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Beauty Expert System to Determine the Skin Problem and the Treatment for Patient at Jasmine Clinic

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Abstract — As people get busy, they want fast and easy service. This also applies to skin services in beauty clinics. The patient wants ease in terms of determining the type of facial skin problem and what treatments are appropriate for them. However, due to the limited number of dermatologists, patients often have to wait a long time to be examined and sometimes even cannot be served due to limited schedules. This expert system is based on how doctors determine the type of facial problems in patients and what treatments are appropriate for the problem. By using a mobile application, this system can be accessed by patients from home, making it easier for patients to get a quick and accurate examination. This application was built using the forward chaining method where later patients will answer questions that are used as a decision branch to determine the skin problem. Eventually the patient can make the required treatment and skin care needs and take them to the clinic.

Keywords— Sistem Pakar, Forward Chaining, Beauty Clinic, Mobile Application

I. INTRODUCTION

Beauty clinics are competing to win the trust of patients by providing medical doctor that specializes in skin care called the dermatologist. Dermatologist serves consultation on facial skin problems experienced by patients by providing appropriate treatment solutions. Without dermatologist and consultation at a beauty clinic, patients are often confused to choose the right product and treatment. Treatments that do not match with the patient's skin condition can worsen their skin problems.

With the development of technology today, the use of technology is a way to help improve the business process in beauty clinic. Through the use of technology, a system is expected to help patients and dermatologist at the beauty clinic. For the dermatologist, the system is expected to help in terms of consultation without meeting directly with patients to determine the skin problem. As for the patients, the system is expected to be able to help patients in schedule a treatment and order skin care products after having online consultation without the need to come to the clinic. Therefore, it is necessary to build a mobile application that can help the interaction between patient and dermatologist being done easily.

Jasmine Beauty Clinic is a beauty clinic that serves consultation on facial skin problems, maintain facial skin, give facial treatments and selling skin care products. For consultation with the dermatologist, patients only can visit the clinic only four days a week with each day only 2 hours consultation time. Because of the limited consultation time, the queue is always long and patients do not have enough time to have skin consultation. Hereby the application expected can help to increase the service given to the patient in order to get skin consultation.

The application will build as an expert system to store the knowledge about skin diagnoses given by the dermatologist. The patient then will answers several questions and the application will match it with the rules stored in the application and given the correct treatment and skin care needed. The result is 94,5% accurate compared to dermatologist manual diagnose, hence the different answer from patient can cause the result different. However the skin care and treatment result also will always be reviewed periodically after patient received it in order to ensure that patient get the correct treatment.

II. LITERATURE STUDY

A. Expert System

According Kusrini [1], expert systems are computer-based systems that use facts, and logical techniques in solving problems that are usually only
can be solved by an expert in that field. Expert system is a system that seeks to adopt human knowledge into computers, so that computers can solve problems as is usually done by experts, and good expert systems are designed so that they can solve a problem by imitating the work of experts [1]

The expert system consists of two main parts, namely: the development environment and the consultation environment. The development environment is used as an

expert system builder both in terms of component development and knowledge base. Consultation environment is used by someone who is not an expert to consult [2]. The components contained in the architecture / structure of the expert system in the picture above are explained as figure 1:

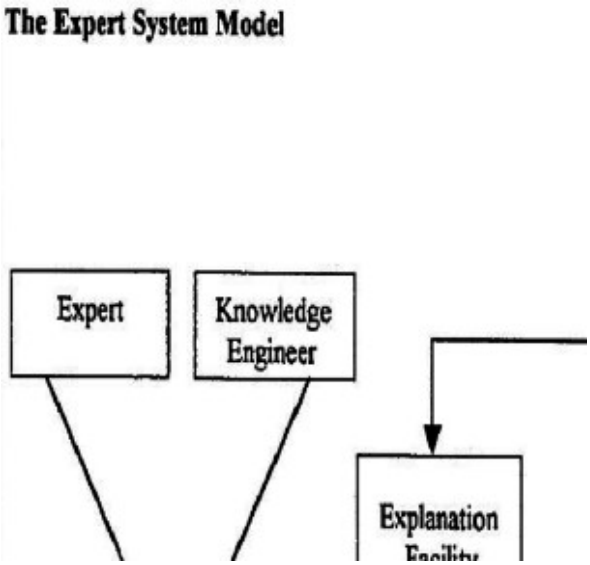

Figure 1. Expert System Component (Model) [3]

i. User Interface

The interface is a mechanism used by users and expert systems to communicate. The interface receives information from the user and transforms it into a form that is acceptable to the system. Besides the interface receives from the system and presents it in a form that can be understood by the user.

