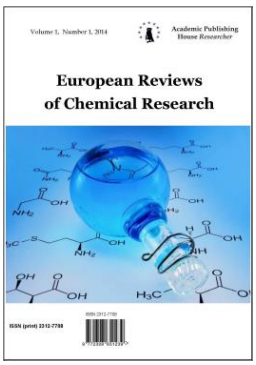

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Fundamentals in Colors, Dyes and Pigments Chemistry: A Review

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Abstract

In this paper review some significant light is focused on the basis, fundamentals and/or the knowledge of colors, dyes and pigments chemistry using many of multi choice questions and their answers. This paper review is recommended for chemist's dyers and colorists. They will find it interesting, informative, stimulating, and contain a mine of information. Also, this paper review is recommended for professors and teachers in the field of colors, dyes and pigments chemistry. They can use it in teaching, as notebook/education lecturers and in their student's examination tests. In addition, this paper review can be used and/or will be most valuable in domestic and/or international scientific and/or chemistry competitions, in organic chemistry as general and particularly in the field of colors, dyes and pigments chemistry. The review covers some essential and general topics in colors, dyes and pigments chemistry, such as synthesis, properties, classification, structures, uses and applications of many aromatic and/or heterocyclic dyes. This paper review acts as a mordant and/or stabilizers for the basics, the fundamentals and/or the knowledge in understanding colors, dyes and pigments chemistry. It is considered as a special and/or specific type of collective review which has been paid little attention and is lacking in the chemistry literature.

Keywords: colors, dyes, pigments, synthesis of dyes, properties of dyes, uses of dyes, classification of dyes.

Introduction

Color will not be seen if the light is absorbed from the infrared or ultraviolet region, but if light is absorbed from the visible region, the substance will appear to be colored. If the substance absorbs all visible light except that comes ponding to yellow, for instance, it will transmit or reflect only yellow and will be seen as yellow. More commonly, however, light of only one color is absorbed, in which case the substance appears to have the complementary color. Thus if the light is absorbed from the red region, the substance will appear green [1]. When light passes through matter or is reflected from it, some of the light may be absorbed. The energy of light is transformed into the energy of motion of molecules; or electrons in the molecules may be promoted to higher energy levels. The energy is eventually transformed into heat. This implies, when matter absorbs the light energy, its temperature is raised. In rare cases, a part of light may be emitted as light of a longer wavelength, and this gives rise to phenomenon of fluorescence. The most important source of color in organic compounds is absorption of light without subsequent emission [1].

Dyes should have suitable colors. They must be able to fix themselves or be capable of being fixed to the fabric. The fixed dyes must have fastness properties such as fastness to light, resistance to the action of water, dilute acids and alkalis, and various organic solvents used in dry cleaning. There is no systematic nomenclature of dyes and many dyes have names that have been given to them by the manufactures. So it is not unusual to find a given dye having several names, and generally each dye has a trade name or names [2]. Dyes are classified according to their chemical constitution or by their application to the fiber. The former is of theoretical value to the chemists, but of little importance to the dyers, who is mainly concerned with the reaction of dyes towards the fiber being used [2].

A pigment is a material that changes the color of reflected or transmitted light as the result of wavelength-selective absorption. This physical process differs from fluorescence, phosphorescence, and other forms of luminescence, in which a material emits light. Many materials selectively absorb certain wavelengths of light. Materials that humans have chosen and developed for use as pigments usually have special properties that make them ideal for coloring other materials. A pigment must have a high tinting strength relative to the materials it colors. It must be stable in solid form at ambient temperatures. For industrial applications, as well as in the arts, permanence and stability are desirable properties. Pigments that are not permanent are called fugitive. Fugitive pigments fade over time, or with exposure to light, while some eventually blacken [3]. Pigments are used for coloring paint, ink, plastic, fabric, cosmetics, food and other materials. Most pigments used in manufacturing and the visual arts are dry colorants, usually ground into a fine powder. This powder is added to a binder (or vehicle), a relatively neutral or colorless material that suspends the pigment and gives the paint its adhesion. A distinction is usually made between a pigment, which is insoluble in its vehicle (resulting in a suspension), and a dye, which either is itself a liquid or is soluble in its vehicle (resulting in a solution). A colorant can act as either a pigment or a dye depending on the vehicle involved. In some cases, a pigment can be manufactured from a dye by precipitating a soluble dye with a metallic salt. The resulting pigment is called a lake pigment. The term biological pigment is used for all colored substances independent of their solubility [3].

