

General framework for structuring introductions

Element	Function
CONTEXT	General statements about a field of research to provide a general context for the writer's study
REVIEW	Statements (ranging from 'general' to 'specific') about previous research to provide pertinent information for the writer's study
GAP	Statements about specific issues or limitations in previous research that motivated the writer's study
PURPOSE	Statements presenting the specific aim(s) of the writer's study

Sample 1

Timing of intermittent preventive treatment for malaria during pregnancy and the implications of current policy on early uptake in north-east Tanzania

\$1 Malaria infection during pregnancy has adverse consequences for both the woman and fetus, accounting for an estimated 26% of severe maternal anemia in sub-Saharan Africa [1] and causing an estimated 100,000–200,000 infant deaths each year through low birth weight [2,3]. **\$2** To address this burden, the World Health Organization recommends a package of interventions including intermittent preventive treatment (IPTp) with the antimalarial drug sulphadoxine-pyrimethamine (SP) at least twice during the second and third trimesters of pregnancy, use of insecticide-treated bednets (ITNs) and effective case management [4]. **\$3** The efficacy of IPTp in reducing maternal parasitaemia and anemia has been demonstrated in several studies [5-7], and the WHO strategy has now been adopted by almost all malaria-endemic countries in Africa [8].

\$4 In Tanzania, it is national policy to offer SP to all pregnant women attending antenatal clinics [9] at between 20 and 24 weeks gestation for the first dose and between 28 and 32 weeks for the second dose [10]. **\$5** It is estimated that uptake of IPTp amongst Tanzanian women who delivered in 2005/06 was 70% for one dose but only 35% for two doses [11]. **\$6** Previous studies have reported a range of factors associated with incomplete coverage of IPTp, including late first attendance at the antenatal clinic [12,13], shortages of staff or drug supply, poor health worker skills, informal charges for IPTp, and inequitable access to ANC services [12]. **\$7** Individual characteristics that have been found to correlate with no or incomplete IPTp uptake are multigravidity [14] and lack of knowledge of the consequences of malaria in pregnancy [15].

\$8 Relatively little is known about the timing of delivery of the first dose of IPTp to pregnant women, however this may influence whether subsequent doses are given and may also be important in terms of time spent at risk of malaria, given the growing evidence that malaria in early pregnancy may be the cause of a significant proportion of the burden of pregnancy-related

malaria. \$9 There is evidence that parasitaemia is highest in the second trimester of pregnancy [16] and that malaria infection during the first trimester may lead to low birthweight [17], and thus the efficacy of IPTp may depend not only on overall uptake, but also the time point during pregnancy at which it is received. \$10 This study examined the timing of delivery of IPTp to pregnant women attending antenatal clinics in northeast Tanzania, in the context of national, individual and facility-related determinants of timely uptake of IPTp.

I. Presenting the context

- General Area
- Sub-area(s)
- Key-topic(s)

Aim: to move from the general area to the sub-area(s) and/or the key topic in a focused way by giving only pertinent facts.

Sample 1.1

\$1 In a modern drinking water distribution system (DWDS), 99 percent of bacteria are likely to be in biofilms attached to the internal surfaces [8]. **\$2** Biofilm formation serves as a source of planktonic bacteria, some of which can cause infection and disease and sometimes accelerate the corrosion of metal pipelines. **\$3** As biofilm formation is unfavorable in DWDS, various strategies have been utilized to control it. **\$4** Among these strategies, chlorine and monochloramine treatments are the most widely used as they are efficient, economical and convenient to use. **\$5** Besides adding chemicals, proper management of the external environmental conditions is also widely used to control biofilm formation in DWDS. **\$6** Among these conditions, phosphorus has recently been identified as a limiting factor to the biofilm formation in DWDS. **\$7** However, so far, due to conflicting findings, the effects of phosphorus on biofilm formation are still subject of debate. **\$8** This chapter will provide a brief overview of the external environment conditions which affects the biofilm formation in DWDS and more attention will be given to effects of phosphorus on biofilm formation.