ii. Knowledge Base

The knowledge base contains knowledge for understanding, formulation, and problem solving.

iii. Knowledge Acquisition

Knowledge acquisition is the accumulation, transfer, and transformation of expertise in solving problems from knowledge sources into computer programs. In this stage, knowledge engineers try to absorb knowledge and then transfer it to the knowledge base. Knowledge is gained from experts, complete with books, databases, research reports, and user experience.

iv. Engine / Motor Inference (Inference Engine)

This component contains the mindset and reasoning mechanism used by experts in solving a problem. An inference engine is a computer program that provides a methodology for reasoning about information that is in the knowledge base and in the workplace, and for formulating conclusions.

Forward chaining method is a method where the search starts from taking facts the facts first and then used to draw conclusions. Forward tracking is a data-driven approach. In this approach tracking starts from the input information, and so on try to draw conclusions. Tracking ahead, looking for facts in accordance with the IF part of the IF-THEN rules [].

B. Skin Type and Problem

Skin typing is needed to properly care for the skin and prevent skin problems. Determining a skin type is essential for crafting the ideal skin care regimen. Skin type is usually due to genetic predisposition, but there are habits that can worsen a skin condition. Each skin type has a specific set of characteristics and symptoms, and thus requires special attention. Based on the discussion with the Jasmine dermatologist, here are five main facial skin types. Table 1 will describe the five facial skin types.

Table 1 Skin Type and Symptoms

Skin Type	Symptoms
Normal	• When oilness and dryness are present, it is rare and tends to be easy to get rid or resolve • Small pores • Even skin tone, with no marked blemishes
Dry	• May have dry and flaky skin • Eczema prone • Sometimes itchy
Oily	• Prone to acne and breakouts • Shiny skin
Combination	• Combination of oily and dry skin • Forehead, nose and chin are oily • Cheeks tend to be dry
Sensitive	• Easily inflamed skin • Deal with great amount of redness and irritation

Conditions that irritate, clog, or inflame the skin can cause symptoms such as redness, swelling, burning, and itching. Allergies, irritants, genetic, makeup, and certain diseases and immune system problems can cause dermatitis, hives, and other skin conditions. Many facial skin problems such as acne, also affect person's appearance. There are several main facial skin problems. Table 2 will describe the main facial skin problems

Table 2 Skin Problem and Descriptions

Skin Problem	Description
Acne	A disease that affects the skin's oil glands. The small holes in the skin (pores) connect to oil glands under the skin. These glands make a substance called sebum. The pores connect to the glands by a canal called a follicle. When the follicle of a skin gland clogs up, a pimple grows. Acne is the most common skin disease. Early treatment is the best way to prevent scars.
Wrinkle	The skin changes as a person age. Sunlight is a major cause of skin aging. Cigarette smoking also contributes to wrinkles. The wrinkling

	increases with the number of cigarettes and years a person has smoked.
Rashes	Red, dry and itchy skin on the face. Many rashes itch, such as those that often develop after an allergic (hypersensitivity) reaction, but some rashes are painful or cause no sensations. Sometimes an immune reaction is triggered by substances a person touches or eats.
Hyperpigmentation	Hyperpigmentation is a common, usually harmless condition in which patches of skin become darker in color than the normal surrounding skin. This darkening occurs when an excess of melanin, the brown pigment that produces normal skin colour, forms deposits in the skin. Hyperpigmentation can affect the skin colour of people of any race.

III. RESULT AND ANALYSIS

A. Skin Analysis

The skin analysis system in this research aims to replace the standard oily, dry, combination and sensitive type system to more fully grasp the complexity of skin functioning, as the current standard skin typing system is not specific enough to help dermatologist and patients choose products. The system is expected to be able to facilitates proper selection of skin care products to treat conditions and enhance overall skin health. Based on research and discussion with dermatologist at Jasmine Beauty Clinic, there are four factors in facial skin that need to be measured to diagnose facial skin type accurately: 1) Skin Hydration: Oily or Dry, 2) Skin Sensitivity: Sensitive or Non-sensitive, 3) Skin Pigmentation: Uneven Pigment or Even Pigment, 4) Wrinkled or Tight. Each factor has the same weight value and will be combined to generate patient's facial skin type. By combining all of the factors using decision tree, it will be found that there are sixteen facial skin types according to Jasmine Beauty Clinic dermatologist, as shown in Figure 2 and Table 3.

