

# Mucormycosis Image classification based on the severity by using Convolutional Neural Network(CNN)

**C.Sugunadevi**

Assistant Professor  
CMR Institute of Technology  
Bengaluru, India

**Dr.I.Manimozhi**

Associate Professor  
East Point College of Engg&Technmology  
Bengaluru, India

**Neha Gopal**

Assistant Professsor  
East Point College of Engg&Technmology  
Bengaluru, India

*Abstract*— Mucormycosis is a rare deadly disease, it is one of the serious fungal infections caused by the fungus called Mucormycetes. Mucormycosis lives everywhere in the environment, if a person has less immunity, (ie) affected with covid-19 before some time, or with the diabetes are likely to be affected quickly, if it enters through the nose, sinus or through the lungs, causes a deadly problem by affecting the eyes and spreads towards the brain rapidly. The purpose of this paper is to classify the images by constructing a Machine Learning - Convolutional Neural Network based on the severity of the symptoms, (whether the symptom is mild or severe) it was accomplished by training and validating/testing the Neural Network by loading the given Dataset. In addition, Image Data Generator is used to build this neural network. The proposed model was coded in python and tested in Jupyter Notebook considering 18 images, the accuracy percentage was 100%. Considering 143 images, the accuracy percentage was 97%. Considering 520 images, the accuracy percentage was 97%.

*Keywords*— *Mucormycosis, fungal infection, Immunity, Machine Learning, Convolutional Neural Network, Image Data Generator*

## I. INTRODUCTION

In the year 2021, entire earth faced a lot of challenges in facing the Black fungus disease, if a person has less immunity, treated for Covid-19 for 2-3 weeks in a hospital, given with antibiotic and steroids and he/she is highly diabetic and had the prolonged use of oxygen, may be the oxygen is delivered in an unhygienic way, there is a possibility to be affected with the Mucormycosis.

A fungus is essentially a sort of germ that may be found all throughout the environment, including in the air, soil, plants, human bodies, and animal bodies. Fungi come in one million different varieties. Although the majority of fungi are benign, some can result in diseases. Fungal infections come in two basic forms: superficial (affecting the skin's surface) and systemic (affecting systems inside the body).

Mucormycosis lives everywhere in the environment, It can enter through the nose, sinus or through the lungs, spreads towards the eyes and the brain rapidly. It can also enter into the body through the wound in hands or legs, but it cause only the local infection in the affected area. The deadly problem occurs only if it enters through the nose, sinus or through the lungs. The biggest cause for the Mucormycosis is the uncared and uncontrolled diabetes range. As well as the less immunized post covid patients. The biggest cause for the Mucormycosis is the uncared and uncontrolled diabetes range. As well as the less immunized post covid patients.

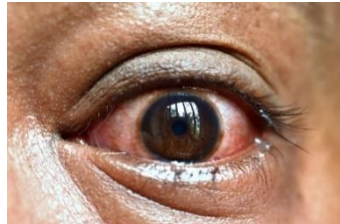


Fig. 1 Infected Eye

The fig. 1 shows the fungus infected areas of eyes, that turns red in color in the affected area with swelling [14].

The types of Mucormycosis are listed below,

- Rhino cerebral Mucormycosis (sinus then brain)

This is common type of infection that occur in sinus which can spread to the brain

- Pulmonary Mucormycosis (lung)

This can easily spread to the person having cancer.

- Gastrointestinal Mucormycosis

This affects the premature and low birth weight children

- Cutaneous Mucormycosis (skin)

This can enter into the body of the persons who has low immunity through wound, cut, burn etc.

Here is the list of fungus which can cause Mucormycosis, the deadly disease.

Rhizopus species, Mucor species, Rhizomucor species, Syncephalastrum species, Cunninghamella, bertholletiae, Apophysomyces species, and Lichtheimia.[11]

#### A. Existing Work

A Novel Deep Learning-Based Black Fungus Disease Identification Using Modified Hybrid Learning Methodology:

It identifies the issue of mucormycosis[1] incidence since it primarily affects those with very low immunity. This creates a modified neural network logic for a machine learning-based classifier known as a hybrid learning-based neural network (HLNNC). Here, the model is trained and tested using the number of photos with and without Black fungus signs.

