In [1]:

**import** tensorflow **as** tf  
  
**from** keras **import** optimizers  
**from** keras.utils **import** load\_img, img\_to\_array  
**from** keras.models **import** Sequential  
**from** keras.layers **import** Dense, Flatten, Dropout, BatchNormalization, Conv2D, MaxPooling2D  
**from** keras.preprocessing.image **import** ImageDataGenerator  
**from** keras.callbacks **import** ModelCheckpoint, EarlyStopping  
  
**from** keras.applications **import** ResNet50, DenseNet201  
**from** keras.applications **import** resnet, densenet  
  
**import** numpy **as** np  
**import** matplotlib.pyplot **as** plt  
  
**import** cv2  
**import** os  
**import** pandas **as** pd

In [2]:

train\_path **=** "data/train"  
valid\_path **=** "data/valid"  
test\_path **=** "data/test"

In [3]:

image\_shape **=** (305,430,3)  
N\_CLASSES **=** 4  
BATCH\_SIZE **=** 32  
  
  
train\_datagen **=** ImageDataGenerator(dtype**=**'float32', rescale**=** 1.**/**255.)  
train\_generator **=** train\_datagen**.**flow\_from\_directory(train\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (305,430),  
 class\_mode **=** 'categorical')  
  
valid\_datagen **=** ImageDataGenerator(dtype**=**'float32', rescale**=** 1.**/**255.)  
valid\_generator **=** valid\_datagen**.**flow\_from\_directory(valid\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (305,430),  
 class\_mode **=** 'categorical')  
  
test\_datagen **=** ImageDataGenerator(dtype**=**'float32', rescale **=** 1.0**/**255.0)  
test\_generator **=** test\_datagen**.**flow\_from\_directory(test\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (305,430),  
 class\_mode **=** 'categorical')

Found 613 images belonging to 4 classes.  
Found 72 images belonging to 4 classes.  
Found 315 images belonging to 4 classes.

In [4]:

class\_names**=**list(test\_generator**.**class\_indices**.**keys())  
print(class\_names)  
  
fig **=** plt**.**figure(figsize**=**(20,5))  
  
image\_batch,label\_batch **=** test\_generator[1]  
**for** i **in** range(15):  
 ax **=** fig**.**add\_subplot(3,5,i**+**1,xticks **=** [], yticks **=** [])  
 ax**.**imshow(image\_batch[i])  
 plt**.**axis('off')  
 plt**.**title(class\_names[np**.**argmax(label\_batch[i])])

['adenocarcinoma', 'large.cell.carcinoma', 'normal', 'squamous.cell.carcinoma']

In [5]:

first\_model **=** Sequential([  
 Conv2D(8, 2, padding**=**'same', activation**=**'relu', input\_shape **=** image\_shape),  
 MaxPooling2D(2),  
 Conv2D(16, 2, padding**=**'same', activation**=**'relu'),  
 MaxPooling2D(2),  
  
 Dropout(0.4),  
 Flatten(),  
 Dense(256, activation**=**'relu'),  
 Dropout(0.4),  
 Dense(4, activation**=**'softmax')  
])  
first\_model**.**summary()

Model: "sequential"  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
 Layer (type) Output Shape Param #   
=================================================================  
 conv2d (Conv2D) (None, 305, 430, 8) 104   
   
 max\_pooling2d (MaxPooling2D (None, 152, 215, 8) 0   
 )   
   
 conv2d\_1 (Conv2D) (None, 152, 215, 16) 528   
   
 max\_pooling2d\_1 (MaxPooling (None, 76, 107, 16) 0   
 2D)   
   
 dropout (Dropout) (None, 76, 107, 16) 0   
   
 flatten (Flatten) (None, 130112) 0   
   
 dense (Dense) (None, 256) 33308928   
   
 dropout\_1 (Dropout) (None, 256) 0   
   
 dense\_1 (Dense) (None, 4) 1028   
   
=================================================================  
Total params: 33,310,588  
Trainable params: 33,310,588  
Non-trainable params: 0  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

In [6]:

checkpointer **=** ModelCheckpoint('chestmodel.hdf5',verbose**=**1, save\_best\_only**=** **True**)  
early\_stopping **=** EarlyStopping(monitor**=** 'val\_loss', patience**=** 10)  
optimizer **=** optimizers**.**Adam(learning\_rate**=** 0.00001, decay**=** 1e-5)  
  
first\_model**.**compile(loss**=** 'categorical\_crossentropy', optimizer**=** optimizer, metrics**=**['acc'])  
history **=** first\_model**.**fit(train\_generator,  
 steps\_per\_epoch **=** 20,  
 epochs **=** 20,  
 verbose **=** 1,  
 validation\_data **=** valid\_generator,  
 callbacks **=** [checkpointer, early\_stopping])

Epoch 1/20  
20/20 [==============================] - ETA: 0s - loss: 1.3019 - acc: 0.3638  
Epoch 1: val\_loss improved from inf to 1.33510, saving model to chestmodel.hdf5  
20/20 [==============================] - 37s 2s/step - loss: 1.3019 - acc: 0.3638 - val\_loss: 1.3351 - val\_acc: 0.3889  
Epoch 2/20  
20/20 [==============================] - ETA: 0s - loss: 1.1889 - acc: 0.4698  
Epoch 2: val\_loss improved from 1.33510 to 1.30384, saving model to chestmodel.hdf5  
20/20 [==============================] - 35s 2s/step - loss: 1.1889 - acc: 0.4698 - val\_loss: 1.3038 - val\_acc: 0.4583  
Epoch 3/20  
20/20 [==============================] - ETA: 0s - loss: 1.0891 - acc: 0.5285  
Epoch 3: val\_loss improved from 1.30384 to 1.18243, saving model to chestmodel.hdf5  
20/20 [==============================] - 36s 2s/step - loss: 1.0891 - acc: 0.5285 - val\_loss: 1.1824 - val\_acc: 0.4306  
Epoch 4/20  
20/20 [==============================] - ETA: 0s - loss: 1.0405 - acc: 0.5856  
Epoch 4: val\_loss did not improve from 1.18243  
20/20 [==============================] - 33s 2s/step - loss: 1.0405 - acc: 0.5856 - val\_loss: 1.2211 - val\_acc: 0.4722  
Epoch 5/20  
20/20 [==============================] - ETA: 0s - loss: 0.9838 - acc: 0.5563  
Epoch 5: val\_loss improved from 1.18243 to 1.16813, saving model to chestmodel.hdf5  
20/20 [==============================] - 34s 2s/step - loss: 0.9838 - acc: 0.5563 - val\_loss: 1.1681 - val\_acc: 0.5000  
Epoch 6/20  
20/20 [==============================] - ETA: 0s - loss: 0.9156 - acc: 0.6460  
Epoch 6: val\_loss improved from 1.16813 to 1.09271, saving model to chestmodel.hdf5  
20/20 [==============================] - 34s 2s/step - loss: 0.9156 - acc: 0.6460 - val\_loss: 1.0927 - val\_acc: 0.5000  
Epoch 7/20  
20/20 [==============================] - ETA: 0s - loss: 0.8544 - acc: 0.6721  
Epoch 7: val\_loss improved from 1.09271 to 1.01040, saving model to chestmodel.hdf5  
20/20 [==============================] - 34s 2s/step - loss: 0.8544 - acc: 0.6721 - val\_loss: 1.0104 - val\_acc: 0.5833  
Epoch 8/20  
20/20 [==============================] - ETA: 0s - loss: 0.8286 - acc: 0.7047  
Epoch 8: val\_loss improved from 1.01040 to 0.99726, saving model to chestmodel.hdf5  
20/20 [==============================] - 34s 2s/step - loss: 0.8286 - acc: 0.7047 - val\_loss: 0.9973 - val\_acc: 0.6111  
Epoch 9/20  
20/20 [==============================] - ETA: 0s - loss: 0.7726 - acc: 0.7064  
Epoch 9: val\_loss improved from 0.99726 to 0.91709, saving model to chestmodel.hdf5  
20/20 [==============================] - 34s 2s/step - loss: 0.7726 - acc: 0.7064 - val\_loss: 0.9171 - val\_acc: 0.6250  
Epoch 10/20  
20/20 [==============================] - ETA: 0s - loss: 0.7546 - acc: 0.7178  
Epoch 10: val\_loss did not improve from 0.91709  
20/20 [==============================] - 33s 2s/step - loss: 0.7546 - acc: 0.7178 - val\_loss: 0.9502 - val\_acc: 0.5000  
Epoch 11/20  
20/20 [==============================] - ETA: 0s - loss: 0.7095 - acc: 0.7520  
Epoch 11: val\_loss did not improve from 0.91709  
20/20 [==============================] - 35s 2s/step - loss: 0.7095 - acc: 0.7520 - val\_loss: 0.9469 - val\_acc: 0.5139  
Epoch 12/20  
20/20 [==============================] - ETA: 0s - loss: 0.6575 - acc: 0.7765  
Epoch 12: val\_loss did not improve from 0.91709  
20/20 [==============================] - 34s 2s/step - loss: 0.6575 - acc: 0.7765 - val\_loss: 0.9319 - val\_acc: 0.5278  
Epoch 13/20  
20/20 [==============================] - ETA: 0s - loss: 0.6456 - acc: 0.7781  
Epoch 13: val\_loss improved from 0.91709 to 0.86059, saving model to chestmodel.hdf5  
20/20 [==============================] - 35s 2s/step - loss: 0.6456 - acc: 0.7781 - val\_loss: 0.8606 - val\_acc: 0.5833  
Epoch 14/20  
20/20 [==============================] - ETA: 0s - loss: 0.6090 - acc: 0.7977  
Epoch 14: val\_loss improved from 0.86059 to 0.80034, saving model to chestmodel.hdf5  
20/20 [==============================] - 34s 2s/step - loss: 0.6090 - acc: 0.7977 - val\_loss: 0.8003 - val\_acc: 0.6667  
Epoch 15/20  
20/20 [==============================] - ETA: 0s - loss: 0.5865 - acc: 0.8124  
Epoch 15: val\_loss did not improve from 0.80034  
20/20 [==============================] - 33s 2s/step - loss: 0.5865 - acc: 0.8124 - val\_loss: 0.8052 - val\_acc: 0.6389  
Epoch 16/20  
20/20 [==============================] - ETA: 0s - loss: 0.5624 - acc: 0.8271  
Epoch 16: val\_loss did not improve from 0.80034  
20/20 [==============================] - 33s 2s/step - loss: 0.5624 - acc: 0.8271 - val\_loss: 0.8778 - val\_acc: 0.5556  
Epoch 17/20  
20/20 [==============================] - ETA: 0s - loss: 0.5373 - acc: 0.8483  
Epoch 17: val\_loss improved from 0.80034 to 0.77890, saving model to chestmodel.hdf5  
20/20 [==============================] - 35s 2s/step - loss: 0.5373 - acc: 0.8483 - val\_loss: 0.7789 - val\_acc: 0.6944  
Epoch 18/20  
20/20 [==============================] - ETA: 0s - loss: 0.5240 - acc: 0.8499  
Epoch 18: val\_loss improved from 0.77890 to 0.76334, saving model to chestmodel.hdf5  
20/20 [==============================] - 35s 2s/step - loss: 0.5240 - acc: 0.8499 - val\_loss: 0.7633 - val\_acc: 0.6806  
Epoch 19/20  
20/20 [==============================] - ETA: 0s - loss: 0.4995 - acc: 0.8728  
Epoch 19: val\_loss improved from 0.76334 to 0.74831, saving model to chestmodel.hdf5  
20/20 [==============================] - 34s 2s/step - loss: 0.4995 - acc: 0.8728 - val\_loss: 0.7483 - val\_acc: 0.6944  
Epoch 20/20  
20/20 [==============================] - ETA: 0s - loss: 0.4820 - acc: 0.8728  
Epoch 20: val\_loss did not improve from 0.74831  
20/20 [==============================] - 33s 2s/step - loss: 0.4820 - acc: 0.8728 - val\_loss: 0.8165 - val\_acc: 0.6111