This introductory segment provides an overview with ideas from the 3 levels:

- General Area (Problems caused by biofilm formation in DWDS)
Should not be too broad in scope. For example, if open with a statement about the importance of water, the idea would be so broad that it would be difficult to narrow down quickly to ideas in the sub-area(s)
- Sub-area(s) (various strategies for controlling of biofilm formation)
- Key-topic (effects of phosphorus on biofilm formation)

Techniques for maintaining continuity of ideas

1. Transitions

to use transitional words or phrases. Such words and phrase 'tell' the reader how the current sentence relates logically to the adjacent sentences.

From sample 1.1 (modified version)

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From sample 1.1 (original version)

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2. Repetition

Using "repetition" effectively, benefits including

- 1). After encountering a word or phrase a few times in a text, you are alerted to the fact that **it is probably a key idea**.
- 2). Can easily locate the repeated words, thus can easily connect details associated with repeated idea in different sentences or paragraphs.

2a. exact repetition.

Sample 1.2 (Pharmacy) reproduced with key ideas highlighted

\$1 Disease management is knowledge-based integrative process intended to continuously improve the value of healthcare delivery at the lowest possible expenditures (Couch, 1998). **\$2** It coordinately incorporates various stakeholders (e.g., patients, practitioners, payers, policy makers, etc) in the value chain, with increasing focus on the perspectives and empowerment strategies of patients. **\$3** Despite heterogeneity, healthcare systems across Asia are facing severe problems of unsustainability, due to high prevalence of chronic diseases, pressure of cost containment and the need to improve the quality of healthcare (Cheah, 2001). **\$4** Hence, **disease management** has been increasingly recognized by most countries in Asia as very useful approach to tackle key problems. **\$5** The use of the approach in western countries has shown that success in **diseases management** depends on detailed evidence-based practice guidelines for practitioners and enhanced capability of self-management of patients. **\$6** Furthermore, it requires sound assessment models to provide robust results for practitioners and policy-makers for decision-making.

2b. repetition using pronouns and demonstrative pronouns.

pronouns: "they" and "It"

demonstrative pronouns: "this", "that", "these" and "those".

Task:

1. Make the following introduction smoother.

2. How did the positioning of repeated words affect the flow of ideas?

\$1 Computer numerical controlled (CNC) machining is a material removal process performed according to pre-generated codes, the NC codes, which contain coordinates information to guide the cutter in a reference coordinate system. **\$2** Generation of the NC codes is done according to the designed part CAD model. **\$3** A machined workpiece within allowed tolerances to the CAD model is produced using a final try-out that is determined from the essential step involving try-outs of the codes. **\$4** Before CNC machining simulation technology emerged, try-outs were usually produced by utilizing soft and inexpensive material to lower the manufacturing cost and shorten the cutting time. **\$5** Virtual reality (VR) based CNC matching simulation technology provides an alternative mechanism. **\$6** Designers and machinists are allowed to inspect the cutting process in a virtual environment (VE) and to request the cutting results, not only geometric but also physical results, interactively. **\$7** Numerous simulation systems have been introduced and are available off-the-shelf in the market now.

\$8 Augmented reality (AR), a term that is frequently mentioned nowadays, is a concept parallel to VR. **\$9** In an AR environment, virtual information (such as texts, images, and videos) is provided to the user by rendering them over the real world. **\$10** Through object-oriented illustrations and guidance provided, the user, with this combined world, has a better understanding of the environment.

II. Presenting the literature review

1. Organizing the review: establishing cohesion (jointed and focused).

Each section of the review should contribute to the understanding of the topic as a whole and you need to make the links explicit as you “bring together” different strands of prior research to present a coherent and cohesive review. At a more “micro” level, you need to identify the information that should be highlighted for each study or each group of studies.