Table 3 Classification of Skin Type

Dry **Sensitive** **Uneven Pigment** **Tight**	**Oily** **Sensitive** **Uneven Pigment** **Tight**	**Dry** **Non-sensitive** **Uneven Pigm** **Tight**
Dry **Sensitive** **Even Pigment** **Tight**	**Oily** **Sensitive** **Even Pigment** **Tight**	**Dry** **Non-sensitive** **Even Pigmen** **Tight**
Dry **Sensitive** **Uneven Pigment**	**Oily** **Sensitive** **Uneven Pigment**	**Dry** **Non-sensitive** **Uneven Pigm**

To determine patient's skin type, the skin analysis will be divided into four sections. The first section is to find out whether the patient's skin is oily or dry with a total of 11 questions. The second section is to find out whether the patient's skin is sensitive or non-sensitive with a total of 13 questions. The third section is to find out whether the patient's skin has uneven pigment or even pigment with a total of 17 questions. The fourth section is to find out whether the patient's skin is wrinkled or tight with a total of 20 questions.

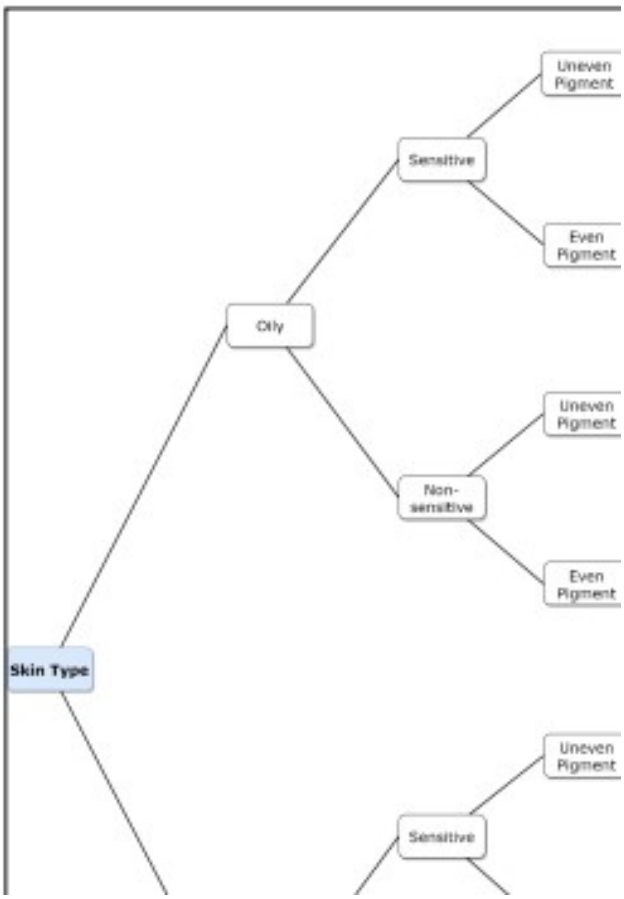

Figure 2 Facial Skin Types

Each section of skin analysis has different scoring as shown in Table 4. The scoring is made based on research conducted by dermatologist at Jasmine Beauty Clinic:

Table 4 Scoring of Skin Type

Section 1: Oily or Dry	**Dry**		
	11 – 16 Very Dry	17 – 26 Slightly Dry	Sli
Section 2: Sensitive or Non-sensitive	**Non-sensitive**		
	18 – 24 Non-sensitive	25 – 29 Slightly Non-sensitive	Sligh
Section 3:	10 – 30	31 – 45	

After the system determines patient's facial skin type, the system then determines skin problems that are appearing or will appear on the patient's face based on facial skin type. According to the dermatologist at Jasmine Beauty Clinic, there are four facial skin problems that are usually experienced by patients, they are: 1) Acne, 2) Redness, Burning, Itching, 3) Hyperpigmentation, 4) Wrinkle. Refer to Table 2.5 to see the list of skin problems for each facial skin type according to Jasmine Beauty Clinic dermatologist. Each facial skin type also has different set of skin care. For example, skin care for Dry, Sensitive, Even Pigment, Tight type must be different with skin care for Oily, Non-sensitive, Uneven Pigment, Wrinkle type, because every facial skin type is unique and has different problems, as shown in table 5.