In [7]:

plt**.**plot(history**.**history['acc'], label **=** 'train',)  
plt**.**plot(history**.**history['val\_acc'], label **=** 'valid')  
  
plt**.**legend(loc **=** 'upper left')  
plt**.**xlabel('epochs')  
plt**.**ylabel('accuracy')  
plt**.**show()

In [8]:

result **=** first\_model**.**evaluate(test\_generator)

10/10 [==============================] - 8s 825ms/step - loss: 1.0265 - acc: 0.4635

In [9]:

image\_shape **=** (460,460,3)  
N\_CLASSES **=** 4  
BATCH\_SIZE **=** 32  
  
train\_datagen **=** ImageDataGenerator(dtype**=**'float32', preprocessing\_function**=**densenet**.**preprocess\_input)  
train\_generator **=** train\_datagen**.**flow\_from\_directory(train\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (460,460),  
 class\_mode **=** 'categorical')  
  
valid\_datagen **=** ImageDataGenerator(dtype**=**'float32', preprocessing\_function**=**densenet**.**preprocess\_input)  
valid\_generator **=** valid\_datagen**.**flow\_from\_directory(valid\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (460,460),  
 class\_mode **=** 'categorical')  
  
test\_datagen **=** ImageDataGenerator(dtype**=**'float32', preprocessing\_function**=**densenet**.**preprocess\_input)  
test\_generator **=** test\_datagen**.**flow\_from\_directory(test\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (460,460),  
 class\_mode **=** 'categorical')

Found 613 images belonging to 4 classes.  
Found 72 images belonging to 4 classes.  
Found 315 images belonging to 4 classes.

In [10]:

dense\_model **=** DenseNet201(include\_top**=False**, pooling**=**'avg', weights**=**'imagenet', input\_shape **=** (image\_shape))  
  
*# make all layers except conv5 layers not trainable*  
**for** layer **in** dense\_model**.**layers:  
 **if** 'conv5' **not** **in** layer**.**name:  
 layer**.**trainable **=** **False**

In [11]:

densenet\_model **=** Sequential()  
densenet\_model**.**add(dense\_model)  
densenet\_model**.**add(Flatten())  
densenet\_model**.**add(BatchNormalization())  
densenet\_model**.**add(Dense(N\_CLASSES, activation**=**'softmax'))  
densenet\_model**.**summary()

Model: "sequential\_1"  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
 Layer (type) Output Shape Param #   
=================================================================  
 densenet201 (Functional) (None, 1920) 18321984   
   
 flatten\_1 (Flatten) (None, 1920) 0   
   
 batch\_normalization (BatchN (None, 1920) 7680   
 ormalization)   
   
 dense\_2 (Dense) (None, 4) 7684   
   
=================================================================  
Total params: 18,337,348  
Trainable params: 6,990,084  
Non-trainable params: 11,347,264  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

In [12]:

optimizer **=** optimizers**.**Adam(learning\_rate**=** 0.00001, decay**=** 1e-6)  
densenet\_model**.**compile(optimizer**=**optimizer, loss **=** 'categorical\_crossentropy', metrics **=** ['acc'])  
  
checkpointer **=** ModelCheckpoint(filepath**=**'./chestmodel-DenseNet201.hdf5',  
 monitor**=**'val\_loss', verbose **=** 1,  
 save\_best\_only**=True**)  
early\_stopping **=** EarlyStopping(verbose**=**1, patience**=**15)

In [13]:

history\_dense **=** densenet\_model**.**fit(train\_generator,  
 steps\_per\_epoch **=** 20,  
 epochs **=** 50,  
 verbose **=** 1,  
 validation\_data **=** valid\_generator,  
 callbacks **=** [checkpointer, early\_stopping])