Common links in review of prior work

Links or relationships	Common uses of the link and relationship
chronology	Begins with the earliest study or type of study and progresses to the latest development
Similarities or differences	Provides a basis for grouping studies according to similar or contrasting features e.g. in approach, methodology, material, and results
Cause-effect	Shows how a study or a group of studies provide(s) reasons, causes or effects in relation to specific aspects of other research
Problem-solution	Highlights how specific issues or problems of a study or a group of studies are addressed or solved in another study or group of studies

Sample 2.1 (Mechanical Engineering)

<p>\$1 In modeling damage and its progression in composite laminates, the material property degradation method can be applied at either the element level or the ply level. \$2 In element-level approaches, it is assumed that damage within an element has an effect on the material properties of that element only and thus degradation is done on an element-basis. \$3 In the studies by Chang et al. (1984, 1987), stiffness reduction is performed at the element level based on a 2-d progressive failure analysis of notched composite laminates. \$4 In the analysis, if matrix cracking is predicted, all material properties except E_x (where x refer to the fiber direction) of the damaged element are reduced according to a Weibull distribution, while the other two in-plane material properties (E_y and V_{xy}) are reduced to zero. \$5 One drawback of this model is that it does not differentiate the stiffness reduction associated with damage due to tensile loading from that due to compressive loading. \$6 In order to overcome this shortcoming, Kress (2005) developed a material degradation model in which the Young’s modulus E_x or E_y of damaged elements due to fiber or matrix failure under tensile loading was reduced to a very small fraction of the original value; these Young’s moduli remained unchanged for damaged elements under compressive loading.</p>	<p>\$1 outlines two different approaches.</p> <p>\$2 and \$3 highlight a common feature of the first approach.</p> <p>\$3 to \$6 review three studies that used the first approach</p> <p>\$3 to \$5 review two studies (by the same authors) that used the first approach.</p> <p>\$5 highlights a problem with the model being reviewed.</p> <p>\$6 signals a problem-solution link and reviews the study that solves the problem highlighted in the previous sentence</p>
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2. Critical evaluation

Three categories of comments

Positive	Achievements of particular studies
Negative	Existing limitations in the literature or weaknesses of particular studies
Neutral	Highlighting 'facts' such as deductions, inferences or implications that were not mentioned in the literature

Sample 2.2

...\$1 Some attempts have been made to reconcile these contradictions. \$2 Burt (2000) extended the structural holes theory by suggesting that the two forms of social capital are not necessarily contradictory, but rather play different roles. \$3 He argued that network closure could serve as one of the significant contingency factors for extracting the value of brokerage, and high performance can be achieved when network closure within the group is high and structural hole outside the group are rich. \$4 Baum and Ingram (2000) elaborated on the different roles and purposes of network structures, and proposed that closed networks serve the purpose of knowledge exploitation, and structural hole may be suitable for knowledge exploration. \$5 Recently, Brass et al. (2004) suggested that by "embedding networks into structures that generate trust" (P.806), the tension between Coleman's close network stance and Burt's structural holes theory can be resolved. \$6 This implies that studying structural embeddedness together with relational embeddedness may provide the way to a theoretical explanation to resolve the ongoing debate.

\$7 These recent efforts in reviewing social network studies (e.g., Brass et al., 2004) and exploring contingency factors (e.g., Burt, 2000; Baum and Ingram, 2000) have made social network literature internally more consistent and externally more powerful in explaining a broader domain of environment circumstances. \$8 However, as highlighted by McEvily et al. (2004), there is a noticeable gap in empirical research on knowledge protection despite its theoretical and practical importance.

\$6: neutral

\$7: positive

\$8: negative

\$9-13: highlight the specific gaps for the writer's study. These specific gaps provide the basis for the objectives of the study (\$14).