Figures (1) and (2) shows the most common chromophores (color appearing and/or carriers groups) and the most common auxochromes (color deepening and/or intensifying groups), respectively. Witt (1876) was the first to show that color usually appeared in a compound when it contained a group with multiple bonds. These groups are called chromophores e.g. NO_2 (nitro), NO (nitrozo), N=N (azo), quinonoid structure, etc. [2], Figure (1). Witt also observed that certain groups which although are not chromophres, deepened the color when being introduced into a colored molecule. These groups are called auxochromes, e.g. OH (hydroxyl), NH_2 (amino), NHR (alkyl amino), NR_2 (dialkyl amino), etc. [2], Figure (2).

Certain other unsaturated groups produce color only when several of them are present in a molecule and when these are conjugated bonds e.g. C=C (ethylene), C=O (carbonyl), C=S (thiocaronyl), C=N (azomethine), etc. [1], Figure (1).

So, chromophores can be classified to strong and weak chromophores due to their strength to impart and/or introduce color to a compound. Strong chromophore (NO_2, NO, N=N) is the group which when present singly is sufficient to give color to a compound. Weak chromophore (C=C, C=O, C=S, C=N) is the group which when present singly is not able to impart color to a compound [4].

I recommend this paper [1-8] review for anyone interested in the subject, chemistry libraries and also in the personal bookshelves of every organic aromatic and/or heterocyclic dyes chemists.

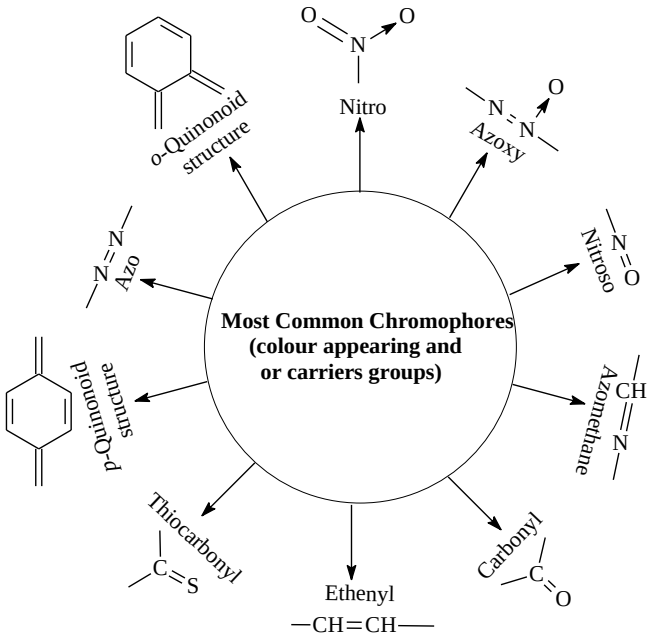

Figure (1)

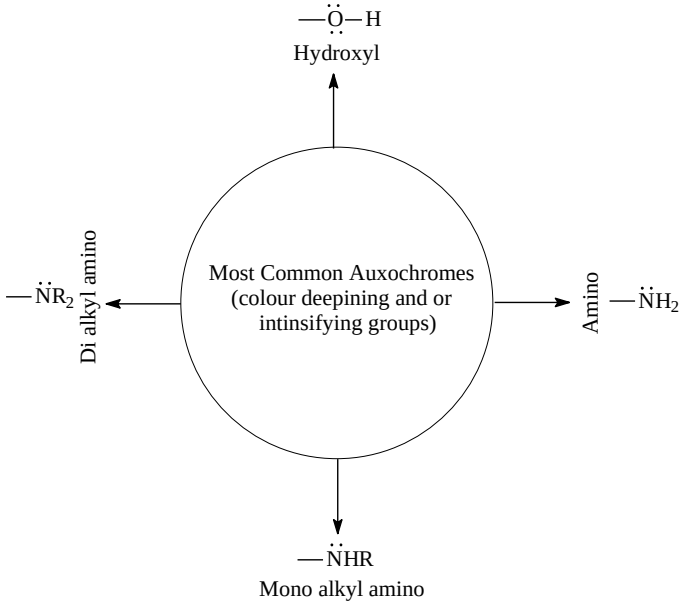

Figure (2)