Epoch 1/50  
20/20 [==============================] - ETA: 0s - loss: 1.2746 - acc: 0.4241   
Epoch 1: val\_loss improved from inf to 1.35903, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 708s 34s/step - loss: 1.2746 - acc: 0.4241 - val\_loss: 1.3590 - val\_acc: 0.3056  
Epoch 2/50  
20/20 [==============================] - ETA: 0s - loss: 0.7516 - acc: 0.7096   
Epoch 2: val\_loss improved from 1.35903 to 1.25306, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 642s 32s/step - loss: 0.7516 - acc: 0.7096 - val\_loss: 1.2531 - val\_acc: 0.3611  
Epoch 3/50  
20/20 [==============================] - ETA: 0s - loss: 0.5307 - acc: 0.8548   
Epoch 3: val\_loss improved from 1.25306 to 1.16742, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 630s 33s/step - loss: 0.5307 - acc: 0.8548 - val\_loss: 1.1674 - val\_acc: 0.4306  
Epoch 4/50  
20/20 [==============================] - ETA: 0s - loss: 0.3911 - acc: 0.9315   
Epoch 4: val\_loss improved from 1.16742 to 1.07667, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 601s 30s/step - loss: 0.3911 - acc: 0.9315 - val\_loss: 1.0767 - val\_acc: 0.5278  
Epoch 5/50  
20/20 [==============================] - ETA: 0s - loss: 0.2907 - acc: 0.9608   
Epoch 5: val\_loss improved from 1.07667 to 0.98941, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 603s 31s/step - loss: 0.2907 - acc: 0.9608 - val\_loss: 0.9894 - val\_acc: 0.5417  
Epoch 6/50  
20/20 [==============================] - ETA: 0s - loss: 0.2343 - acc: 0.9739   
Epoch 6: val\_loss improved from 0.98941 to 0.90225, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 590s 30s/step - loss: 0.2343 - acc: 0.9739 - val\_loss: 0.9022 - val\_acc: 0.6389  
Epoch 7/50  
20/20 [==============================] - ETA: 0s - loss: 0.1963 - acc: 0.9804   
Epoch 7: val\_loss improved from 0.90225 to 0.81465, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 616s 32s/step - loss: 0.1963 - acc: 0.9804 - val\_loss: 0.8146 - val\_acc: 0.6667  
Epoch 8/50  
20/20 [==============================] - ETA: 0s - loss: 0.1489 - acc: 0.9918   
Epoch 8: val\_loss improved from 0.81465 to 0.75294, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 620s 31s/step - loss: 0.1489 - acc: 0.9918 - val\_loss: 0.7529 - val\_acc: 0.6806  
Epoch 9/50  
20/20 [==============================] - ETA: 0s - loss: 0.1282 - acc: 0.9935   
Epoch 9: val\_loss improved from 0.75294 to 0.69144, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 593s 30s/step - loss: 0.1282 - acc: 0.9935 - val\_loss: 0.6914 - val\_acc: 0.7083  
Epoch 10/50  
20/20 [==============================] - ETA: 0s - loss: 0.1122 - acc: 0.9984   
Epoch 10: val\_loss improved from 0.69144 to 0.62937, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 609s 30s/step - loss: 0.1122 - acc: 0.9984 - val\_loss: 0.6294 - val\_acc: 0.7361  
Epoch 11/50  
20/20 [==============================] - ETA: 0s - loss: 0.0910 - acc: 0.9967   
Epoch 11: val\_loss improved from 0.62937 to 0.58640, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 620s 32s/step - loss: 0.0910 - acc: 0.9967 - val\_loss: 0.5864 - val\_acc: 0.7639  
Epoch 12/50  
20/20 [==============================] - ETA: 0s - loss: 0.0827 - acc: 0.9967   
Epoch 12: val\_loss improved from 0.58640 to 0.53926, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 617s 31s/step - loss: 0.0827 - acc: 0.9967 - val\_loss: 0.5393 - val\_acc: 0.7778  
Epoch 13/50  
20/20 [==============================] - ETA: 0s - loss: 0.0723 - acc: 0.9984   
Epoch 13: val\_loss improved from 0.53926 to 0.50799, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 629s 32s/step - loss: 0.0723 - acc: 0.9984 - val\_loss: 0.5080 - val\_acc: 0.8194  
Epoch 14/50  
20/20 [==============================] - ETA: 0s - loss: 0.0686 - acc: 0.9984   
Epoch 14: val\_loss improved from 0.50799 to 0.48278, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 619s 31s/step - loss: 0.0686 - acc: 0.9984 - val\_loss: 0.4828 - val\_acc: 0.8333  
Epoch 15/50  
20/20 [==============================] - ETA: 0s - loss: 0.0564 - acc: 0.9984   
Epoch 15: val\_loss improved from 0.48278 to 0.46031, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 593s 30s/step - loss: 0.0564 - acc: 0.9984 - val\_loss: 0.4603 - val\_acc: 0.8472  
Epoch 16/50  
20/20 [==============================] - ETA: 0s - loss: 0.0534 - acc: 0.9967   
Epoch 16: val\_loss improved from 0.46031 to 0.43231, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 611s 30s/step - loss: 0.0534 - acc: 0.9967 - val\_loss: 0.4323 - val\_acc: 0.8611  
Epoch 17/50  
20/20 [==============================] - ETA: 0s - loss: 0.0492 - acc: 0.9984   
Epoch 17: val\_loss improved from 0.43231 to 0.40284, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 601s 30s/step - loss: 0.0492 - acc: 0.9984 - val\_loss: 0.4028 - val\_acc: 0.8750  
Epoch 18/50  
20/20 [==============================] - ETA: 0s - loss: 0.0440 - acc: 0.9984   
Epoch 18: val\_loss improved from 0.40284 to 0.38264, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 598s 30s/step - loss: 0.0440 - acc: 0.9984 - val\_loss: 0.3826 - val\_acc: 0.8750  
Epoch 19/50  
20/20 [==============================] - ETA: 0s - loss: 0.0416 - acc: 0.9984   
Epoch 19: val\_loss improved from 0.38264 to 0.36698, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 595s 30s/step - loss: 0.0416 - acc: 0.9984 - val\_loss: 0.3670 - val\_acc: 0.8889  
Epoch 20/50  
20/20 [==============================] - ETA: 0s - loss: 0.0349 - acc: 0.9984   
Epoch 20: val\_loss improved from 0.36698 to 0.35265, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 608s 30s/step - loss: 0.0349 - acc: 0.9984 - val\_loss: 0.3526 - val\_acc: 0.9028  
Epoch 21/50  
20/20 [==============================] - ETA: 0s - loss: 0.0320 - acc: 1.0000   
Epoch 21: val\_loss improved from 0.35265 to 0.34310, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 628s 32s/step - loss: 0.0320 - acc: 1.0000 - val\_loss: 0.3431 - val\_acc: 0.9028  
Epoch 22/50  
20/20 [==============================] - ETA: 0s - loss: 0.0321 - acc: 0.9984   
Epoch 22: val\_loss improved from 0.34310 to 0.33517, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 628s 32s/step - loss: 0.0321 - acc: 0.9984 - val\_loss: 0.3352 - val\_acc: 0.9028  
Epoch 23/50  
20/20 [==============================] - ETA: 0s - loss: 0.0285 - acc: 0.9984   
Epoch 23: val\_loss improved from 0.33517 to 0.33129, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 640s 32s/step - loss: 0.0285 - acc: 0.9984 - val\_loss: 0.3313 - val\_acc: 0.9028  
Epoch 24/50  
20/20 [==============================] - ETA: 0s - loss: 0.0239 - acc: 1.0000   
Epoch 24: val\_loss improved from 0.33129 to 0.32224, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 628s 32s/step - loss: 0.0239 - acc: 1.0000 - val\_loss: 0.3222 - val\_acc: 0.9167  
Epoch 25/50  
20/20 [==============================] - ETA: 0s - loss: 0.0237 - acc: 0.9984   
Epoch 25: val\_loss did not improve from 0.32224  
20/20 [==============================] - 591s 30s/step - loss: 0.0237 - acc: 0.9984 - val\_loss: 0.3256 - val\_acc: 0.9167  
Epoch 26/50  
20/20 [==============================] - ETA: 0s - loss: 0.0229 - acc: 0.9984   
Epoch 26: val\_loss did not improve from 0.32224  
20/20 [==============================] - 601s 30s/step - loss: 0.0229 - acc: 0.9984 - val\_loss: 0.3257 - val\_acc: 0.9028  
Epoch 27/50  
20/20 [==============================] - ETA: 0s - loss: 0.0239 - acc: 0.9967   
Epoch 27: val\_loss improved from 0.32224 to 0.30986, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 628s 31s/step - loss: 0.0239 - acc: 0.9967 - val\_loss: 0.3099 - val\_acc: 0.9167  
Epoch 28/50  
20/20 [==============================] - ETA: 0s - loss: 0.0199 - acc: 1.0000   
Epoch 28: val\_loss improved from 0.30986 to 0.30104, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 638s 32s/step - loss: 0.0199 - acc: 1.0000 - val\_loss: 0.3010 - val\_acc: 0.9167  
Epoch 29/50  
20/20 [==============================] - ETA: 0s - loss: 0.0254 - acc: 0.9967   
Epoch 29: val\_loss did not improve from 0.30104  
20/20 [==============================] - 594s 30s/step - loss: 0.0254 - acc: 0.9967 - val\_loss: 0.3020 - val\_acc: 0.9167  
Epoch 30/50  
20/20 [==============================] - ETA: 0s - loss: 0.0179 - acc: 0.9984   
Epoch 30: val\_loss improved from 0.30104 to 0.28376, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 602s 30s/step - loss: 0.0179 - acc: 0.9984 - val\_loss: 0.2838 - val\_acc: 0.9306  
Epoch 31/50  
20/20 [==============================] - ETA: 0s - loss: 0.0161 - acc: 1.0000   
Epoch 31: val\_loss improved from 0.28376 to 0.28088, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 606s 30s/step - loss: 0.0161 - acc: 1.0000 - val\_loss: 0.2809 - val\_acc: 0.9306  
Epoch 32/50  
20/20 [==============================] - ETA: 0s - loss: 0.0205 - acc: 0.9967   
Epoch 32: val\_loss did not improve from 0.28088  
20/20 [==============================] - 586s 30s/step - loss: 0.0205 - acc: 0.9967 - val\_loss: 0.2821 - val\_acc: 0.9306  
Epoch 33/50  
20/20 [==============================] - ETA: 0s - loss: 0.0186 - acc: 0.9967   
Epoch 33: val\_loss did not improve from 0.28088  
20/20 [==============================] - 612s 31s/step - loss: 0.0186 - acc: 0.9967 - val\_loss: 0.2826 - val\_acc: 0.9167  
Epoch 34/50  
20/20 [==============================] - ETA: 0s - loss: 0.0156 - acc: 1.0000   
Epoch 34: val\_loss improved from 0.28088 to 0.27533, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 609s 30s/step - loss: 0.0156 - acc: 1.0000 - val\_loss: 0.2753 - val\_acc: 0.9167  
Epoch 35/50  
20/20 [==============================] - ETA: 0s - loss: 0.0207 - acc: 0.9967   
Epoch 35: val\_loss did not improve from 0.27533  
20/20 [==============================] - 616s 31s/step - loss: 0.0207 - acc: 0.9967 - val\_loss: 0.2762 - val\_acc: 0.9167  
Epoch 36/50  
20/20 [==============================] - ETA: 0s - loss: 0.0152 - acc: 0.9984   
Epoch 36: val\_loss did not improve from 0.27533  
20/20 [==============================] - 606s 31s/step - loss: 0.0152 - acc: 0.9984 - val\_loss: 0.2783 - val\_acc: 0.9167  
Epoch 37/50  
20/20 [==============================] - ETA: 0s - loss: 0.0177 - acc: 0.9984   
Epoch 37: val\_loss improved from 0.27533 to 0.26709, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 594s 31s/step - loss: 0.0177 - acc: 0.9984 - val\_loss: 0.2671 - val\_acc: 0.9167  
Epoch 38/50  
20/20 [==============================] - ETA: 0s - loss: 0.0146 - acc: 0.9967   
Epoch 38: val\_loss improved from 0.26709 to 0.26631, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 589s 30s/step - loss: 0.0146 - acc: 0.9967 - val\_loss: 0.2663 - val\_acc: 0.9167  
Epoch 39/50  
20/20 [==============================] - ETA: 0s - loss: 0.0140 - acc: 0.9984   
Epoch 39: val\_loss did not improve from 0.26631  
20/20 [==============================] - 622s 31s/step - loss: 0.0140 - acc: 0.9984 - val\_loss: 0.2710 - val\_acc: 0.9167  
Epoch 40/50  
20/20 [==============================] - ETA: 0s - loss: 0.0124 - acc: 0.9984   
Epoch 40: val\_loss did not improve from 0.26631  
20/20 [==============================] - 615s 31s/step - loss: 0.0124 - acc: 0.9984 - val\_loss: 0.2667 - val\_acc: 0.9167  
Epoch 41/50  
20/20 [==============================] - ETA: 0s - loss: 0.0165 - acc: 0.9967   
Epoch 41: val\_loss improved from 0.26631 to 0.26338, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 627s 31s/step - loss: 0.0165 - acc: 0.9967 - val\_loss: 0.2634 - val\_acc: 0.9167  
Epoch 42/50  
20/20 [==============================] - ETA: 0s - loss: 0.0116 - acc: 0.9967   
Epoch 42: val\_loss did not improve from 0.26338  
20/20 [==============================] - 617s 31s/step - loss: 0.0116 - acc: 0.9967 - val\_loss: 0.2654 - val\_acc: 0.9167  
Epoch 43/50  
20/20 [==============================] - ETA: 0s - loss: 0.0105 - acc: 0.9984   
Epoch 43: val\_loss improved from 0.26338 to 0.26071, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 643s 32s/step - loss: 0.0105 - acc: 0.9984 - val\_loss: 0.2607 - val\_acc: 0.9167  
Epoch 44/50  
20/20 [==============================] - ETA: 0s - loss: 0.0107 - acc: 1.0000   
Epoch 44: val\_loss improved from 0.26071 to 0.25640, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 626s 31s/step - loss: 0.0107 - acc: 1.0000 - val\_loss: 0.2564 - val\_acc: 0.9167  
Epoch 45/50  
20/20 [==============================] - ETA: 0s - loss: 0.0138 - acc: 0.9967   
Epoch 45: val\_loss did not improve from 0.25640  
20/20 [==============================] - 569s 29s/step - loss: 0.0138 - acc: 0.9967 - val\_loss: 0.2607 - val\_acc: 0.9167  
Epoch 46/50  
20/20 [==============================] - ETA: 0s - loss: 0.0185 - acc: 0.9967   
Epoch 46: val\_loss improved from 0.25640 to 0.24892, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 629s 32s/step - loss: 0.0185 - acc: 0.9967 - val\_loss: 0.2489 - val\_acc: 0.9306  
Epoch 47/50  
20/20 [==============================] - ETA: 0s - loss: 0.0088 - acc: 1.0000   
Epoch 47: val\_loss improved from 0.24892 to 0.24080, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 643s 32s/step - loss: 0.0088 - acc: 1.0000 - val\_loss: 0.2408 - val\_acc: 0.9306  
Epoch 48/50  
20/20 [==============================] - ETA: 0s - loss: 0.0105 - acc: 0.9984   
Epoch 48: val\_loss did not improve from 0.24080  
20/20 [==============================] - 606s 31s/step - loss: 0.0105 - acc: 0.9984 - val\_loss: 0.2438 - val\_acc: 0.9306  
Epoch 49/50  
20/20 [==============================] - ETA: 0s - loss: 0.0127 - acc: 0.9967   
Epoch 49: val\_loss did not improve from 0.24080  
20/20 [==============================] - 628s 31s/step - loss: 0.0127 - acc: 0.9967 - val\_loss: 0.2420 - val\_acc: 0.9167  
Epoch 50/50  
20/20 [==============================] - ETA: 0s - loss: 0.0103 - acc: 0.9984   
Epoch 50: val\_loss improved from 0.24080 to 0.23717, saving model to .\chestmodel-DenseNet201.hdf5  
20/20 [==============================] - 638s 32s/step - loss: 0.0103 - acc: 0.9984 - val\_loss: 0.2372 - val\_acc: 0.9306

