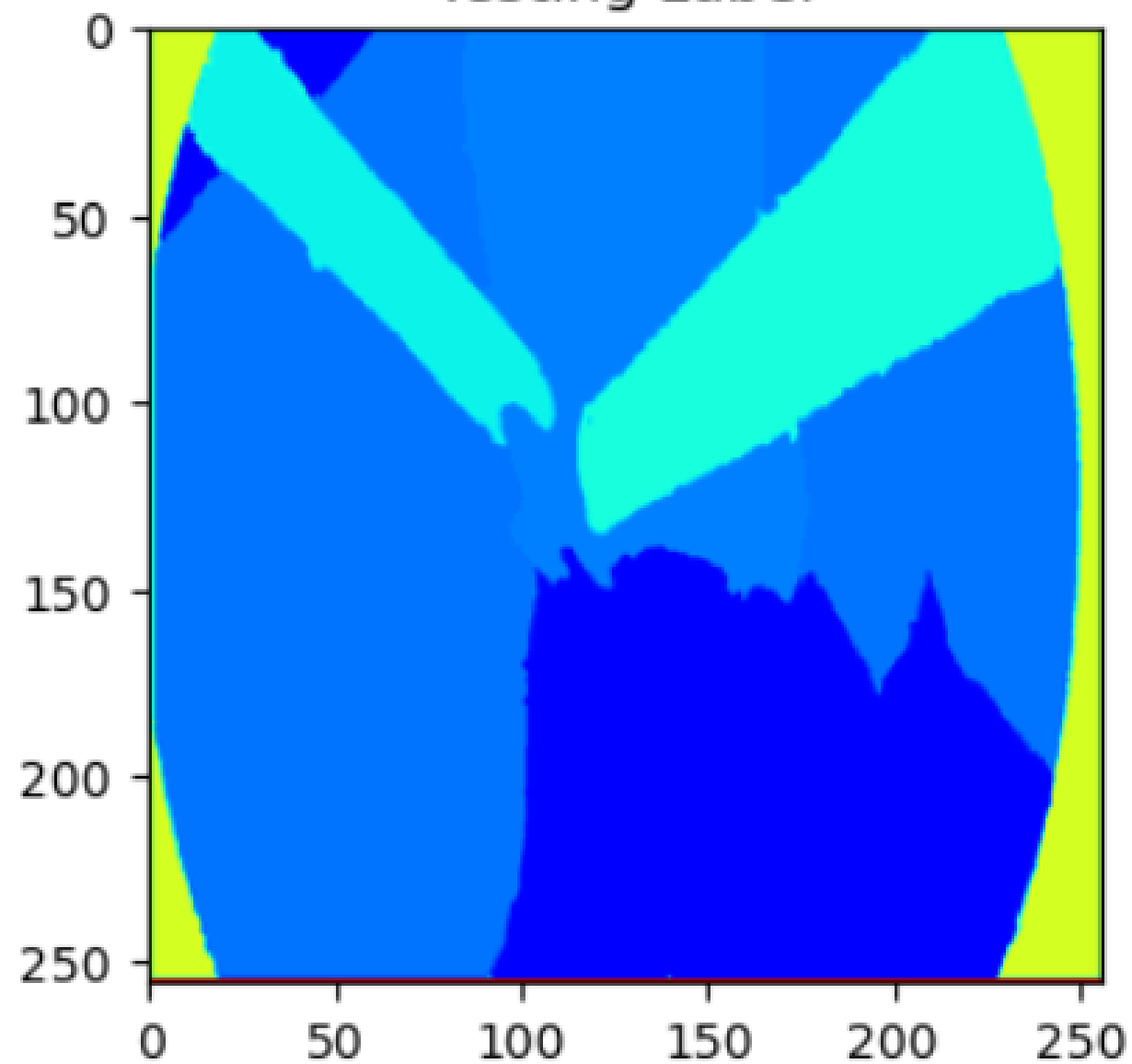


Predictions

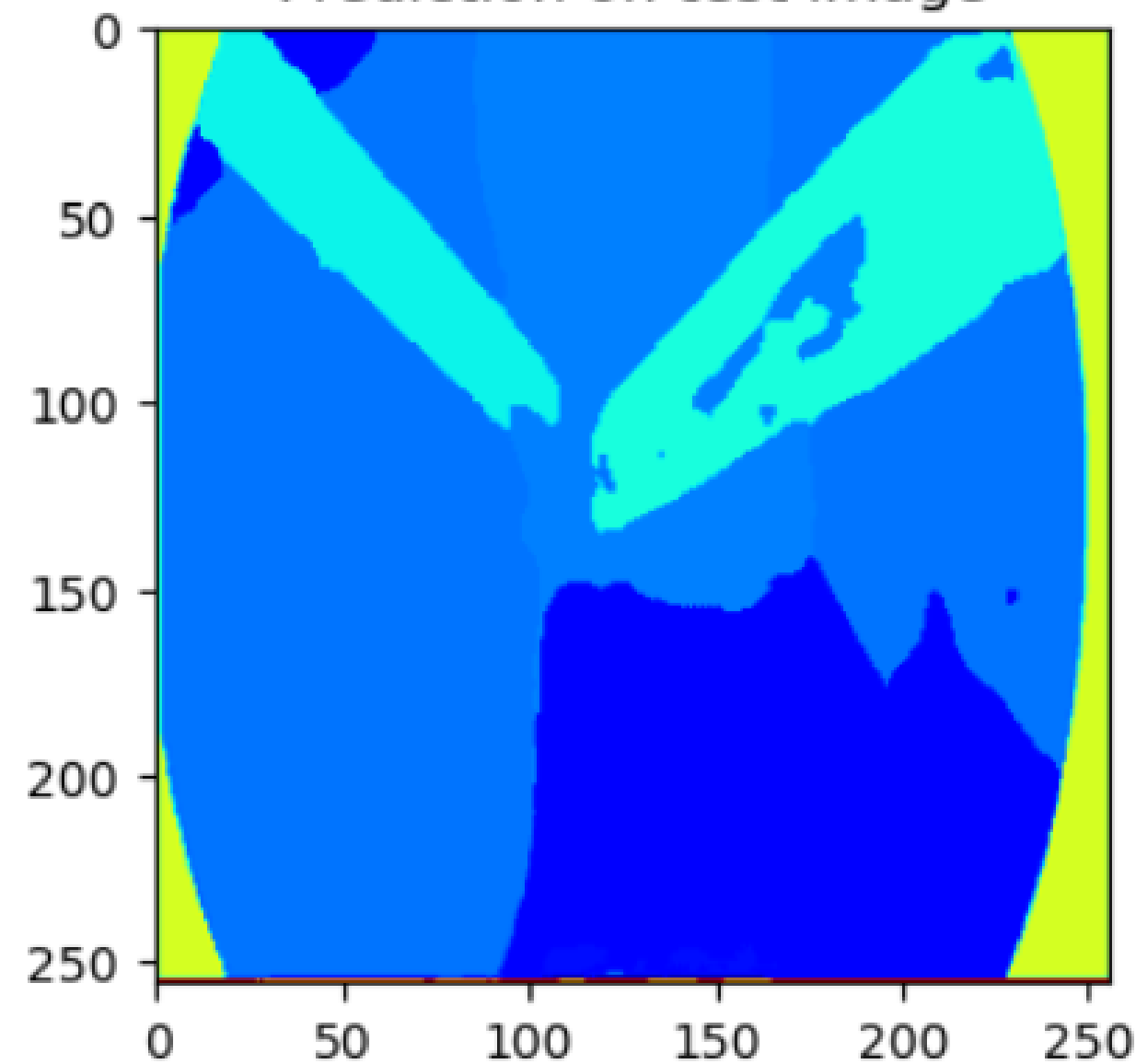
Testing Image



Testing Label



Prediction on test image



ADAM optimier:

Accuracy

```
Epoch 8/10
43/43 [=====] - 40s 934ms/step - loss: 0.3545 - accuracy: 0.9027 - val_loss: 0.2992 - val_accuracy: 0.9170
Epoch 9/10
43/43 [=====] - 38s 888ms/step - loss: 0.2587 - accuracy: 0.9286 - val_loss: 0.2632 - val_accuracy: 0.9266
Epoch 10/10
43/43 [=====] - 40s 934ms/step - loss: 0.2325 - accuracy: 0.9350 - val_loss: 0.2649 - val_accuracy: 0.9230
```

Mean IOU:

Mean IoU = 0.27770364

F1 Score:

F1 Score = 0.9148

IoU:

```
IoU for class 0 : 0.9601482830339814
IoU for class 1 : 0.9141982072691782
IoU for class 2 : 0.8639324168244336
IoU for class 3 : 0.8959091733468751
IoU for class 4 : 0.5067260285109008
IoU for class 5 : 0.3640179195999345
IoU for class 6 : 0.9948964626984546
IoU for class 7 : 0.9993084089337293
Mean IoU = 0.8123921
```

DICE COEFFICIENT:

```
Dice coefficient for class 0 : 0.9796690294754972
Dice coefficient for class 1 : 0.9551761189593695
Dice coefficient for class 2 : 0.9269997227649575
Dice coefficient for class 3 : 0.9450971448862332
Dice coefficient for class 4 : 0.6726186697812592
Dice coefficient for class 5 : 0.5337436031730444
Dice coefficient for class 6 : 0.997441703167571
Dice coefficient for class 7 : 0.9996540848509513
Mean Dice coefficient: 0.8763000096323604
```

FINAL CONCLUSIONS:

Model	Accuracy	Precision	Recall	F1Score	Mean IoU	Dice coefficient	
UNet	0.9864	0.99	0.99	0.9863	0.947	0.972	
UNet++	0.9878	0.99	0.99	0.9878	0.953	0.9753	
Dense Unet	0.9701	0.97	0.97	0.9699	0.8709	0.9245	
Ensemble	0.9862	0.99	0.99	0.9861	0.9454	0.9711	
Dilated	0.98	0.86	0.67	0.6578	0.669	0.7519	
Nested	0.9772	0.98	0.98	0.9771	0.9013	0.9448	
Inception	0.9875	0.99	0.99	0.9875	0.9525	0.975	
Attention	0.8334	0.87	0.83	0.8252	0.5506	0.635	
ResUnet	0.6456	0.7	0.65	0.6314	0.3678	0.43938	

THANK YOU!!!