Multi choice questions in colors, dyes and pigment chemistry:

1- OH group is the auxochrome in:

a- Picric acid;
b- Pinacyanol;
c- Gentian violet.

2- 1-Nitroso-2-naphthol is the scientific name of:

a- Green resorcin;

b- Green naphthol;
c- Yellow naphthol (Naphthol Yellow S).

3- Nitroso group is the chromophore in:
a- Green resorcin;
b- Yellow naphthol (Naphthol Yellow S);
c- Ethyl red.

4- 2,4-dinitroso-resorcinol is the scientific name of:
a- Orange II;
b- Acid red;
c- Green resorcin.

5- NO_2-groups are the chromophores in:
a- Chrysoidine;
b- Picric acid;
c- Kryptocyanine.

6- OH-groups are the auxochromes in:
a- Acid red;
b- Methyl orange;
c- Green resorcin.

7- Triethylorthoformate is used in the preparation of:
a- Kryptocyanine dye;
b- Ethyl red dye;
c- Apocyanine dye.

8- p-quinonoid structure is the chromophore in:
a- Orange II;
b- Green resorcin;
c- Auramine O.

9- Synthesized by coupling diazonium salt of sulphanilic acid with N,N-dimethylamino benzene:
a- Bismarck brown;
b- Methyl orange;
c- Chrysoidine.

10- OH groups are the auxochromes in:
a- Acid red dye;
b- Alizarin dye;
c- Methyl orange.

11- Prepared by condensing phthalic anhydride with catechol in the presence of concentrated H_2SO_4:
a- Alizarin;
b- Congo red;
c- Malachite green.

12- NH_2-groups are the auxochromes in:
a-Crystal violet;
b-Pararosaniline;
c-Indigotin.

13- 2,4-dinitroso-1-naphthol-7-sulphonic acid is the scientific name of:
a- Picric acid;
b- Yellow naphthol (Naphthol yellow S);
c- Orange II.

14- In acid media, methyl orange gives:
a- Two mesomeric structures;
b- Three mesomeric structures;
c- Four mesomeric structures.

15- p.quinonoid structure is the chromophore in:
a- Nitro and nitroso dyes;
b- Triarylmethane dyes;
c- Indigoid dyes.

16- $N(CH_3)_2$ groups are the auxochromes in:
a- Malachite green dye;
b- Dobener violet dye;
c- Roseaniline dye.

17- In acid media, congo red gives:
a- Two mesomeric structures;
b- Three mesomeric structures;
c- Four mesomeric structures.

18- p.quinonoid structure is the chromophore in:
a- Green resorcin;
b- Alizarin;
c- Green naphthol.

19- In acid media, methyl orange has:
a- Yellow color;
b- Red color;
c- Violet color.

20- In acid media, congo red dye gives:
a- Red color;
b- Orange color;
c- Blue color.

21- The color of phenolphthaleine in acid media is:
a- White and/or colorless;
b- Pink and/or red color;
c- Blue color.

22- Alizarin dye is used in:
a-Manufacturing of inks;
b-Coloring foods;
c-Coloring woods.

23- NH_2-groups are the auxochromes in:
a- Phenolphthaleine;
b- Congo red;
c-Erythrosine.

24- In Base media, methyl orange has:
a- Yellow color;
b- Green color;
c- Blue color.

25- Azo grop is the chromophore in:
a- Green naphthol;
b- Eosin;
c- Methyl orange.

26- Cyanine dyes are used in medicine as:
a- a laxative;
b- Antibiotics;
c- Antitumor and/or anticancer agents.