## II. PROBLEM STATEMENT

Mucormycosis, is actually a family/group of black fungus, that is one of the dangerous and deadly disease if it is transmitted through nose. The problem statement of this paper is to train the Convolutional Neural Network and to find the severity of Black Fungus disease that occurs in different parts of the human body. Different types of infected pictures have been taken and trained such that it can test the given images with the train knowledge.

Mucormycosis can develop when a patient's immune system is impaired and they inhale Mucor spores. This is an unusual, non-contagious disease that, if not treated immediately, can be disabling or fatal. Mucormycosis infections have become more common in the recent decade, due to a rise in the number of organ transplantation.

## III. PROPOSED WORK

If it is not detected at the early state, it will cause a serious problem may also leads to death. The symptoms (8) that cause Mucormycosis are,

Around the eyes and nose, there is pain and redness.

Fever

Coughing

Severe unnatural headaches

Sinus pains

Forehead pain

Visual disturbances – blurred or doubled

Nausea and bloody vomits

Swelling on one side of the face

Numbness in face

Shortness of breath

HIV positive persons having low immunity

Discolouration around the bridge of the nose

Diarrhea

Blood in the stool

## IV. ANALYSIS

Fungi are most commonly observed in people's kitchens, when fruits rot or bread becomes mold. Fungi have been around 400 million years and perform a significant function on the planet. They have aided plants in their transition from aquatic to terrestrial settings, and they continue to assist them in obtaining minerals from the soil.

When the immune system is weakened by another sickness, harmless fungi take advantage of the situation and penetrate into the human tissues. These illnesses are known as opportunistic infections

But fungus rarely produce fatal infections, in contrast to their dangerous bacterial relatives. A few fungi, like the Candida yeast[10], can sporadically cause a serious illness. Candida can live without any problems on healthy people's skin as well as in their mouths, throats, and vaginal canals. If the host's body has been compromised by a different illness or medication, it might result in diaper rash, vaginal infections, and oral thrush.

People with COVID-19, HIV/AIDS, and other viral infections, congenital bone marrow disease, severe burns, malignancies, and untreated or inconsistently controlled diabetes are more susceptible to develop mucormycosis. Patients with COVID-19 who have used steroids are particularly vulnerable because steroids impair the immune system. Because of this, steroid use should be limited to emergencies [10].

When mucor infects the sinuses, it can extend to the lungs, brain, and central nervous system. Mucormycosis symptoms frequently include fever, headache, reddish and swollen skin around the nose or eyes, face pain, coughing up crimson or dark secretions, and shortness of breath. It is diagnosed with a tissue biopsy and an X-ray scan of the lungs. When mucormycosis is discovered early, the two most effective treatments are amphotericin B, leishmaniasis, and posaconazole [12].].

#### A. Image Classification – Mucormycosis

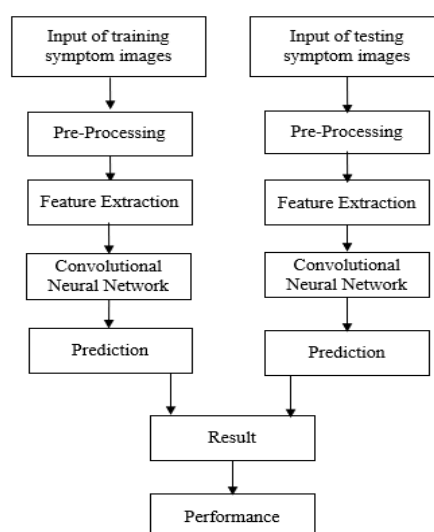


Fig. 2 Block Diagram for Mucormycosis Image Classification

The infected images are selected and pre-processed, then the features are extracted, the next step is to develop the Convolutional Neural Network, Black Fungus severity is predicted by taking a sample of the training images and testing images.

## V. IDENTIFICATION

### A. *Nose Fluid*

In most cases, Black Fungus is diagnosed by taking a sample of the fluid from the nose and sending it to the lab to test it. The doctor may also order tissue biopsy, MRI scan, and CT scan to diagnose Mucormycosis.