In [14]:

plt**.**plot(history\_dense**.**history['acc'], label **=** 'train',)  
plt**.**plot(history\_dense**.**history['val\_acc'], label **=** 'valid')  
  
plt**.**legend(loc **=** 'upper left')  
plt**.**xlabel('epochs')  
plt**.**ylabel('accuracy')  
plt**.**show()

In [15]:

dns\_result **=** densenet\_model**.**evaluate(test\_generator)

10/10 [==============================] - 260s 26s/step - loss: 0.6689 - acc: 0.7587

In [16]:

image\_shape **=** (460,460,3)  
N\_CLASSES **=** 4  
BATCH\_SIZE **=** 32  
  
train\_datagen **=** ImageDataGenerator(dtype**=**'float32')  
train\_generator **=** train\_datagen**.**flow\_from\_directory(train\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (460,460),  
 class\_mode **=** 'categorical')  
  
valid\_datagen **=** ImageDataGenerator(dtype**=**'float32')  
valid\_generator **=** valid\_datagen**.**flow\_from\_directory(valid\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (460,460),  
 class\_mode **=** 'categorical')  
  
test\_datagen **=** ImageDataGenerator(dtype**=**'float32')  
test\_generator **=** test\_datagen**.**flow\_from\_directory(test\_path,  
 batch\_size **=** BATCH\_SIZE,  
 target\_size **=** (460,460),  
 class\_mode **=** 'categorical')

Found 613 images belonging to 4 classes.  
Found 72 images belonging to 4 classes.  
Found 315 images belonging to 4 classes.

In [17]:

res\_model **=** ResNet50(include\_top**=False**, pooling**=**'avg', weights**=**'imagenet', input\_shape **=** (image\_shape))  
  
*# make all layers except conv5 layers not trainable*  
**for** layer **in** res\_model**.**layers:  
 **if** 'conv5' **not** **in** layer**.**name:  
 layer**.**trainable **=** **False**

In [18]:

resnet\_model **=** Sequential()  
resnet\_model**.**add(res\_model)  
resnet\_model**.**add(Dropout(0.4))  
resnet\_model**.**add(Flatten())  
resnet\_model**.**add(BatchNormalization())  
resnet\_model**.**add(Dropout(0.4))  
resnet\_model**.**add(Dense(N\_CLASSES, activation**=**'softmax'))  
resnet\_model**.**summary()

Model: "sequential\_2"  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
 Layer (type) Output Shape Param #   
=================================================================  
 resnet50 (Functional) (None, 2048) 23587712   
   
 dropout\_2 (Dropout) (None, 2048) 0   
   
 flatten\_2 (Flatten) (None, 2048) 0   
   
 batch\_normalization\_1 (Batc (None, 2048) 8192   
 hNormalization)   
   
 dropout\_3 (Dropout) (None, 2048) 0   
   
 dense\_3 (Dense) (None, 4) 8196   
   
=================================================================  
Total params: 23,604,100  
Trainable params: 14,988,292  
Non-trainable params: 8,615,808  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

In [19]:

optimizer **=** optimizers**.**Adam(learning\_rate**=** 0.00001, decay**=** 1e-5)  
resnet\_model**.**compile(optimizer**=**optimizer, loss **=** 'categorical\_crossentropy', metrics **=** ['acc'])

In [20]:

checkpointer **=** ModelCheckpoint(filepath**=**'./finalmodel-ResNet50.hdf5',  
 monitor**=**'val\_loss', verbose **=** 1,  
 save\_best\_only**=True**)  
early\_stopping **=** EarlyStopping(verbose**=**1, patience**=**20)