Phrases used for Evaluation

Commonly used phrases for positive evaluation	<p>... is highly significant in that it successful...</p> <p>... provides an effective/innovative way to...</p> <p>... is novel in terms of...</p> <p>... has/have far-reaching (wide — ranging) implications since...</p> <p>... provided the important insight that...</p>
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	<p>... is particularly promising because...</p> <p>... is noteworthy in that...</p> <p>... is a major milestone/breakthrough in the development of...</p> <p>... paved the way for...</p> <p>... provides a powerful tool for the study of...</p> <p>...comprehensive examination/discussion of...</p> <p>...is highly advantageous in that...</p> <p>... highly commendable for providing important information o...</p> <p>...has potential in that it possesses the advantage of...</p> <p>...a valuable/significant contribution to...</p>
Commonly used phrases for negative evaluation:	<p>A serious or major drawback with/of this approach is...</p> <p>The problem with this explanation/approach is...</p> <p>... explanation is not plausible since...</p> <p>... is limited to...</p> <p>...is not consistent with...</p> <p>...does not adequately account for ...</p> <p>...did not take into account...</p> <p>... did not consider...</p> <p>...overlooked/neglected/ignored an important ...</p> <p>... overstated/underestimated...</p> <p>... failed to address the question of...</p> <p>... failed to recognize...</p> <p>... is questionable/flawed since...</p>

III. Presenting the specific research gaps

Critical evaluation -> negative comments vs. research gaps:

Comments which involve negative evaluations in general should be distinguished from specific research gaps that lead to your research. Negative evaluations about aspects that will not be addressed in your study are defined as comments. On the other hand, negative evaluations that form the basis of the objectives of your study are known as specific gaps.

Statements presenting specific gaps should be concise and accurate, showing the need for the research that you are presenting in your paper or thesis. For a thesis, these statements may appear in different locations:

1. When there is one introduction chapter (i.e., when the literature review is presented in Chapter 1), specific gaps may be presented:
 - a. in different parts of the literature review if the specific gaps are drawn from reviews of

different strands of research. The specific gaps may appear at the end of each major section of the review or after a group of related studies (as illustrated in Sample 3.1) (Sample 3.2).

- b. at the end of the literature review if the specific gaps are drawn from the review as a whole (Sample 3.3).

Sample: 3.1 specific gaps at the end of a section of review

Although the literature on network structure has shed some light on how network may affect the development of firm capabilities, it ignores a potential source of contingency in the tie-capability relation. So far, it is now known whether the effect of network structure on capability building may vary depending on the content of network ties.

Sample: 3.2 specific gaps after a group of related studies

Currently, Rapid Estimate of Adult Literacy in Medicine (REALM) and Test of functional Health Literacy in Adults (TOFHLA) are the two most widely used diagnostic health literacy tests in the U.S. A major disadvantage of REALM is its inability to evaluate a patient's comprehension of the medical terms, as the patient may be able to pronounce the word correctly without understanding it (Speros, 2005). In comparison, TOFHLA is considered a golden standard for measuring functional health literacy (Baker et al., 1999). However, there is doubt that it lacks content validity among English-speaking patients in Asia, as its Medicaid-related contents may be unfamiliar to patients in this region. Therefore, in order to test the functional health literacy level of Asian patients, new tests need to be developed based on local contexts when validation of existing instruments is not feasible.

Sample: 3.3 specific gaps at the end of the entire literature review

Based on the above review of both traditional free trial product and the free trail software literature, it becomes obvious that the offer of FTS may have both beneficial and harmful effects on the software vendors. More importantly, whether the provision of free trial is persuasive in terms of the consumer's decision-making for purchase and can further contribute to the overall welfare of the software market remains unknown. Furthermore, there is little information about how the features of the target trial product may influence the trial process and decision making. Therefore, from the profit-oriented parties' perspective, it is highly imperative to find the most prominent influential factors which may induce the FTS adopters' purchasing behavior. Specifically, how software users use the FTS during its trial period and what kind of responses they will generate towards the FTS offer require investigation.