### B. *Dutch Kit*

Because the fungi must be cultivated in the lab before the specific group can be determined, current procedures take at least 10 to 15 days to confirm. It was decided to create a Dutch kit. It is imported from the Netherlands, as the name suggests. In 24 to 48 hours, the kit as a whole identifies fungal infection. All we need is a sample of the patient's blood and, if possible, a lesion. Mucormycosis comes in five different forms, each of which may be easily identified and discriminated using this method.

### C. *Mucormycosis Detection Kit*

Scientists at a facility in South 24 Parganas' Bakrahat district developed the DiAGSure Mucormycosis Detection Kit.

### D. *Fungal Culture test*

A fungus culture test aids in the diagnosis of fungus infections

#### 1) *Tests for Superficial Fungal Infections*

##### a) *KOH prep (potassium hydroxide solution)*

Tissue, a vaginal swab, body fluids, sputum, scrapings of the skin, hair- or nail-clippings, A skilled laboratory technician or healthcare professional evaluates the sample after a chemical solution dissolves non-fungal components to expose yeast cells and fungal hyphae (branching filaments). Primary screening technique that finds fungi but doesn't tell you what kind of fungus is there. A category of rapid tests is called rapid tests.

##### b) *Calcofluor white stain*

Body fluids, sputum, a vaginal swab, hair or nail clipping, and skin scrapings. A more sensitive way to see fungi is made possible by the stain, which adheres to the fungal components in a sample and fluoresces (glows) when exposed to ultraviolet light. Although fungi are found, no particular fungus is named. A category of rapid tests is called rapid tests.

##### c) *Fungal culture*

Skin, nail, and hair samples can be found in body fluids, tissue, vaginal swabs, sputum, and blood. The sample is put on or into nutritive media and incubated in order to develop any fungi

it may contain. The basic approach to diagnose a fungal infection involves growing fungus for identification tests and subsequent susceptibility testing. It took weeks for the results to come in.

## 2) *Tests for Superficial Fungal Infections*

### a) *Susceptibility testing*

Sample of fungus isolated in culture. Following up on a fungal culture, susceptibility testing may be requested to identify the most potent antifungal agent(s) to employ when a pathogenic fungus has been found. Guidance in therapy Following culture, days to weeks

### b) *Antigen testing*

Blood, urine, CSF, and other bodily fluids Identifies proteins linked to a certain fungus. A variety of fungus can be tested using this method. Determine the type of fungus that has infected you. For some fungi, quick testing are available (e.g., Cryptococcus, Histoplasma species).

Blood, body fluids, and CSF Identifies an immunological reaction to a particular fungus; can be performed on a single sample or on acute and convalescent samples collected two to three weeks apart. Determine whether a fungal infection is recent or current, and monitor the treatment. days or weeks. DNA and RNA molecular assays.

Fungus culture sample, blood, CSF, and bodily fluids The genetic material of a certain fungus is detected. Others fungi are detectable; however, it is not yet generally available, and some are only available in laboratory settings for a few days to weeks.

### a) *Are there any common strains of infection with black fungus?*

Two types of Black Fungus infections, namely Rhino-Orbito-Cerebral Mucormycosis (ROCM) and Pulmonary Mucormycosis, have been reported among Coronavirus patients, according to the Indian Express report. Patients who have already recovered from Coronavirus as well as those who are now under treatment for Covid-19 have both been found to have high prevalences of both of these categories.

When it comes to ROCM infections, the disease typically has an impact on the patient's nose, eyes, and brain. The infection starts in the nose and quickly spreads to the area of the eye's bone cavity. Patients can identify the signs of a RCOM infection in three phases.

### E. *Mucormycosis affected people experiences the following stages*

The patient has nasal blockage and congestion, as well as pain inside the nose, during the initial stage. Swelling and numbness on the patient's face are also possible side effects.

The patient also has headache and orbital pain during the second stage of the illness, when the virus reaches the bone cavity around the eye. The patient will have pain in the rear and front of

his or her eye. Patients may experience blurred vision, partial blindness, or full blindness in one or both eyes as the severity of the infection increases in the second stage.

The infection reaches the jaw of the mouth at the third stage, and patients begin to feel tingling, chilling, or burning throughout their entire body. Patients with a brain infection may also have fever, an unsteady body walk, unconsciousness, and black spots on the skin near the nose or eye.

#### *F. What can be done?*

Consultation with an ENT doctor and ophthalmologist.

MRI or CT scan if needed, as per doctor's advice

No self-treatment with steroids, which is unsafe.

Monitoring of blood sugar and salt levels.

## VI. LITERATURE REVIEW

### Image Classification Using Convolutional Neural Networks:[9]

Deep learning, a novel area in machine learning, is used in numerous signal and picture applications. The main objective is to classify images using Convolutional neural networks (CNN), a Deep Learning approach. The method is tested on several widely used datasets, including aerial remote sensing images and scene photos from the SUN database. The performance of the algorithm is evaluated based on classification accuracy and the quality metric known as Mean Squared Error (MSE). A graphical representation of the experimental data is shown based on MSE vs the number of training epochs. The analysis of the experimental findings using quality metrics and graphical representation shows that the algorithm (CNN) produces results that are reasonably accurate.

### Black Fungus Development in SARS-COVID-19 Patients:

The infection in hand, known as mucormycosis, is brought on by fungi belonging to the Mucorales family. By invading a person's vascular wall, it specifically damages endothelium cells. Due to its spread toward the brain, sepsis and multiorgan failure arise. The length of time it takes to diagnose a patient mostly relies on their general health. SARS-CoV-2, a coronavirus that causes bacterial and fungal illnesses, is the cause of the 2019 coronavirus disease (COVID-19). Numerous patients who received COVID-19 treatment have been reported to suffer mucormycosis. In the majority of instances, corticosteroids, remdesivir, and tocilizumab are used as treatments (4.1 percent).

### Mucormycosis (Black Fungus): A Review:

Mucormycosis is an invasive infection caused by the Mucorales order of the Zygomycete class of fungus. In patients undergoing hematological and allogeneic stem cell transplantation, Mucormycosis has emerged as an invasive mycosis. Because spores in airway mucus are

eliminated through mucociliary transport, members afflicted with fungal infections are uncommon in nasal mucus.

## VII. METHODOLOGY

Methodology is to train and validate the Neural Network by loading the given images from the folder of train data set and validate data set that consists of in turn two folders of images of mild and severe. The dataset used for the classification is available as Open-Source from Kaggle. To create this neural network, used tensor flow keras and Image Data Generator. The Data Generator is used to correctly construct labels for the given photographs; depending on the image, it can be Mild symptom or Severe symptom

The model is efficiently built using a convolutional neural network with max pooling and dense layers. When you use imageDataGenerator, the images in the Severe and Mild folders will be labelled as having a severe symptom. Three-dimensional matrix of Image is obtained with the help of cv2.imread. Shape of the matrix is also obtained. Generating the training and validation dataset by using ImageGenerator. Train images are converted into DataSet by taking the path of the directory. Multiple sized images cannot be given to the neural networks, so it has to be resized to 200\*200 that is target size and batch size need to be included.

Next step is to Include the class indices 0 and 1 to indicate the severity and mild, as the neural networks will not take the string value. It converts all the classes or folders that are available in the dataset to a binary value. By displaying the classes information, we will see to that all the indices of the images that are available in the mild will be given value 0 and the images that are available in the severe will be given value 1. Introducing convolution network with maxpooling.

### A. Algorithm

Input: Library files, Dataset with images import

Output: Training a Neural Network with CNN Algorithm

that classifies the image based on the fungi infection severity in any parts of a body.

Procedure:

Step 1: Load the directory that has the training

Images from the local.

Step 2: Generate the training and validating elements

Step 3: Convert the training element to a Dataset, that can be given as an input to the Neural Network

Step 4: Use flow from\_ directory to generate labels and resize the images to the same size.

Step 5: Add class\_ indices to give numerical values

to the images.



Step 6: tf.keras.model used to design convolutional network specifying layers as a list.

Step 7: Call the model. Predict(Images)

Step 8: print If 'Symptom is Mild'

Else 'Symptom is Severe'

Step 9: Image Classification done

*B. How does it works ?*

Analyzing the severity of disease can help to improve the efficiency with which tasks are completed and the decision-making can be done immediately.