In [21]:

history\_res **=** resnet\_model**.**fit(train\_generator,  
 steps\_per\_epoch **=** 20,  
 epochs **=** 120,  
 verbose **=** 1,  
 validation\_data **=** valid\_generator,  
 callbacks **=** [checkpointer, early\_stopping])

Epoch 1/120  
20/20 [==============================] - ETA: 0s - loss: 1.9557 - acc: 0.3230   
Epoch 1: val\_loss improved from inf to 1.33971, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 532s 26s/step - loss: 1.9557 - acc: 0.3230 - val\_loss: 1.3397 - val\_acc: 0.3333  
Epoch 2/120  
20/20 [==============================] - ETA: 0s - loss: 1.4095 - acc: 0.4682   
Epoch 2: val\_loss improved from 1.33971 to 1.19159, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 521s 26s/step - loss: 1.4095 - acc: 0.4682 - val\_loss: 1.1916 - val\_acc: 0.4028  
Epoch 3/120  
20/20 [==============================] - ETA: 0s - loss: 1.2018 - acc: 0.5710   
Epoch 3: val\_loss improved from 1.19159 to 1.07681, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 508s 25s/step - loss: 1.2018 - acc: 0.5710 - val\_loss: 1.0768 - val\_acc: 0.4722  
Epoch 4/120  
20/20 [==============================] - ETA: 0s - loss: 1.0002 - acc: 0.6264   
Epoch 4: val\_loss improved from 1.07681 to 0.97091, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 519s 26s/step - loss: 1.0002 - acc: 0.6264 - val\_loss: 0.9709 - val\_acc: 0.5417  
Epoch 5/120  
20/20 [==============================] - ETA: 0s - loss: 0.8125 - acc: 0.7015   
Epoch 5: val\_loss improved from 0.97091 to 0.88884, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 500s 25s/step - loss: 0.8125 - acc: 0.7015 - val\_loss: 0.8888 - val\_acc: 0.5694  
Epoch 6/120  
20/20 [==============================] - ETA: 0s - loss: 0.6337 - acc: 0.7553   
Epoch 6: val\_loss improved from 0.88884 to 0.84350, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 499s 25s/step - loss: 0.6337 - acc: 0.7553 - val\_loss: 0.8435 - val\_acc: 0.6111  
Epoch 7/120  
20/20 [==============================] - ETA: 0s - loss: 0.6471 - acc: 0.7651   
Epoch 7: val\_loss improved from 0.84350 to 0.77393, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 500s 25s/step - loss: 0.6471 - acc: 0.7651 - val\_loss: 0.7739 - val\_acc: 0.6389  
Epoch 8/120  
20/20 [==============================] - ETA: 0s - loss: 0.5611 - acc: 0.7928   
Epoch 8: val\_loss improved from 0.77393 to 0.71159, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 498s 25s/step - loss: 0.5611 - acc: 0.7928 - val\_loss: 0.7116 - val\_acc: 0.6944  
Epoch 9/120  
20/20 [==============================] - ETA: 0s - loss: 0.4349 - acc: 0.8222   
Epoch 9: val\_loss improved from 0.71159 to 0.64038, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 487s 25s/step - loss: 0.4349 - acc: 0.8222 - val\_loss: 0.6404 - val\_acc: 0.7361  
Epoch 10/120  
20/20 [==============================] - ETA: 0s - loss: 0.3709 - acc: 0.8564   
Epoch 10: val\_loss improved from 0.64038 to 0.59664, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 498s 25s/step - loss: 0.3709 - acc: 0.8564 - val\_loss: 0.5966 - val\_acc: 0.7500  
Epoch 11/120  
20/20 [==============================] - ETA: 0s - loss: 0.3226 - acc: 0.8891   
Epoch 11: val\_loss improved from 0.59664 to 0.55275, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 487s 24s/step - loss: 0.3226 - acc: 0.8891 - val\_loss: 0.5527 - val\_acc: 0.7917  
Epoch 12/120  
20/20 [==============================] - ETA: 0s - loss: 0.3117 - acc: 0.8891   
Epoch 12: val\_loss improved from 0.55275 to 0.52780, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 505s 25s/step - loss: 0.3117 - acc: 0.8891 - val\_loss: 0.5278 - val\_acc: 0.8056  
Epoch 13/120  
20/20 [==============================] - ETA: 0s - loss: 0.2599 - acc: 0.9086   
Epoch 13: val\_loss improved from 0.52780 to 0.49260, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 484s 25s/step - loss: 0.2599 - acc: 0.9086 - val\_loss: 0.4926 - val\_acc: 0.8333  
Epoch 14/120  
20/20 [==============================] - ETA: 0s - loss: 0.2654 - acc: 0.9086   
Epoch 14: val\_loss improved from 0.49260 to 0.48418, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 545s 27s/step - loss: 0.2654 - acc: 0.9086 - val\_loss: 0.4842 - val\_acc: 0.8333  
Epoch 15/120  
20/20 [==============================] - ETA: 0s - loss: 0.1961 - acc: 0.9364   
Epoch 15: val\_loss improved from 0.48418 to 0.46820, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 506s 25s/step - loss: 0.1961 - acc: 0.9364 - val\_loss: 0.4682 - val\_acc: 0.8611  
Epoch 16/120  
20/20 [==============================] - ETA: 0s - loss: 0.1554 - acc: 0.9429   
Epoch 16: val\_loss improved from 0.46820 to 0.44889, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 521s 26s/step - loss: 0.1554 - acc: 0.9429 - val\_loss: 0.4489 - val\_acc: 0.8611  
Epoch 17/120  
20/20 [==============================] - ETA: 0s - loss: 0.1622 - acc: 0.9592   
Epoch 17: val\_loss improved from 0.44889 to 0.43298, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 492s 25s/step - loss: 0.1622 - acc: 0.9592 - val\_loss: 0.4330 - val\_acc: 0.8611  
Epoch 18/120  
20/20 [==============================] - ETA: 0s - loss: 0.1575 - acc: 0.9462   
Epoch 18: val\_loss improved from 0.43298 to 0.42063, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 497s 25s/step - loss: 0.1575 - acc: 0.9462 - val\_loss: 0.4206 - val\_acc: 0.8611  
Epoch 19/120  
20/20 [==============================] - ETA: 0s - loss: 0.1392 - acc: 0.9576   
Epoch 19: val\_loss improved from 0.42063 to 0.40932, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 478s 24s/step - loss: 0.1392 - acc: 0.9576 - val\_loss: 0.4093 - val\_acc: 0.8889  
Epoch 20/120  
20/20 [==============================] - ETA: 0s - loss: 0.1247 - acc: 0.9690   
Epoch 20: val\_loss did not improve from 0.40932  
20/20 [==============================] - 511s 26s/step - loss: 0.1247 - acc: 0.9690 - val\_loss: 0.4240 - val\_acc: 0.8611  
Epoch 21/120  
20/20 [==============================] - ETA: 0s - loss: 0.1247 - acc: 0.9592   
Epoch 21: val\_loss improved from 0.40932 to 0.40632, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 513s 26s/step - loss: 0.1247 - acc: 0.9592 - val\_loss: 0.4063 - val\_acc: 0.8611  
Epoch 22/120  
20/20 [==============================] - ETA: 0s - loss: 0.1149 - acc: 0.9674   
Epoch 22: val\_loss improved from 0.40632 to 0.37583, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 489s 24s/step - loss: 0.1149 - acc: 0.9674 - val\_loss: 0.3758 - val\_acc: 0.8611  
Epoch 23/120  
20/20 [==============================] - ETA: 0s - loss: 0.0667 - acc: 0.9869   
Epoch 23: val\_loss improved from 0.37583 to 0.36980, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 491s 25s/step - loss: 0.0667 - acc: 0.9869 - val\_loss: 0.3698 - val\_acc: 0.8750  
Epoch 24/120  
20/20 [==============================] - ETA: 0s - loss: 0.1119 - acc: 0.9657   
Epoch 24: val\_loss did not improve from 0.36980  
20/20 [==============================] - 510s 26s/step - loss: 0.1119 - acc: 0.9657 - val\_loss: 0.3781 - val\_acc: 0.8611  
Epoch 25/120  
20/20 [==============================] - ETA: 0s - loss: 0.0724 - acc: 0.9821   
Epoch 25: val\_loss did not improve from 0.36980  
20/20 [==============================] - 508s 26s/step - loss: 0.0724 - acc: 0.9821 - val\_loss: 0.3757 - val\_acc: 0.8889  
Epoch 26/120  
20/20 [==============================] - ETA: 0s - loss: 0.0703 - acc: 0.9821   
Epoch 26: val\_loss did not improve from 0.36980  
20/20 [==============================] - 478s 24s/step - loss: 0.0703 - acc: 0.9821 - val\_loss: 0.3735 - val\_acc: 0.8889  
Epoch 27/120  
20/20 [==============================] - ETA: 0s - loss: 0.0568 - acc: 0.9837   
Epoch 27: val\_loss did not improve from 0.36980  
20/20 [==============================] - 520s 26s/step - loss: 0.0568 - acc: 0.9837 - val\_loss: 0.3766 - val\_acc: 0.8889  
Epoch 28/120  
20/20 [==============================] - ETA: 0s - loss: 0.0566 - acc: 0.9853   
Epoch 28: val\_loss did not improve from 0.36980  
20/20 [==============================] - 489s 25s/step - loss: 0.0566 - acc: 0.9853 - val\_loss: 0.3914 - val\_acc: 0.8611  
Epoch 29/120  
20/20 [==============================] - ETA: 0s - loss: 0.0586 - acc: 0.9837   
Epoch 29: val\_loss did not improve from 0.36980  
20/20 [==============================] - 517s 26s/step - loss: 0.0586 - acc: 0.9837 - val\_loss: 0.3775 - val\_acc: 0.8750  
Epoch 30/120  
20/20 [==============================] - ETA: 0s - loss: 0.0459 - acc: 0.9853   
Epoch 30: val\_loss improved from 0.36980 to 0.36845, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 519s 26s/step - loss: 0.0459 - acc: 0.9853 - val\_loss: 0.3685 - val\_acc: 0.8750  
Epoch 31/120  
20/20 [==============================] - ETA: 0s - loss: 0.0332 - acc: 0.9967   
Epoch 31: val\_loss improved from 0.36845 to 0.36685, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 510s 27s/step - loss: 0.0332 - acc: 0.9967 - val\_loss: 0.3668 - val\_acc: 0.8611  
Epoch 32/120  
20/20 [==============================] - ETA: 0s - loss: 0.0443 - acc: 0.9869   
Epoch 32: val\_loss improved from 0.36685 to 0.35232, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 528s 26s/step - loss: 0.0443 - acc: 0.9869 - val\_loss: 0.3523 - val\_acc: 0.9028  
Epoch 33/120  
20/20 [==============================] - ETA: 0s - loss: 0.0488 - acc: 0.9951   
Epoch 33: val\_loss improved from 0.35232 to 0.33483, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 492s 24s/step - loss: 0.0488 - acc: 0.9951 - val\_loss: 0.3348 - val\_acc: 0.9028  
Epoch 34/120  
20/20 [==============================] - ETA: 0s - loss: 0.0317 - acc: 0.9935   
Epoch 34: val\_loss improved from 0.33483 to 0.32357, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 514s 26s/step - loss: 0.0317 - acc: 0.9935 - val\_loss: 0.3236 - val\_acc: 0.9028  
Epoch 35/120  
20/20 [==============================] - ETA: 0s - loss: 0.0426 - acc: 0.9918   
Epoch 35: val\_loss improved from 0.32357 to 0.31923, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 508s 26s/step - loss: 0.0426 - acc: 0.9918 - val\_loss: 0.3192 - val\_acc: 0.9028  
Epoch 36/120  
20/20 [==============================] - ETA: 0s - loss: 0.0359 - acc: 0.9886   
Epoch 36: val\_loss improved from 0.31923 to 0.31005, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 498s 25s/step - loss: 0.0359 - acc: 0.9886 - val\_loss: 0.3101 - val\_acc: 0.9167  
Epoch 37/120  
20/20 [==============================] - ETA: 0s - loss: 0.0376 - acc: 0.9918   
Epoch 37: val\_loss did not improve from 0.31005  