Table 5 Facial Skin Symptomps

No.	Facial Skin Type	Acne	Redness, Burning, Itching	Hy
1	**Dry, Sensitive, Uneven Pigment, Tight**	✓	✓	
2	**Dry, Sensitive, Even Pigment, Tight**	✓	✓	
3	**Dry, Sensitive, Uneven Pigment, Wrinkled**	✓	✓	
4	**Dry, Sensitive, Even Pigment,**	✓	✓	
7	**Oily, Sensitive, Uneven Pigment, Wrinkled**	✓	✓	
8	**Oily, Sensitive, Even Pigment, Wrinkled**	✓	✓	
9	**Oily, Non-sensitive, Uneven Pigment, Tight**	×	×	
10	**Oily, Non-sensitive, Even Pigment, Tight**	×	×	
11	**Oily, Non-sensitive, Uneven Pigment, Wrinkled**	×	×	
12	**Oily, Non-sensitive, Even Pigment, Wrinkled**	×	×	
13	**Dry, Non-sensitive, Uneven Pigment,**	×	×	

B. Business Process Requirement

The application will start from registration whereby the patient only needs to register the mobile number and doing verification. After that, patient should take the skin analysis test to define which skin type and skin problem the patient has. The skin analysis test is divided into four sections and patient needs to answer all the questions to get the result. Patient will get temporary result after answering each section. After finish answering the test, patient can view the result. The result reveals the patient's skin type and skin problems. After that, patient finally can view the recommendation. The recommendation will show the list of skin care products to use in the morning and night, and the list of treatments based on the skin analysis test. Patient can book skin care products and schedule a treatment using this

application. All the results and recommendations will be stored in database and patients can view the skin analysis history or skin diary.

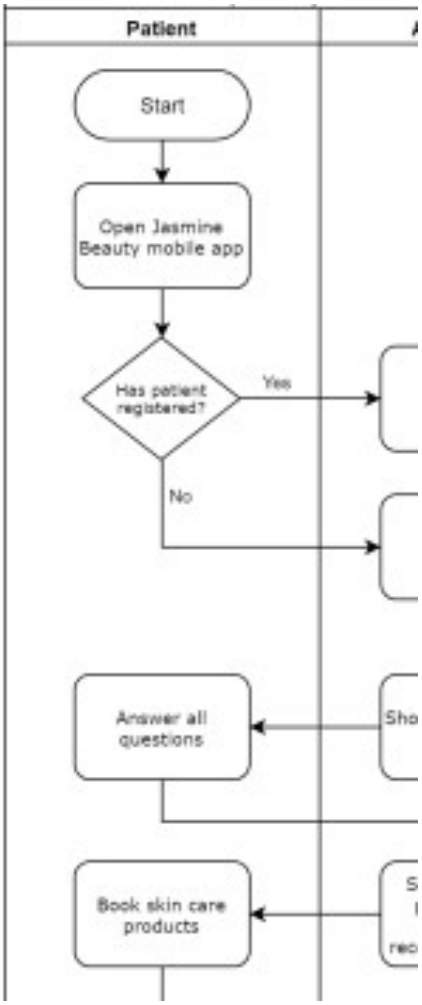

Figure 3. New Business Process

C. Application Design

Use case diagram is a diagram to describe the system modelling level between actors and the system. The purpose of a use case is to define a piece of coherent behaviour without revealing the internal structure of the system. Typically use case involves a sequence of interaction between user and the system. Use case diagram defines what will happen in the program. Figure 4 shows the use case diagram of Jasmine Beauty Clinic mobile application. Based on the requirement and the needs, there are two actors called Patient and Administrator

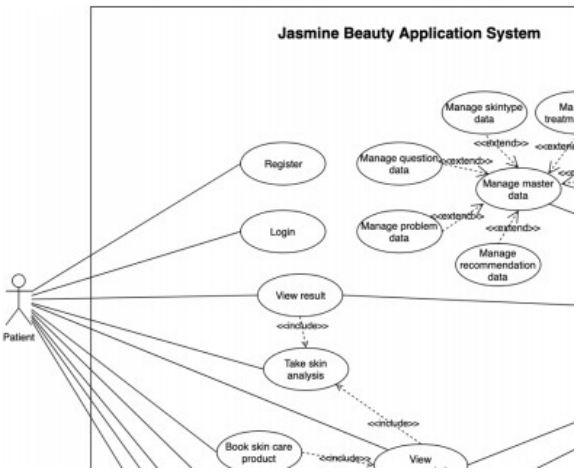

Figure 4 Use Case Diagram

Figure 5 shows the whole entity relationship diagram in Jasmine Beauty mobile application. The diagram consists of 19 tables. The database will be built using MySQL.