27- In base media, congo red has:
a- Red color;
b- Blue color;
c- Yellow color.

28- $N(Me)_2$ groups are the auxochromes in:
a- Methyl orange;
b- Phenolphthaleine sulphone;
c-Besmark brown.

29- The color of phenolphthaleine dye in base media is:
a- Green color;
b- White and/or colorless;
c- Pink and/or red color.

30- Azo groups are the chromophores in:

a-Indigotin dye;
b-Fluorescein dye;
c- Congo red dye.

31- 2,4-diamino-azo-benzene is the scientific name of:

a- Chrysoidine;
b- Acid Red;
c- Green resorcin.

32- NH_2-groups are the auxochromes in:

a- Bismarck brown;
b- Alizarin;
c- Phenolphthaleine.

33- Azo group is the chromophore in:

a-Fluorescein dye;
b- Chrysoidine dye;
c- Alizarin.

34- NH_2-groups are the auxochromes in:

a- Methyl orange;
b- Chrysoidine;
c- Picric acid.

35- Azo groups are the chromophores in:

a- Yellow naphthol;
b- Green naphthol;
c- Besmark brown.

36- Phenolphthaleine is used as:

a- Extremely powerful laxative;
b- Antiseptic agent;
c- anticancer agent.

37-Fluorescein is used as:

a- Anticancer agent;
b- A mild purgative;
c- Antitumor agent.

38- OH-group is the auxochrome in:

a- Orange II;
b- Crystal violet;
c- Gentian violet.

39- Azo-, Nitro- and SO_3H-groups are the chromophores in:

a- Acid red;
b- Green resorcin;
c- Orange II.

40- Chrysoidine is prepared by coupling benzene diazonium chloride (diazotized aniline) with:

a- o.phenylene diamine;
b- p.phenylene diamine;
c- m.phenylene diamine.

41- Gives orange-red color in acid media:

a- Phenolphthaleine;
b-Fluorescein.
c- Eosin.

42- NH_2 is the auxochrome in:

a- Methyl orange;
b- Acid red;
c-Erythrosine.

43- Azo- and SO_3H-group are the chromophores in:

a- Eosin;
b- Malachite green;

c- Orange II.

44- Gives strong and/or deep green color in base media:

a-Fluorescein;
b- Eosin;
c-Erythrosine.

45- OH-group is the auxochrome in:

a- Dobener violet;
b- Yellow naphthol (Naphthol Yellow S);
c- Pararosaniline.

46- Nitroso group is the chromophore in:

a- Green naphthol;
b- Acid red;
c- Bismarck brown.

47- The color of fluorescein in acid media is:

a- Green;
b- Orange-red;
c- Yellow.

48- Nitro and sulphonic groups are the chromophores in:

a- Yellow naphthol (Naphthol Yellow S);
b- Chrysoidine;
c- Green naphthol.

49- Reaction of 2 mole of 1-ethyl-quinaldinium iodide salts with triethylorthoformate in alcohol / basic solution gives:

a- 2,2-Trimethine cyanine dye;
b- 2,4-Trimethine cyanine dye;
c- 4,4-trimethine cyanine dye.

50- Reaction of 2 mole of 1-ethyl-lepidinium iodide salts with triethylorthoformate in alcohol / basic solution gives:

a- 2,4-Trimethine cyanine dye;
b- 4,4-Trimethine cyanine dye;
c- 2,2-Trimethine cyanine dye.

51- The color of fluorescein dye in base media is:

a- Red color;
b- Orange color;
c- Strong and/or deep green color.

52- Alizarin dye is:

a- 1,2-diamino anthraquinone;
b- 1,2-dihydroxy anthraquinone;
c- 1-amino-2-hydroxy anthraquinone.

53- Malachite green takes its name from:

a- Its constitution nature;
b- Its classification nature;
c- The fact that it has a deep blue-green color resembling that of the malachite (copper ore).

54- Chrysoidine dye is:

a- 2,4-diamino azo benzene;
b- 2,4-dihydroxy azo benzene;
c- 2-amino-4-hydroxy azo benzene.

55- Reaction of 2 mole of 1-ethyl-quinaldinium iodide salts with triethylorthoformate in alcohol / basic solution gives:

a- Pinacyanol;
b- Kryptocyanine;
c- Ethyl red.

56- Reaction of 2 mole of 1-ethyl-lepidinium iodide salts with triethylorthoformate in alcohol/basic solution gives:

a- Ethyl red;
b- Pinacyanol;

c- Kryptocyanine.

57- Reaction of 1-ethylquinolinium iodide salts with 1-ethylquinaldinium iodide salts in alcohol / basic solution gives:

a- Pinacyanol;
b- Ethyl red;
c- Kryptocyanine.

58- Synthesized within the fabric (i.e produced on the fibre) and may be applied to any type of fibre:

a- Ingrain dyes;
b- Disperse dyes;
c- Mordant dyes.

59- Gentian violet is used as:

a- Antitumor agent;
b- Antiseptic agent;
c-Coloring food.

60- Absorbance is due to:

a- Excitation of electron to higher energy level;
b- Emission of electron to lower energy level;
c- Fluorescence of electron.

61- Fluorescence is due to:

a- Excitation of electron to higher energy level;
b- Emission of electron to lower energy level;
c- Absorbance of electron.

62- Used as antiseptic agent:

a- Bismark brown;
b- Alizarin;
c- Gentian violet.

63- Pinacyanol sensitizes the emulsion of silver bromide to the:

a- Green region (350-600 nm);
b- Red region (350-710 nm);
c- Yellow region.

64- Ingrain dyes:

a- Synthesized within the fabric (produced on the fibre) and may be applied to any type of fibre;
b- Are those which are used in their reduced state;
c- Do not dye fibre directly, they require a mordant.

65- Kryptocyanine sensitizes the emulsion of silver bromide to the:

a- Green region (350-600 nm);
b- Red region (350-710 nm);
c- Infra-red radiation.

66- The disodium salt of Eosin has:

a- Two resonance forms;
b- Three resonance forms;
c- Four resonance forms.

67- The disodium salt of phenolphthaleine sulphone has:

a- Two resonance forms;
b- Three resonance forms;
c- Four resonance forms.

68- The disodium salt of Erythrosine has:

a- Two resonance forms;
b- Three resonance forms;
c- Four resonance forms.

69- The disodium salt of tetrabromophenolphthaleine has:

a- Two resonance forms;
b- Three resonance forms;
c- Four resonance forms.

70- The disodium salt of Mercurochrome has:
a- Two resonance forms;
b- Three resonance forms;
c- Four resonance forms.

71- Its chloride salt has four resonance structures:
a- Rhodamine B;
b- Eosin;
c-Erythrosine.

72-Fluorescein dye is:
a- Cationic dye;
b- Anionic dye;
c- Zwitter ion dye.

73- Leuco is a greek word which means:
a-Colorless and/or white;
b- Yellow;
c- Orange.

74- Monomethine cyanine dyes are also named:
a- Simple cyanine dyes;
b- Hemi cyanine dyes;
c- Styryl cyanine dyes.

75- Its disodium salt has two resonance structures:
a- Phenolphthaleine;
b-Fluorescein;
c- Eosin.

76- Its disodium salt has four resonance structures:
a- Phenolphthaleine;
b- Tetra bromophenolphthaleine;
c- Eosin.

77- Pentamethine cyanine dyes are also named:
a- Carbocyanine dyes;
b- Dicarbocyanine dyes;
c- Tricarbocyanine dyes.

78- Heptamethine cyanine dyes are also named:
a- Tricarbocyanine dyes;
b- Tetracarbocyanine dyes;
c- Pentacarbocyanine dyes.

79- The chromophores in indigotin dye are:
a- 2 C=O and/or 2 o.quinonoid charged structures;
b- Nitro and/or nitroso groups;
c- Azo- and/or SO_3H-group.

80- Its disodium salt has four resonance forms:
a- Fluorescein;
b- Phenolphthaleine sulphone;
c- Tetra bromophenolphthaleine sulphone.

81- Its disodium salt has two resonance forms:
a-Erythrosine;
b- Rhodamine B;
c- Phenolphthaleine sulphone.

82- The auxochromes in indigotin dye are :
a- 2 NH-groups;
b- 2 NH_2-groups;
c- 2 C=O-groups.

83- The chromophores in thioindigotin dye are:
a- 2 C=O and/or 2 o.quinonoid charged structure;
b- Nitro and/or nitroso groups;
c- Azo- and/or SO_3H-groups;

84-Phenolphthaleine dye is:

a- Cationic dye;
b- Anionic dye;
c- Zwitter ion dye.

85-Erythrosine dye is:

a- Anionic dye;
b- Cationic dye;
c- Zwitter ion dye.

86- The auxochromes in thioindigotin dye are:

a- 2 
b- 2 C=O.
c- 2 NH.

87- Orlon fibres are:

a- Polyamide fibres;
b- Polyester fibres;
c- Polyacrylonitrile fibres.

88- Its disodium salt has two resonance forms:

a-Erythrosine;
b- Eosin;
c- Tetrabromophenolphthaleine sulphone.

89- Its disodium salt has four resonance forms:

a- Rhodamine B;
b-Erythrosine;
c- Phenolphthaleine.

90- Eosin is:

a- Zwitter ion dye;
b- Cationic dye;
c- Anionic dye.

91- Phenolphthaleine sulphone is:

a- Cationic dye;
b- Anionic dye;
c- Zwitter ion dye.

92- Its disodium salt has four resonance forms:

a- Mercurochrome;
b- Phenolphthaleine;
c- Phenolphthaleine sulphone.

93- Tetrabromophenolphthaleine sulphone dye is:

a- Anionic dye;
b- Cationic dye;
c- Zwitter ion dye.

94- Mercurochrome is:

a- Cationic dye;
b- Anionic dye;
c- Zwitter ion dye.

95- Nylon 66 is formed via condensation polymerization reaction of hexamethylene diamine with:

a- Adipic acid;
b- Glutaric acid;
c- Malonic acid.

96- Nylon 610 is formed via condensation polymerization reaction of hexamethylene diamine with:

a- Adipic acid;
b- Sebacic acid.
c- Glutaric acid.

97- Nylon 6 is formed via self condensation of:

a- 6-amino hexanoic acid;

b- 6-amino octanoic acid;.
c- 6-amino heptanoic acid.

98- Orlon fibres are formed via polymerization of:

a- Acrylonitrile;
b- Acrylic acid;
c- Ethylene.

99- Nylon 66 is formed via polymerization condensation reaction of adipic acid with:

a- Hexamethylene diamine;
b- Heptamethylene diamine;
c- Tetramethylene diamine.

100- Nylon 610 is formed via polymerization condensation reaction of sebacic acid with:

a- Pentamethylene diamine;
b- Hexamethylene diamine;
c- Octamethylene diamine.

101- Nylon 6 is formed via self polymerization condensation reaction of:

a- 6-aminohexanoic acid;
b- 5-aminohexanoic acid;
c- 4-aminohexanoic acid.

102- Nylon 6 is formed via self polymerization condensation reaction of:

a- 6-aminohexanoic acid;
b- 6-hydroxyhexanoic acid;
c- 6-mercaptohexanoic acid.

103-The name cyanine (from the Greek Kyanos) was attributed to its:

a-Beautiful blue color;
b-Beautiful orange color;
c-Beautiful yellow color.

104-Thermochromism is the property of substance to change color due to a change in:

a-Solvent polarity.
b-Temperature.
c-pH media (hydrogen ion concentration).

105-Solvatochromism means change in the color of a substance due to a change in:

a-pH media (hydrogen ion concentration).
b-Solvent polarity.
c-Temperature.

106-Halochromism is the property of substance to change color due to a change in:

a-Temperature.
b-pH media (hydrogen ion concentration).
c-Solvent polarity.

The Answers

1- a- Picric acid.
2- b- Green naphthol.
3- a- Green resorcin.
4- c- Green resorcin.
5- b- Picric acid.
6- c- Green resorcin.
7- a- Kryptocyanine dye.
8- c- Auramine O.
9- b- Methyl orange.
10- b- Alizarin dye.
11- a- Alizarin.
12- b-Pararosaniline.
13- b- Yellow naphthol (Naphthol yellow S).
14- a- Two mesomeric structures.

15- b- Triarylmethane dyes.
16- a- Malachite green dye.
17- a- Two mesomeric structures.
18- b- Alizarin.
19- b- Red color.
20- c- Blue color.
21- a- White and/or colorles.
22- a-Manufacturing of inks.
23- b- Congo red.
24- a- Yellow color.
25- c- Methyl orange.
26- c- Antitumor and/or anticancer agents.
27- a- Red color.
28- a- Methyl orange.
29- c- Pink and/or red color.
30- c- Congo red dye.
31- a- Chrysoidine.
32- a- Bismark brown.
33- b- Chrysoidine dye.
34- b- Chrysoidine.
35- c- Bismarck brown.
36- a- Extremely powerful laxative.
37- b- A mild purgative.
38- a- Orange II.
39- a- Acid red.
40- c- m.phenylene diamine.
41- b-Fluorescein.
42- b- Acid red.
43- c- Orange II.
44- a-Fluorescein.
45- b- Yellow naphthol (Naphthol Yellow S).
46- a- Green naphthol.
47- b- Orange-red.
48- a- Yellow naphthol (Naphthol Yellow S).
49- a- 2,2-Trimethine cyanine dye.
50- b- 4,4-Trimethine cyanine dye.
51- c- Strong and/or deep green color.
52- b- 1,2-dihydroxy anthraquinone.
53- c- The fact that it has a deep blue-green color resembling that of the malachite (copper ore).
54- a- 2,4-diamino azo benzene.
55- a- Pinacyanol.
56- c- Kryptocyanine.
57- b- Ethyl red.
58- a- Ingrain dyes.
59- b- Antiseptic agents.
60- a- Excitation of electron to higher energy level.
61- b- Emission of electron to lower energy level.
62- c- Gentian violet.
63- b- Red region (350-710 nm).
64- a- Synthesized within the fabric (produced on the fibre) and may be applied to any type of fibre.
65- c- Infra-red radiation.
66- c- Four resonance forms.
67- a- Two resonance forms.
68- c- Four resonance forms.

69- a- Two resonance forms.
70- c- Four resonance forms.
71- a- Rhodamine B.
72- b- Anionic dye.
73- a-Colorless and/or white.
74- a- Simple cyanine dyes.
75- a- Phenolphthaleine.
76- c- Eosin.
77- b- Dicarbocyanine dyes.
78- a- Tricarbocyanine dyes.
79- a- 2C=O and/or 20.quinonoid charged structures.
80- a-Fluorescein.
81- c- Phenolphthaleine sulphone.
82- a- 2NH groups.
83- a- 2C=O and/or 2.0.quinonoid charged structure.
84- a- Cationic dye.
85- a- Anionic dye.
86-a- 2-S
87- c-Polyacrylonitrile fibres.
88- c- Tetrabromophenolphthaleine sulphone.
89- b-Erythrosine.
90- c- Anionic dye.
91- b- Anionic dye.
92- a- Mercurochrome.
93- a- Anionic dye.
94- b- Anionic dye.
95- a- Adipic acid.
96- b- Sebacic acid.
97- a- 6-amino hexanoic acid.
98- a- Acrylonitrile.
99- a- Hexamethylene diamine.
100- b- Hexamethylene diamine.
101- a- 6-aminohexanoic acid.
102- a- 6-aminohexanoic acid.
103-a-Beautiful Blue color.
104-b-Temperature.
105-b-Solvent polarity.
106-b-pH media (hydrogen ion concentration).

Conflict of interest:
There is no conflict of interes.

Conclusion

The developments of color theories in addition to dyes and pigments synthesis and their applications in textile and non textile multidisciplinary area is growing continuously and rabidly. Certainly, this will makes the present and/or the future of this branch of organic chemistry (color, dyes and pigments chemistry) is effective, fruitful and very bright.

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