- 2. Specific gaps can be divided into the following broad categories.
 - a) Those related to inadequacies and limitations.
 - b) Those related to conflicting or controversial findings or ideas.
 - c) Those related to extension of ideas in new directions.

Sample 3.3(a) (Mechanical Engineering)

The experimental study of Thomas and Williams (2005) found that there exists a transition area from the irregular cell structure to the ultimate regular cell structure. However, due to limitations, in their experimental setup, they did not investigate the relationship between transition length and sloping oblique angle qualitatively. The aim of the present study was to use simulation technology to examine this relationship by imposing an existing detonation wave in the diverging/converging chambers with various oblique angles as the initial condition.

[Specific gap related to an inadequacy in a previous study]

Sample 3.3(b) (Biological Sciences)

In view of the results of the above studies, it is still controversial whether definitive HSCs migrate within the compartments or just emerge de nova. This study attempted to resolve the controversy by tracing definitive HSC using a fluorescence-uncaging-detection approach.

[Specific gap related to conflicting conclusions of previous studies]

Sample 3.3(c) (Industrial and Systems Engineering)

These studies have shown that the FTR planning framework proposed by Liu (2007) is able to determine the optimal stress level for conducting the FTR, given the sample size and test duration, while ensuring that the asymptotic variance of the ML estimate for the quantity of interest is minimized. In view of the robustness of the framework, it is worthwhile to extend the FTR planning framework and examine its applicability for scenarios where sample size and test duration do not remain constant.

[Specific gap related to extending previous research in a new direction]

IV. Presenting the aims and significance of your research

Examine Sample 4.1 and answer the following questions:

- At the beginning of the section on aims (Section 1.3), the author summarizes the research gaps (which have been discussed at relevant points in earlier literature review sections). Is there a need to summarize these gaps before presenting the aims of the study? Why or why not?
- Consider the format used for statements of specific gaps and statements of significance. Do you think the use of buffeted or numbered lists is appropriate? Why or why not?
- What does the writer suggest in the statements on the significance of the study?
- What do the statements of scope tell us about the study?

Sample 4.1

Specific gaps	<p>1.3. Objectives and Significance of the Study</p> <p>Research gaps for the current study of surface conductivity and gas sensing on carbon materials are summarized below:</p> <p>Since the mechanism for surface conductivity of hydrogen terminated surface on diamond is still unclear, different controversial models have been proposed. The mechanism becomes even more complex when different adsorbates instead of water are introduced to study the H-diamond conductivity.</p> <ul style="list-style-type: none"> ● Although hydrogen terminated diamond has been used as a sensor to detect various gases like ammonia, carbon monoxide, nitrogen monoxide, carbon monoxide, hydrocarbon, etc. its detailed mechanism has yet to be explored and understood. All models proposed currently are based on electron transfer doping model. It is debatable whether this model is able to show the surface conductivity change on hydrogenated diamond. ● There are two different models to describe the mechanism growth of corn-shape carbon nanofibres. However, none have used in situ high-resolution TEM to investigate its mechanism during growing process. ● Currently, there are few studies on kinetic and sensitivity of gas sensing on hydrogenated diamond and carbon nanofibres.
Aim	<p>The main aim of this study was to propose a surface conductivity mechanism on hydrogen terminated diamond to describe how the p-type hydrogenated diamond can be used as a sensor to detect toxic gases. The specific objectives of this research were to:</p> <ul style="list-style-type: none"> ● propose an alternative model for the mechanism of surface conductivity of hydrogenated diamond. ● study the reaction mechanism of various gases like oxygen, air, water