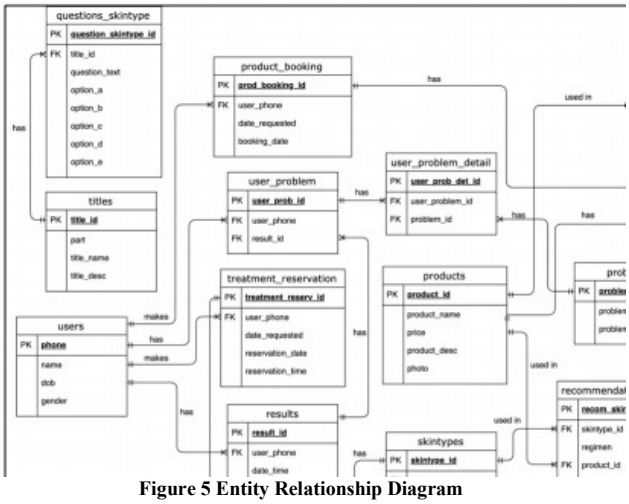

Figure 5 Entity Relationship Diagram

Meanwhile some of the user interface can be shown in the figure 6, 7 and 8. Figure 6 show the user interface where patient need to answer several questions.

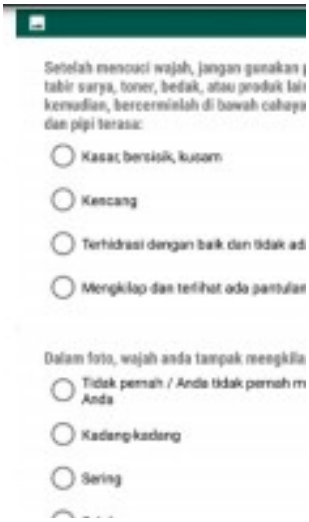

Figure 6 Skin Analysis Test

Figure 7 show the user interface where the application give the skin result analysis to the patient.

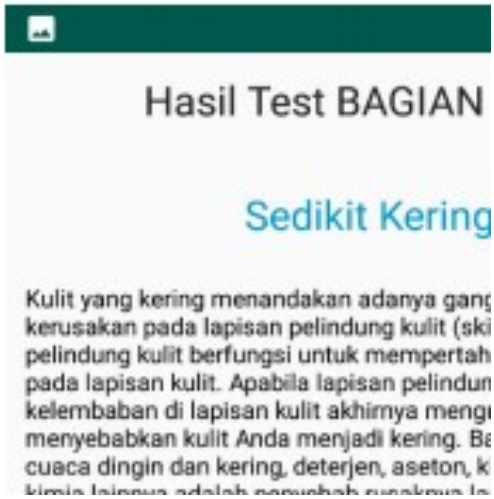

Figure 7 Skin Analysis Result

Figure 8 show the user interface where the application give the treatment reccomendation to the patient.

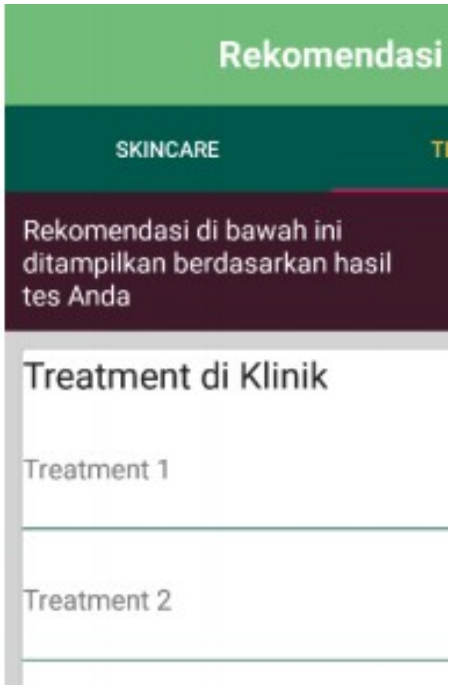

Figure 8 Treatment Reccomendation

D. Test Result

Table 6 shown the test result done for the testing scenario for the application.

Table 6 Test Result

Scenario	Description	Result
Registration	User can register using mobile phone number	Pass
Double Registration	User cannot register using the same mobile number	Pass
Login	User can login using the mobile number registered	Pass
Wrong ID or Password	User cannot login if ID (mobile number) or password is wrong	Pass
Skin Analysis	User can answer the skin analysis and get the reccomendation	Pass
Skin Analysis skip question	User cannot continue the skin analysis if there is blank answer	Pass
Booking Treatment	User can book the treatment	Pass
Booking Skin Care Product	User can book the skin care product	Pass
Skin Diary	User can review the skin analysis result taken previously and doing review	Pass

The testing also compare between the dermatologist manual consultation and result of application online consultation, whereby the result shown in table 3.5. From 16 cases taken, only 1 result is different where it might be caused from the different answer given by the patient.