The Fig. 3 shows that the symptom is severe based on the comparison with the training dataset.

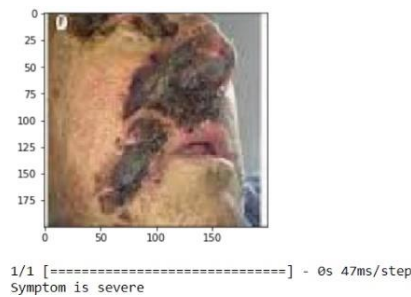


Fig. 3 Severe Symptom

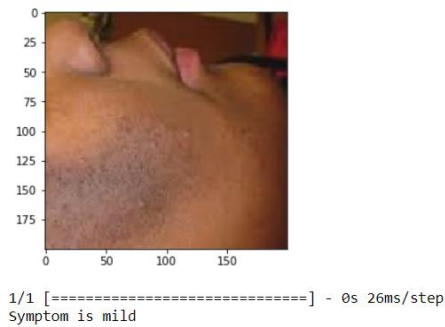


Fig. 4 Mild Symptom

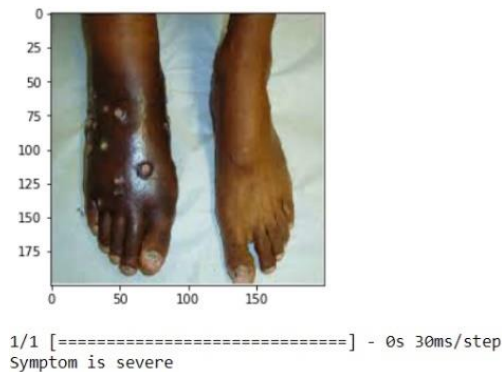


Fig. 5 Severe Symptom

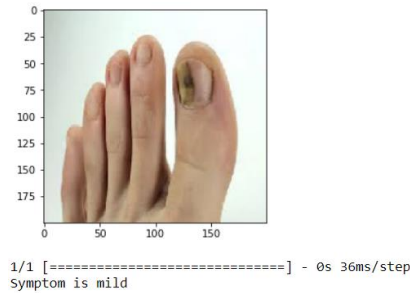


Fig. 6 Mild Symptom

C. Performance Evaluation

The below Fig. 7 shows the confusion Matrix that gives the details of 18 images in total, that has been tested and it gives the accurate results. Fig. 8 shows the confusion matrix of 143 images has been tested and Fig. 9 shows the confusion matrix of 520 images, that has been tested in the trained model with fine accuracy.

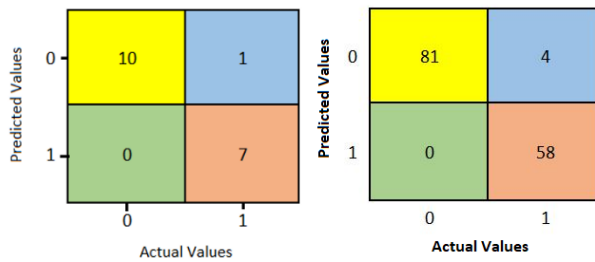


Fig. 7 Matrix for 18 images

Fig. 8 Matrix for 143 images

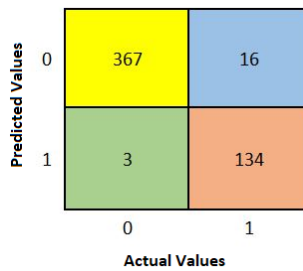


Fig. 9 Matrix for 520 images

VIII. ADVANTAGES

With the different types of images like face, leg, hand, able to achieve 97% of accuracy. That can be used to treat the patients based on the severity of the Mucormycosis affection.

IX. CONCLUSION

As the Mucormycosis is a life threatening disease that affects the people having very low immunity. They might be affected with covid-19 before some time, HIV/AIDS or with the

diabetes has the higher priority for the fungus to develop Mucormycosis. If it can enter through the nose, sinus or through the lungs, possibility of recovery is less. The severity detection of a disease may help to treat in priority way by classification of given images using a Machine Learning and developing Convolutional Neural Network with the trained and validated DataSet. The accuracy of classification comes around 97%. The future work can implemented in such a way that the accuracy can be improved much better with the use of different Machine Learning Algorithms.

#### X. REFERENCES

- [1] S. Karthikeyan ,1 G. Ramkumar ,2 S. Aravindkumar ,3 M. Tamilselvi ,4 S Ramesh ,5 and A. RanjithA Novel Deep Learning-Based Black Fungus Disease Identification Using Modified Hybrid Learning Methodology, Volume 2022, Article ID 4352730
- [2] Black Fungus Development in SARS-COVID-19 Patients, Journal of Infectious Diseases and Epidemiology – 2022, DOI: 10.23937/2474-3658/1510248, Volume 8 | Issue 2.(literature survey)
- [3] MUCORMYCOSI (BLACK FUNGUS): A REVIEW Review Article International Journal of Current Pharmaceutical Research 13(5):10-13 , September 2021. DOI: 10.22159/ijcpr.2021v13i5.1888
- [4] S. Ramteke, B.L. Sahu Novel coronavirus disease 2019 (COVID-19) pandemic: considerations for the biomedical waste sector in India Case Studies in Chemical and Environmental Engineering, 2 (2020), p. 100029, 10.1016/j.cscee.2020.100029
- [5] M.A. Andrews, B. Areekal, K.R. Rajesh, et al.First confirmed case of COVID-19 infection in India: a case report. Indian J Med Res, 151 (5) (2020 May), pp. 490-492, 10.4103/ijmr.IJMR\_2131\_20
- [6] After black fungus and white fungus, another fungal infection aspergillosis, hits India (n.d.). [online]. Available: <https://www.dnaindia.com/india/report-after-black-fungus-and-white-fungus-another-fungal-infection-aspergillosis-hits-india-2892150J>. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [7] M.A. Andrews, B. Areekal, K.R. Rajesh, et al.First confirmed case of COVID-19 infection in India: a case report.Indian J Med Res, 151 (5) (2020 May), pp. 490-492, 10.4103/ijmr.IJMR\_2131\_20
- [8] Mild or moderate covid-19 N Engl J Med, 383 (2020),pp. 1757-1766, 10.1056/NEJMcp2009249 Paltauf A (1885) XXV. Mycosis mucorina. In: Band 102. De Gruyter, 543-564
- [9] Image Classification Using Convolutional Neural Networks Deepika Jaswal, Sowmya.V, K.P.Soman, International Journal of Scientific & Engineering Research, Volume 5, Issue 6, June-2014 ISSN 2229-5518
- [10] <https://virinchihospitals.com/mucormycosis-black-fungus-infection-in-eye-facts-and-myths/>
- [11] A. Chowdhary, B. Tarai, A. Singh, A. SharmaMultidrug-resistant Candida auris infections in critically ill coronavirus disease patients, India, April–July 2020 Emerg Infect Dis, 26 (2020), pp. 2694-2696, 10.3201/eid2611.203504

- [12] A. Chowdhary, B. Tarai, A. Singh, A. Sharma Multidrug-resistant *Candida auris* infections in critically ill coronavirus disease patients, India, April–July 2020 *Emerg Infect Dis*, 26 (2020), pp. 2694-2696, 10.3201/eid2611.203504
- [13] <https://www.webmd.com/lung/mucormycosis-black-fungus-infection>
- [14] <https://virinchihospitals.com/mucormycosis-black-fungus-infection-in-eye-facts-and-myths/>
- [15] <https://rarediseases.org/rare-diseases/mucormycosis/>
- [16] [https://www.who.int/india/emergencies/coronavirus-disease-\(covid-19\)/mucormycosis](https://www.who.int/india/emergencies/coronavirus-disease-(covid-19)/mucormycosis)
- [17] [https://www.cdc.gov/fungal/diseases/mucormycosis/treatment.html#:~:text=Mucormycosis%20is%20a%20serious%20infection,mouth%20\(positaconazole%2C%20isavuconazole\).](https://www.cdc.gov/fungal/diseases/mucormycosis/treatment.html#:~:text=Mucormycosis%20is%20a%20serious%20infection,mouth%20(positaconazole%2C%20isavuconazole).)
- [18] S. Karthikeyan ,1 G. Ramkumar ,2 S. Aravindkumar ,3 M. Tamilselvi ,4 S Ramesh ,5 and A. RanjithA Novel Deep Learning-Based Black Fungus Disease Identification Using Modified Hybrid Learning Methodology, Volume 2022, Article ID 4352730
- [19] Black Fungus Development in SARS-COVID-19 Patients, *Journal of Infectious Diseases and Epidemiology – 2022*, DOI: 10.23937/2474-3658/1510248, Volume 8 | Issue 2.(literature survey)
- [20] MUCORMYCOSIS (BLACK FUNGUS): A REVIEW Review Article *International Journal of Current Pharmaceutical Research* 13(5):10-13 , September 2021. DOI: 10.22159/ijcpr.2021v13i5.1888
- [21] S. Ramteke, B.L. Sahu Novel coronavirus disease 2019 (COVID-19) pandemic: considerations for the biomedical waste sector in India *Case Studies in Chemical and Environmental Engineering*, 2 (2020), p. 100029, 10.1016/j.csee.2020.100029
- [22] M.A. Andrews, B. Areekal, K.R. Rajesh, et al.First confirmed case of COVID-19 infection in India: a case report. *Indian J Med Res*, 151 (5) (2020 May), pp. 490-492, 10.4103/ijmr.IJMR\_2131\_20
- [23] After black fungus and white fungus, another fungal infection aspergillosis, hits India (n.d.). [online]. Available: <https://www.dnaindia.com/india/report-after-black-fungus-and-white-fungus-another-fungal-infection-aspergillosis-hits-india-2892150J>. Clerk Maxwell, *A Treatise on Electricity and Magnetism*, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [24] M.A. Andrews, B. Areekal, K.R. Rajesh, et al.First confirmed case of COVID-19 infection in India: a case report.*Indian J Med Res*, 151 (5) (2020 May), pp. 490-492, 10.4103/ijmr.IJMR\_2131\_20
- [25] Mild or moderate covid-19 *N Engl J Med*, 383 (2020),pp. 1757-1766, 10.1056/NEJMcp2009249 Paltauf A (1885) XXV. Mycosis mucorina. In: Band 102. De Gruyter, 543-564
- [26] Image Classification Using Convolutional Neural Networks Deepika Jaswal, Sowmya.V, K.P.Soman, *International Journal of Scientific & Engineering Research*, Volume 5, Issue 6, June-2014 ISSN 2229-5518
- [27] <https://virinchihospitals.com/mucormycosis-black-fungus-infection-in-eye-facts-and-myths/>
- [28] A. Chowdhary, B. Tarai, A. Singh, A. SharmaMultidrug-resistant *Candida auris* infections in critically ill coronavirus disease patients, India, April–July 2020 *Emerg Infect Dis*, 26 (2020), pp. 2694-2696, 10.3201/eid2611.203504

- [29] A. Chowdhary, B. Tarai, A. Singh, A. Sharma                      Multidrug-resistant *Candida auris* infections in critically ill coronavirus disease patients, India, April–July 2020 *Emerg Infect Dis*, 26 (2020), pp. 2694-2696, 10.3201/eid2611.203504
- [30] <https://www.webmd.com/lung/mucormycosis-black-fungus-infection>
- [31] <https://virinchihospitals.com/mucormycosis-black-fungus-infection-in-eye-facts-and-myths/>
- [32] <https://rarediseases.org/rare-diseases/mucormycosis/>
- [33] [https://www.who.int/india/emergencies/coronavirus-disease-\(covid-19\)/mucormycosis](https://www.who.int/india/emergencies/coronavirus-disease-(covid-19)/mucormycosis)
- [34] [https://www.cdc.gov/fungal/diseases/mucormycosis/treatment.html#:~:text=Mucormycosis%20is%20a%20serious%20infection,mouth%20\(posaconazole%2C%20isavuconazole\).](https://www.cdc.gov/fungal/diseases/mucormycosis/treatment.html#:~:text=Mucormycosis%20is%20a%20serious%20infection,mouth%20(posaconazole%2C%20isavuconazole).)