Significance	<p>vapor, ammonia, hydrocarbon, hydrogen, carbon tetrachloride, carbon tetrafluoride and carbon tetrabromide when adsorbed on hydrogenated diamond for sensor application.</p> <ul style="list-style-type: none"> ● investigate the proper mechanism growth of corn-shaped carbon nanofibres using in situ high resolution transmission electron microscopy. ● investigate the sensitivity and reaction kinetics of different gases on hydrogen terminated diamond surface and carbon nanofibres. <p>The results of this present study may have significant impact on both providing an alternative material as gas sensor device and understanding the theory behind:</p> <ul style="list-style-type: none"> ● the mechanism of surface conductivity on hydrogenated diamond and corn-shaped Carbon nanofibres growth. ● The reaction mechanism and kinetic of gas sensing on hydrogenated diamond and carbon nanofibres
Scope	<p>It is understood that using carbon materials as sensor is a new discovery and as such, there may be a few problematic issues involved. For example, the mechanism of surface conductivity changes when exposed to adsorbates and their reaction kinetics. The process on fabricating a gas sensor device is very complicated and involves many engineering issues, but these are not central to this study and hence are beyond the scope of this thesis.</p>

Commentary for Task 4.1

The section starts with a summary of the specific research gaps presented earlier in the Literature Review sections. This restatement of gaps serves to remind the reader of the problems or needs that have motivated the study. The summary enables the reader to quickly see the logical link between the specific gaps drawn from previous work and the specific aims of the present research i.e., how the aims match the specific gaps that have been established in the review. Such a summary is particularly helpful when specific gaps appear in different sections of the literature review since it makes reading easier for the reader as he/she need not search for the gaps in the earlier literature review sections, which can be lengthy and detailed.

The writer's presentation of statements of gaps, aims and significance of the study in the form of a bulleted list is helpful for readability. If the writer had presented these ideas in three paragraphs, the reader would need to read more carefully, i.e., the format would be less reader-friendly. For purpose statements, stating the general aim before moving on to the specific objectives helps improve clarity.

In the statements on significance, the writer highlights the possible contribution of the work for the research community providing the justification for carrying out the research. He makes two types of predictions about the research results:

1. the potential or expected practical benefits from possible applications of the research findings, and
2. how certain areas of knowledge in the field of research may be extended by the research findings.

The first point (an alternative material as gas sensor device) takes a practical orientation, while the second (understanding the underlying theory) reflects a theoretical orientation.

Statements of scope, which may not appear in a journal paper, are critical in a thesis as they show that the investigation is focused on what is essential, given the constraints of time and resources. In the statements of scope of the above sample, the writer shows that he is aware of the challenges since the use of carbon materials as sensor is still in the initial stage of development. The writer also highlights that the focus is only on the material used and that other related aspects (such as changes in mechanism of surface conductivity and engineering issues in the fabrication of the sensor device) are not considered because of time constraints.

1. Writing AIMS

When you write statements of purpose, it is important to distinguish between the 'what' (aims) and the 'how' (strategy, framework, procedure or methodology chosen). If a sentence includes both the 'what' and the 'how', remember that the 'what' (the aim) should be in a prominent position i.e. presented early in the sentence, before the 'how'. Consider the difference in focus in the following examples:

Example 4.2:

A three-dimensional LBM Fortran program incorporating different curved boundary condition treatments was used to study the blood flow through 3D real arterial bifurcation and circular tubes of different constrictions.

(Inappropriate focus)

学生课题练习(Correct focus ...)

The aim of the research was to study the blood flow through 3D real arterial bifurcation and circular tubes of different constrictions using a three-dimensional LBM Fortran program incorporating different curved boundary condition treatments.

2. Writing SIGNIFICANCE

Statements about the significance of your study are typically predictions in terms of **positive outcomes** that may emerge on the basis of results you had anticipated before you started on your research. When presenting such predictions, writers typically sound cautious, displaying a tentative attitude reflected by the use of modal auxiliaries or expressions indicating an appropriate degree of tentativeness. Note that the statements should not state the actual contributions derived from the results of your Study. The actual contributions will instead be presented later in the conclusion.