20/20 [==============================] - 496s 25s/step - loss: 0.0376 - acc: 0.9918 - val\_loss: 0.3135 - val\_acc: 0.9167  
Epoch 38/120  
20/20 [==============================] - ETA: 0s - loss: 0.0324 - acc: 0.9918   
Epoch 38: val\_loss did not improve from 0.31005  
20/20 [==============================] - 511s 26s/step - loss: 0.0324 - acc: 0.9918 - val\_loss: 0.3174 - val\_acc: 0.9167  
Epoch 39/120  
20/20 [==============================] - ETA: 0s - loss: 0.0271 - acc: 0.9951   
Epoch 39: val\_loss did not improve from 0.31005  
20/20 [==============================] - 500s 25s/step - loss: 0.0271 - acc: 0.9951 - val\_loss: 0.3160 - val\_acc: 0.9028  
Epoch 40/120  
20/20 [==============================] - ETA: 0s - loss: 0.0232 - acc: 0.9967   
Epoch 40: val\_loss did not improve from 0.31005  
20/20 [==============================] - 518s 26s/step - loss: 0.0232 - acc: 0.9967 - val\_loss: 0.3185 - val\_acc: 0.9028  
Epoch 41/120  
20/20 [==============================] - ETA: 0s - loss: 0.0170 - acc: 0.9967   
Epoch 41: val\_loss did not improve from 0.31005  
20/20 [==============================] - 475s 24s/step - loss: 0.0170 - acc: 0.9967 - val\_loss: 0.3135 - val\_acc: 0.9028  
Epoch 42/120  
20/20 [==============================] - ETA: 0s - loss: 0.0224 - acc: 0.9967   
Epoch 42: val\_loss improved from 0.31005 to 0.30549, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 504s 25s/step - loss: 0.0224 - acc: 0.9967 - val\_loss: 0.3055 - val\_acc: 0.9167  
Epoch 43/120  
20/20 [==============================] - ETA: 0s - loss: 0.0201 - acc: 0.9951   
Epoch 43: val\_loss did not improve from 0.30549  
20/20 [==============================] - 484s 25s/step - loss: 0.0201 - acc: 0.9951 - val\_loss: 0.3123 - val\_acc: 0.9167  
Epoch 44/120  
20/20 [==============================] - ETA: 0s - loss: 0.0263 - acc: 0.9951   
Epoch 44: val\_loss did not improve from 0.30549  
20/20 [==============================] - 513s 26s/step - loss: 0.0263 - acc: 0.9951 - val\_loss: 0.3070 - val\_acc: 0.9167  
Epoch 45/120  
20/20 [==============================] - ETA: 0s - loss: 0.0167 - acc: 0.9967   
Epoch 45: val\_loss improved from 0.30549 to 0.29482, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 509s 25s/step - loss: 0.0167 - acc: 0.9967 - val\_loss: 0.2948 - val\_acc: 0.9167  
Epoch 46/120  
20/20 [==============================] - ETA: 0s - loss: 0.0211 - acc: 0.9967   
Epoch 46: val\_loss improved from 0.29482 to 0.29021, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 547s 27s/step - loss: 0.0211 - acc: 0.9967 - val\_loss: 0.2902 - val\_acc: 0.9028  
Epoch 47/120  
20/20 [==============================] - ETA: 0s - loss: 0.0419 - acc: 0.9902   
Epoch 47: val\_loss improved from 0.29021 to 0.27402, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 484s 25s/step - loss: 0.0419 - acc: 0.9902 - val\_loss: 0.2740 - val\_acc: 0.9444  
Epoch 48/120  
20/20 [==============================] - ETA: 0s - loss: 0.0260 - acc: 0.9951   
Epoch 48: val\_loss did not improve from 0.27402  
20/20 [==============================] - 503s 25s/step - loss: 0.0260 - acc: 0.9951 - val\_loss: 0.3173 - val\_acc: 0.8889  
Epoch 49/120  
20/20 [==============================] - ETA: 0s - loss: 0.0259 - acc: 0.9918   
Epoch 49: val\_loss did not improve from 0.27402  
20/20 [==============================] - 475s 24s/step - loss: 0.0259 - acc: 0.9918 - val\_loss: 0.3326 - val\_acc: 0.8889  
Epoch 50/120  
20/20 [==============================] - ETA: 0s - loss: 0.0308 - acc: 0.9951   
Epoch 50: val\_loss did not improve from 0.27402  
20/20 [==============================] - 509s 26s/step - loss: 0.0308 - acc: 0.9951 - val\_loss: 0.3396 - val\_acc: 0.9028  
Epoch 51/120  
20/20 [==============================] - ETA: 0s - loss: 0.0204 - acc: 0.9951   
Epoch 51: val\_loss did not improve from 0.27402  
20/20 [==============================] - 493s 25s/step - loss: 0.0204 - acc: 0.9951 - val\_loss: 0.3093 - val\_acc: 0.9306  
Epoch 52/120  
20/20 [==============================] - ETA: 0s - loss: 0.0184 - acc: 0.9967   
Epoch 52: val\_loss did not improve from 0.27402  
20/20 [==============================] - 503s 25s/step - loss: 0.0184 - acc: 0.9967 - val\_loss: 0.2776 - val\_acc: 0.9444  
Epoch 53/120  
20/20 [==============================] - ETA: 0s - loss: 0.0179 - acc: 0.9935   
Epoch 53: val\_loss did not improve from 0.27402  
20/20 [==============================] - 479s 24s/step - loss: 0.0179 - acc: 0.9935 - val\_loss: 0.2784 - val\_acc: 0.9167  
Epoch 54/120  
20/20 [==============================] - ETA: 0s - loss: 0.0211 - acc: 0.9935   
Epoch 54: val\_loss did not improve from 0.27402  
20/20 [==============================] - 520s 26s/step - loss: 0.0211 - acc: 0.9935 - val\_loss: 0.2750 - val\_acc: 0.9167  
Epoch 55/120  
20/20 [==============================] - ETA: 0s - loss: 0.0214 - acc: 0.9951   
Epoch 55: val\_loss improved from 0.27402 to 0.27154, saving model to .\finalmodel-ResNet50.hdf5  
20/20 [==============================] - 506s 26s/step - loss: 0.0214 - acc: 0.9951 - val\_loss: 0.2715 - val\_acc: 0.9028  
Epoch 56/120  
20/20 [==============================] - ETA: 0s - loss: 0.0152 - acc: 0.9984   
Epoch 56: val\_loss did not improve from 0.27154  
20/20 [==============================] - 571s 29s/step - loss: 0.0152 - acc: 0.9984 - val\_loss: 0.2809 - val\_acc: 0.9167  
Epoch 57/120  
20/20 [==============================] - ETA: 0s - loss: 0.0183 - acc: 0.9918   
Epoch 57: val\_loss did not improve from 0.27154  
20/20 [==============================] - 580s 29s/step - loss: 0.0183 - acc: 0.9918 - val\_loss: 0.2982 - val\_acc: 0.9167  
Epoch 58/120  
20/20 [==============================] - ETA: 0s - loss: 0.0133 - acc: 0.9951   
Epoch 58: val\_loss did not improve from 0.27154  
20/20 [==============================] - 542s 28s/step - loss: 0.0133 - acc: 0.9951 - val\_loss: 0.2894 - val\_acc: 0.9167  
Epoch 59/120  
20/20 [==============================] - ETA: 0s - loss: 0.0169 - acc: 0.9967   
Epoch 59: val\_loss did not improve from 0.27154  
20/20 [==============================] - 513s 27s/step - loss: 0.0169 - acc: 0.9967 - val\_loss: 0.2902 - val\_acc: 0.9167  
Epoch 60/120  
20/20 [==============================] - ETA: 0s - loss: 0.0192 - acc: 0.9951   
Epoch 60: val\_loss did not improve from 0.27154  
20/20 [==============================] - 540s 28s/step - loss: 0.0192 - acc: 0.9951 - val\_loss: 0.3008 - val\_acc: 0.9028  
Epoch 61/120  
20/20 [==============================] - ETA: 0s - loss: 0.0192 - acc: 0.9935   
Epoch 61: val\_loss did not improve from 0.27154  
20/20 [==============================] - 517s 26s/step - loss: 0.0192 - acc: 0.9935 - val\_loss: 0.3044 - val\_acc: 0.9028  
Epoch 62/120  
20/20 [==============================] - ETA: 0s - loss: 0.0094 - acc: 0.9984   
Epoch 62: val\_loss did not improve from 0.27154  
20/20 [==============================] - 534s 27s/step - loss: 0.0094 - acc: 0.9984 - val\_loss: 0.3135 - val\_acc: 0.9028  
Epoch 63/120  
20/20 [==============================] - ETA: 0s - loss: 0.0143 - acc: 0.9951   
Epoch 63: val\_loss did not improve from 0.27154  
20/20 [==============================] - 601s 30s/step - loss: 0.0143 - acc: 0.9951 - val\_loss: 0.3160 - val\_acc: 0.9028  
Epoch 64/120  
20/20 [==============================] - ETA: 0s - loss: 0.0153 - acc: 0.9967   
Epoch 64: val\_loss did not improve from 0.27154  
20/20 [==============================] - 594s 30s/step - loss: 0.0153 - acc: 0.9967 - val\_loss: 0.3187 - val\_acc: 0.9028  
Epoch 65/120  
20/20 [==============================] - ETA: 0s - loss: 0.0188 - acc: 0.9951   
Epoch 65: val\_loss did not improve from 0.27154  
20/20 [==============================] - 582s 29s/step - loss: 0.0188 - acc: 0.9951 - val\_loss: 0.2861 - val\_acc: 0.9306  
Epoch 66/120  
20/20 [==============================] - ETA: 0s - loss: 0.0119 - acc: 0.9967   
Epoch 66: val\_loss did not improve from 0.27154  
20/20 [==============================] - 572s 29s/step - loss: 0.0119 - acc: 0.9967 - val\_loss: 0.2849 - val\_acc: 0.9167  
Epoch 67/120  
20/20 [==============================] - ETA: 0s - loss: 0.0247 - acc: 0.9967   
Epoch 67: val\_loss did not improve from 0.27154  
20/20 [==============================] - 568s 29s/step - loss: 0.0247 - acc: 0.9967 - val\_loss: 0.3152 - val\_acc: 0.8889  
Epoch 68/120  
20/20 [==============================] - ETA: 0s - loss: 0.0188 - acc: 0.9951   
Epoch 68: val\_loss did not improve from 0.27154  
20/20 [==============================] - 557s 28s/step - loss: 0.0188 - acc: 0.9951 - val\_loss: 0.3169 - val\_acc: 0.8889  
Epoch 69/120  
20/20 [==============================] - ETA: 0s - loss: 0.0131 - acc: 0.9951   
Epoch 69: val\_loss did not improve from 0.27154  
20/20 [==============================] - 557s 28s/step - loss: 0.0131 - acc: 0.9951 - val\_loss: 0.3040 - val\_acc: 0.9028  
Epoch 70/120  
20/20 [==============================] - ETA: 0s - loss: 0.0164 - acc: 0.9935   
Epoch 70: val\_loss did not improve from 0.27154  
20/20 [==============================] - 579s 29s/step - loss: 0.0164 - acc: 0.9935 - val\_loss: 0.3317 - val\_acc: 0.9028  
Epoch 71/120  
20/20 [==============================] - ETA: 0s - loss: 0.0102 - acc: 0.9984   
Epoch 71: val\_loss did not improve from 0.27154  
20/20 [==============================] - 562s 28s/step - loss: 0.0102 - acc: 0.9984 - val\_loss: 0.3509 - val\_acc: 0.8750  
Epoch 72/120  
20/20 [==============================] - ETA: 0s - loss: 0.0119 - acc: 0.9967   
Epoch 72: val\_loss did not improve from 0.27154  
20/20 [==============================] - 569s 29s/step - loss: 0.0119 - acc: 0.9967 - val\_loss: 0.3506 - val\_acc: 0.8750  
Epoch 73/120  
20/20 [==============================] - ETA: 0s - loss: 0.0182 - acc: 0.9967   
Epoch 73: val\_loss did not improve from 0.27154  
20/20 [==============================] - 553s 28s/step - loss: 0.0182 - acc: 0.9967 - val\_loss: 0.3481 - val\_acc: 0.8750  
Epoch 74/120  
20/20 [==============================] - ETA: 0s - loss: 0.0196 - acc: 0.9951   
Epoch 74: val\_loss did not improve from 0.27154  
20/20 [==============================] - 568s 29s/step - loss: 0.0196 - acc: 0.9951 - val\_loss: 0.3932 - val\_acc: 0.8889  
Epoch 75/120  
20/20 [==============================] - ETA: 0s - loss: 0.0136 - acc: 0.9984   
Epoch 75: val\_loss did not improve from 0.27154  
20/20 [==============================] - 544s 27s/step - loss: 0.0136 - acc: 0.9984 - val\_loss: 0.3881 - val\_acc: 0.8889  
Epoch 75: early stopping