IV. SUMMARY

There are several points that could be concluded on the development of mobile application for skin care personalization at Jasmine Beauty Clinic:

1. The application can determine the user's facial skin type and facial skin problems and have 93.75% similarity as dermatologist manual consultation.
2. The application can give recommendation on what skin care products and treatments the user should take.
3. The application manages to do booking skin care products and treatments.
4. The application can help users to get immediate result to prevent their facial skin problem from getting worse without having to meet the dermatologist.

For future development, the application should be improved in adding notification to notify user's upcoming treatment schedule or to notify product pickup schedule and enable users to pay products via the mobile application.

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Table 3.5 Result Comparation

Patient	Online Consultation			Dermatologist Consultation			Result
	Skin Problem	Treatment	Product	Skin Problem	Treatment	Product	
1	Dry, Sensitive, Uneven Pigment, Tight	A,B,C,D	1,2,3,4	Dry, Sensitive, Uneven Pigment, Tight	A,B,C,D	1,2,3,4	Same
2	Dry, Sensitive, Even Pigment, Tight	A,B,D	1,2,4	Dry, Sensitive, Even Pigment, Tight	A,B,D	1,2,4	Same
3	Dry, Sensitive, Uneven Pigment, Wrinkled	A,B,C,E	1,2,3,5	Dry, Sensitive, Uneven Pigment, Wrinkled	A,B,C,E	1,2,3,5	Same
4	Dry, Sensitive, Even Pigment, Wrinkled	A,B,E	1,2,5	Dry, Sensitive, Even Pigment, Wrinkled	A,B,E	1,2,5	Same
5	Oily, Sensitive, Uneven Pigment, Tight	F,B,C,D	6,2,3,4	Oily, Sensitive, Uneven Pigment, Tight	F,B,C,D	6,2,3,4	Same
6	Oily, Sensitive, Even Pigment, Tight	F,B,D	6,2,4	Oily, Sensitive, Even Pigment, Tight	F,B,D	6,2,4	Same
7	Oily, Sensitive, Uneven Pigment, Wrinkled	F,B,C,E	6,2,3,5	Oily, Sensitive, Uneven Pigment, Wrinkled	F,B,C,E	6,2,3,5	Same
8	Oily, Sensitive, Even Pigment, Wrinkled	F,B,E	6,2,4	Oily, Sensitive, Even Pigment, Wrinkled	F,B,E	6,2,4	Same
9	Oily, Non-sensitive, Uneven Pigment, Tight	F,G,C,D	6,7,3,4	Oily, Non-sensitive, Uneven Pigment, Tight	F,G,C,D	6,7,3,4	Same
10	Oily, Non-sensitive, Even Pigment, Tight	F,G,E	6,7,3	Oily, Non-sensitive, Even Pigment, Tight	F,G,E	6,7,3	Same
11	Oily, Non-sensitive, Uneven Pigment, Wrinkled	F,G,D,H	6,7,3,9	Oily, Non-sensitive, Even Pigment, Wrinkled	F,G,C,D	6,7,3,4	Different
12	Oily, Non-sensitive, Even Pigment, Wrinkled	F,G,C,D	6,7,3,4	Oily, Non-sensitive, Even Pigment, Wrinkled	F,G,C,D	6,7,3,4	Same
13	Dry, Non-sensitive, Uneven Pigment, Tight	A, G, C, D	1,7,3,4	Dry, Non-sensitive, Uneven Pigment, Tight	A, G, C, D	1,7,3,4	Same
14	Dry, Non-sensitive, Even Pigment, Tight	A,G,C,E	1,7,4,5	Dry, Non-sensitive, Even Pigment, Tight	A,G,C,E	1,7,4,5	Same
15	Dry, Non-sensitive, Uneven Pigment, Wrinkled	A,G,D,F	1,7,6,5	Dry, Non-sensitive, Uneven Pigment, Wrinkled	A,G,D,F	1,7,6,5	Same
16	Dry, Non-sensitive, Even Pigment, Wrinkled	A,G,F,C	1,7,8,9	Dry, Non-sensitive, Even Pigment, Wrinkled	A,G,F,C	1,7,8,9	Same