Example 4.3

Apoptosis plays important roles in many human diseases. Bax is known to be one of the key regulatory factors that mediate multiple death signals and Map-1 is a novel Bax-associating

protein. Therefore, the investigation of the regulatory roles of Map-1 in Bax-mediated apoptosis signaling pathway in this study **may extend** our understanding of the mechanism of Bax activation and function. If Map-1 is demonstrated to be an important factor for Bax activation and function, its post-translational regulation could **provide new avenues** for exploring novel therapeutic strategies for combating major human diseases.

3. Defining the SCOPE of your research

Statements of scope present the boundaries which '**confine**' your research so that it is manageable (considering time constraints and the availability of resources). These statements typically present **what is included in contrast to what is excluded** so as to clearly define the boundaries of the research. The boundaries are often associated with the choices you exercised as a researcher since you have some degree of control regarding what you want to exclude or include in your study. Justification is sometimes provided for the boundaries drawn.

Example 4.4

Like previous theoretical, numerical or experimental studies on blood flow, this study could not consider all the factors in the studies of blood flow. To simplify the problem, some assumptions were made in the study. Firstly, we assumed the blood is a Newtonian fluid, which is a common assumption in many blood flow studies since the blood usually behaves as a Newtonian fluid in large arteries, especially at moderate to high shear rates (Ku, 1997). For the study of blood flow through compliant vascular tube, we also assumed that the wall of vascular tube is rigid, which is also assumed in many blood flow studies. The third assumption, used in the part of the study of the flow through axisymmetric rigid vascular tubes, is that the flow field is axially symmetric. This assumption is valid for our laminar blood flow studies as it is known that the Reynolds number in artery is usually in range of 100-1000, which means that in most cases, the blood flow in artery is laminar.

4. Phrases used for statements of aim, significance and scope

Commonly used phrases for statements of purpose:

In the first/second/final part of this study/thesis ...
 The overall/main aim of...
 More specifically, the aims of this study/thesis ...
 This thesis proposes/discusses/presents...
 ... by comparing/evaluating/analyzing ...
 ... using the framework/strategy of ...
 ... an exploratory study ...
 ... a new approach/(theoretical) framework ...
 ... a detailed analysis of ...
 ... a systematic/comprehensive investigation of ...

Commonly used phrases for statements of significance:

... important/significant for several reasons ...

... may offer a clearer explanation for ...
... may contribute to a better understanding of ...
... may provide insights into ...
... may shed light on ...
... may provide guidelines for ...
... may lay the foundation of/for...
... may provide the basis for ...

(Note that 'may' is used in the above examples as an illustration; other modals may be more appropriate depending on the level of tentativeness associated with the predicted Contributions.)

Commonly used phrases for statements of scope

The focus of the study is...
... is/are not central to this study ...
... is/are discussed in less detail.
... is only discussed briefly.
... is excluded from this study.
... is not considered .
... is restricted to ...
... is beyond the scope of this study.
... assumes that ...
There is no intention to...
It is not the task of this study to ...

Exercise 1

The invention of optical microscope brings the development of cell biology and microbiology four hundred years ago. Our knowledge comes from the observations of different specimens directly, such as cell, tissue or body. The resolution of images is restricted by microscope and the wavelength of light: the wavelength shorter, the resolution higher. However, light has toxicity on cell and other samples when its wavelength is shorter than UV. Even with precise optical device, high refractive index medium and optimized experiment conditions, the resolution of standard optical microscope is still limited by the diffraction of light. In general, the lateral resolution is 200-300nm while the axial resolution is between 500 and 700nm. It is not enough to resolve many small sub-cellular structures.

For a long time, scientists attempted to break the diffraction limit. Synge proposed that use of lens whose N.A. is less than wavelength may improve the imaging of samples' surface in 1928. This theory was confirmed by Ash and Nichols for the first time in experiment, and then developed to near-field microscopy [1, 2]. Familiar one is total internal reflection fluorescence microscopy (TIRFM), suitable for imaging of structures less than 200nm close to the glass slides[3]. On the other side, far-field microscopy is also an important part of imaging techniques. Standing wave fluorescence microscope (SWFM)[4], 4 Pi confocal microscope, illumination Interference Microscopy (I2M), Incoherent Imaging Interference Microscopy (I3M) and combination of I2M and I3M (I5M)[5], all above were designed using interference of light to improve the conventional optical microscope. However, they did not meet the resolution requirements of biologists, resulting in less applications. Achieving super resolution is one of the biggest challenges to be solved in optics. During the recent twenty years, this problem got great breakthrough. The appearance of structure illumination microscopy (SIM)[6], saturated structure illumination microscopy (SSIM)[7] and stimulated emission depletion microscopy (STED)[8] bring the resolution into nanometer. In 2006, photoactivation localization microscopy (PALM)[9], stochastic optical reconstruction microscopy (STORM)[10] and fluorescence photoactivation localization microscopy (FPALM)[11], which relied on single molecule localization, were realized in three independent labs.

Breakthroughs in techniques often provide impetus for basic studies. The development of super-resolution microscopy absolutely offer powerful tools for us to understand biology further more. In this review, we will briefly present the basic principles of typical super-resolution microscopy above, summarize their features and differences, and illustrate their applications in biology with advanced researches.

Exercise 2

Recently, confocal microscopy (CM) has been widely used in many fields like biological research and medical diagnoses [1-3]. It has not only a submicron spatial resolution, but also optical sectioning capability to eliminate from images the background caused by out-of-focus light. This is achieved by introducing a small pinhole aperture to the detection plane which acts as a spatial filter to block highly scattered out-of-focus light. However, it severely suffers from a limited imaging depth penetration in thick tissue as a result of multiple scattering [4], which significantly reduces the spatial resolution. In order to retain high resolution in the deep tissue imaging, a number of gating methods have been implemented to sort out image-bearing unscattered or less-scattered photons to construct a high-quality image of an object embedded in a deep tissue, such as spatial gating methods [5], polarization gating methods [6], time gating methods [7], angle gating methods and coherence gating methods [8]. Focal modulation microscopy (FMM) is one of the spatial gating methods.

Specifically, FMM is an optical heterodyne technique based on the confocal framework, which is proposed to provide superior image contrast with sub-micron spatial resolutions at large penetration depths in highly scattering media such as biological tissues. To achieve this goal, FMM utilizes the coherence property of the light source. A spatial-temporal modulation scheme is used in the system to differentially phase modulate segments of the excitation beam. When these segments of the beam were focused by the objective lens, they generate an intensity modulation exclusively at the focal region. After demodulation of the collected fluorescence signal at the designated modulation frequency, We can discriminate the in-focus fluorescence from the multiple-scattered background, thus the signal to background ratio (SBR) can be greatly enhanced compared to confocal microscopy [9]. Previously, researchers have proved that FMM can be performed with various different geometries for the two illuminating beams, which must originate from non-overlapping apertures in the front focal plane of the objective. Particularly, they find that focal modulation microscopy with annular apertures (AFMM) can further enhance the back-ground rejection compared with D-shaped apertures (DFMM), and thus the penetration depth can be further extended [10]. What's more, polarization of the input light beam is also believed to have an impact on the performance of the FMM system.

The scalar diffraction theory is applicable only if the numerical aperture (NA) of the objective lens is not too high [11]. In case of high-NA objective lens, polarization effects cannot be neglected and thus vectorial diffraction theory must be applied [12]. According to our knowledge, many papers before were based on scalar diffraction theory. However, in general cases, high-NA aplanatic lens (AL) was preferred for better spatial resolution [13]. In the following section, we develop a theoretical model for FMM based on vectorial diffraction theory. Different polarization patterns are studied on AFMM to optimize the spatial resolution. Other properties, like integrated intensity and background rejection capability are also presented.