In [22]:

plt**.**plot(history\_res**.**history['acc'], label **=** 'train',)  
plt**.**plot(history\_res**.**history['val\_acc'], label **=** 'valid')  
  
plt**.**legend(loc **=** 'upper left')  
plt**.**xlabel('epochs')  
plt**.**ylabel('accuracy')  
plt**.**show()

In [23]:

result **=** resnet\_model**.**evaluate(test\_generator)

10/10 [==============================] - 190s 20s/step - loss: 0.6706 - acc: 0.8254

In [24]:

**from** keras.models **import** load\_model  
resnet50\_model **=** load\_model('finalmodel-ResNet50.hdf5')

In [25]:

paths **=** ["data/test/adenocarcinoma/", "data/test/large.cell.carcinoma/", "data/test/normal/", "data/test/squamous.cell.carcinoma/"]  
results **=** {"adeno":{0:0, 1:0, 2:0, 3:0},  
 "large":{0:0, 1:0, 2:0, 3:0},  
 "normal":{0:0, 1:0, 2:0, 3:0},  
 "squamous":{0:0, 1:0, 2:0, 3:0}}  
  
**for** path, key **in** zip(paths, results**.**keys()):  
   
 **for** file **in** os**.**listdir(path):  
 img **=** tf**.**keras**.**utils**.**load\_img(  
 (path **+** file), target\_size**=**(460, 460)  
 )  
 img\_array **=** tf**.**keras**.**utils**.**img\_to\_array(img)  
 img\_array **=** tf**.**expand\_dims(img\_array, 0)  
 prediction **=** resnet50\_model**.**predict(img\_array, verbose**=**0)  
 results[key][np**.**argmax(prediction)] **=** results**.**get(key)**.**get(np**.**argmax(prediction),0) **+** 1  
  
results

Out[25]:

{'adeno': {0: 70, 1: 9, 2: 1, 3: 40},  
 'large': {0: 8, 1: 36, 2: 0, 3: 7},  
 'normal': {0: 0, 1: 0, 2: 54, 3: 0},  
 'squamous': {0: 2, 1: 1, 2: 0, 3: 87}}

In [26]:

df **=** pd**.**DataFrame(results)  
  
print("Overall accuracy is : {:.2f}%\n"**.**format((df["adeno"][0] **+** df["large"][1] **+** df["normal"][2] **+** df["squamous"][3]) **/** 315 **\*** 100))  
  
print("Adeno cancer detection accuracy is : {:.2f}%"**.**format(df["adeno"][0] **/** df["adeno"]**.**sum() **\*** 100))  
print("Large cell cancer detection accuracy is : {:.2f}%"**.**format(df["large"][1] **/** df["large"]**.**sum() **\*** 100))  
print("Normal chest detection accuracy is : {:.2f}%"**.**format(df["normal"][2] **/** df["normal"]**.**sum() **\*** 100))  
print("Squamous cell cancer detection accuracy is : {:.2f}%"**.**format(df["squamous"][3] **/** df["squamous"]**.**sum() **\*** 100))  
  
print("\nConfusion Matrix :")  
df**.**transpose()

Overall accuracy is : 78.41%  
  
Adeno cancer detection accuracy is : 58.33%  
Large cell cancer detection accuracy is : 70.59%  
Normal chest detection accuracy is : 100.00%  
Squamous cell cancer detection accuracy is : 96.67%  
  
Confusion Matrix :

Out[26]:

|  | **0** | **1** | **2** | **3** |
| --- | --- | --- | --- | --- |
| **adeno** | 70 | 9 | 1 | 40 |
| **large** | 8 | 36 | 0 | 7 |
| **normal** | 0 | 0 | 54 | 0 |
| **squamous** | 2 | 1 | 0 | 87 |

In [38]:

confusion\_matrix **=** df**.**transpose()  
  
**import** numpy **as** np  
  
confusion\_matrix **=** np**.**array(confusion\_matrix)  
  
precision **=** np**.**diag(confusion\_matrix) **/** np**.**sum(confusion\_matrix, axis**=**0)  
  
recall **=** np**.**diag(confusion\_matrix) **/** np**.**sum(confusion\_matrix, axis**=**1)  
  
f1\_score **=** 2 **\*** precision **\*** recall **/** (precision **+** recall)  
  
row\_names **=** ["adeno", "large", "normal", "squamous"]  
**for** i **in** range(len(row\_names)):  
 print(f"Class {row\_names[i]}: Precision = {precision[i]:.2f}, Recall = {recall[i]:.2f}, F1 score = {f1\_score[i]:.2f}")

Class adeno: Precision = 0.88, Recall = 0.58, F1 score = 0.70  
Class large: Precision = 0.78, Recall = 0.71, F1 score = 0.74  
Class normal: Precision = 0.98, Recall = 1.00, F1 score = 0.99  
Class squamous: Precision = 0.65, Recall = 0.97, F1 score = 0.78

In [27]:

img\_path **=** "data/test/squamous.cell.carcinoma/000111.png"  
  
class\_names**=**list(test\_generator**.**class\_indices**.**keys())  
  
img **=** tf**.**keras**.**utils**.**load\_img(img\_path, target\_size**=**(460, 460))  
img\_array **=** tf**.**keras**.**utils**.**img\_to\_array(img)  
img\_array **=** tf**.**expand\_dims(img\_array, 0)  
  
prediction **=** resnet50\_model**.**predict(img\_array)  
  
print(  
 "This image most likely belongs to {} with a {:.2f} percent confidence."  
 **.**format(class\_names[np**.**argmax(prediction)], 100 **\*** np**.**max(prediction))  
)

1/1 [==============================] - 1s 584ms/step  
This image most likely belongs to squamous.cell.carcinoma with a 99.79 percent confidence.

In [28]:

img\_path **=** "data/test/adenocarcinoma/000115.png"  
  
class\_names**=**list(test\_generator**.**class\_indices**.**keys())  
  
img **=** tf**.**keras**.**utils**.**load\_img(img\_path, target\_size**=**(460, 460))  
img\_array **=** tf**.**keras**.**utils**.**img\_to\_array(img)  
img\_array **=** tf**.**expand\_dims(img\_array, 0)  
  
prediction **=** resnet50\_model**.**predict(img\_array)  
  
print(  
 "This image most likely belongs to {} with a {:.2f} percent confidence."  
 **.**format(class\_names[np**.**argmax(prediction)], 100 **\*** np**.**max(prediction))  
)

1/1 [==============================] - 1s 680ms/step  
This image most likely belongs to squamous.cell.carcinoma with a 53.72 percent confidence.

In [29]:

img\_path **=** "data/test/large.cell.carcinoma/000126.png"  
  
class\_names**=**list(test\_generator**.**class\_indices**.**keys())  
  
img **=** tf**.**keras**.**utils**.**load\_img(img\_path, target\_size**=**(460, 460))  
img\_array **=** tf**.**keras**.**utils**.**img\_to\_array(img)  
img\_array **=** tf**.**expand\_dims(img\_array, 0)  
  
prediction **=** resnet50\_model**.**predict(img\_array)  
  
print(  
 "This image most likely belongs to {} with a {:.2f} percent confidence."  
 **.**format(class\_names[np**.**argmax(prediction)], 100 **\*** np**.**max(prediction))  
)

1/1 [==============================] - 1s 513ms/step  
This image most likely belongs to large.cell.carcinoma with a 96.75 percent confidence.

In [30]:

img\_path **=** "data/medical/Normal/001.PNG"  
  
class\_names**=**list(test\_generator**.**class\_indices**.**keys())  
  
img **=** tf**.**keras**.**utils**.**load\_img(img\_path, target\_size**=**(460, 460))  
img\_array **=** tf**.**keras**.**utils**.**img\_to\_array(img)  
img\_array **=** tf**.**expand\_dims(img\_array, 0)  
  
prediction **=** resnet50\_model**.**predict(img\_array)  
  
print(  
 "This image most likely belongs to {} with a {:.2f} percent confidence."  
 **.**format(class\_names[np**.**argmax(prediction)], 100 **\*** np**.**max(prediction))  
)

1/1 [==============================] - 1s 887ms/step  
This image most likely belongs to normal with a 68.16 percent confidence.

In [31]:

img\_path **=** "data/medical/Adenocarcinoma/001.PNG"  
  
class\_names**=**list(test\_generator**.**class\_indices**.**keys())  
  
img **=** tf**.**keras**.**utils**.**load\_img(img\_path, target\_size**=**(460, 460))  
img\_array **=** tf**.**keras**.**utils**.**img\_to\_array(img)  
img\_array **=** tf**.**expand\_dims(img\_array, 0)  
  
prediction **=** resnet50\_model**.**predict(img\_array)  
  
print(  
 "This image most likely belongs to {} with a {:.2f} percent confidence."  
 **.**format(class\_names[np**.**argmax(prediction)], 100 **\*** np**.**max(prediction))  
)

1/1 [==============================] - 1s 507ms/step  
This image most likely belongs to normal with a 75.96 percent confidence.

In [33]:

img\_path **=** "data/medical/Large cell/001.PNG"  
  
class\_names**=**list(test\_generator**.**class\_indices**.**keys())  
  
img **=** tf**.**keras**.**utils**.**load\_img(img\_path, target\_size**=**(460, 460))  
img\_array **=** tf**.**keras**.**utils**.**img\_to\_array(img)  
img\_array **=** tf**.**expand\_dims(img\_array, 0)  
  
prediction **=** resnet50\_model**.**predict(img\_array)  
  
print(  
 "This image most likely belongs to {} with a {:.2f} percent confidence."  
 **.**format(class\_names[np**.**argmax(prediction)], 100 **\*** np**.**max(prediction))  
)

1/1 [==============================] - 1s 505ms/step  
This image most likely belongs to normal with a 76.32 percent confidence.

In [34]:

img\_path **=** "data/medical/Squamous/001.PNG"  
  
class\_names**=**list(test\_generator**.**class\_indices**.**keys())  
  
img **=** tf**.**keras**.**utils**.**load\_img(img\_path, target\_size**=**(460, 460))  
img\_array **=** tf**.**keras**.**utils**.**img\_to\_array(img)  
img\_array **=** tf**.**expand\_dims(img\_array, 0)  
  
prediction **=** resnet50\_model**.**predict(img\_array)  
  
print(  
 "This image most likely belongs to {} with a {:.2f} percent confidence."  
 **.**format(class\_names[np**.**argmax(prediction)], 100 **\*** np**.**max(prediction))  
)

1/1 [==============================] - 0s 476ms/step  
This image most likely belongs to normal with a 98.20 percent confidence.

In [ ]: